



**SAN BERNARDINO COUNTY
SOLID WASTE MANAGEMENT DIVISION**
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ADDENDUM NO. 3

**FINAL CLOSURE CONSTRUCTION IMPROVEMENTS
AT THE COLTON SANITARY LANDFILL**

JUNE 13, 2022

~~BIDS OPEN: 10:00A.M. JUNE 2, 2022~~

BIDS OPEN: 10:00A.M. JUNE 22, 2022

PLANS AND SPECIAL PROVISIONS:

- I. Amend anywhere within the construction drawings and technical specifications (and applicable sections of the project documents): ~~60-mil~~ **50-mil** LLDPE Super Gripnet Geomembrane”

AMEND THE SPECIAL PROVISIONS AS FOLLOWS:

- II. Delete and replace the entire Section 2G-A Alternative “A” LLDPE Geomembrane – Super Grip Net with the attached Section 2G-A Alternative “A” LLDPE Geomembrane – Super Grip Net 50 Mil Geomembrane.
- III. Delete and replace in its entirety Bid Schedule supplied in ADDENDUM 1 with the attached Bid Schedule Pages 23 thru 29 - ADDENDUM 3 (attached). Bids must be submitted on these sheets or will be deemed Non-responsive.
- IV. Delete and replace in its entirety the Construction Quality Assurance Plan found in Appendix A of the Special Provisions with the attached Construction Quality Assurance (CQA) Plan dated June 2022.

QUESTIONS:

- V. The following question(s) have been received by bidders:

Q1. Where can oversize material that is removed during foundation fill placement be stockpiled on site?
A1. Oversized material will be disposed of at the on-site reconsolidation area or at a designated location onsite determined by the Engineer.

Q2. Will contractors be allowed to construct access roads/ramps on the existing slopes or will import traffic be restricted to existing benches?

A2. Contractor will be allowed to construct access roads/ramps on the existing slopes with the following conditions:

1. Roads/ramps are to be removed at the end of the project, and
2. Cost for importing material used to construct the roads/ramps will be at the contractor's expense. However, if the material is incorporated into the design of the site and meets the import material specification, the County will pay for the material per the pertinent bid item. Contractor will not be allowed to "lose" the material over the landfill site.

Q3. Will foundation fill material that is placed to design contours on slopes be required to be placed in horizontal lifts and trimmed back or can slope fill be placed parallel to the slope face?

A3. Foundation fill material placed to design contours on slopes can be placed parallel to the slope face.

Q4. Please provide CAD files for the existing LFG wells and piping and the proposed LFG wells and piping.

A4. Please submit an email request directly to Johnny.Gayman@dpw.sbcounty.gov. A link will be provided where you can download the files.

Q5. Is the contractor allowed to work on new LFG piping and well installation in more than a 4 acre section if the existing LFG system is not shut down?

A5. Yes, contractor will be allowed to work on new LFG piping and well installation in more than 4 acres sections. However, the existing LFG system must remain in operation.

Q6. Where is the designated disposal area for existing piping that is not salvageable?

A6. LFG piping that is not salvageable shall be disposed of at the reconsolidation area, crushed and broken up with compaction equipment with 12" of cover material placed on top.

Q7. Is there a DBE goal / good faith effort required for this project?

A7. There is no DBE goal or good faith effort required for this project.

The addition of these requirements shall be considered in concert with existing documents in preparation of bids. If you have any questions, please contact Johnny Gayman at (909) 386-8688.

Marc A. Rodabaugh

MARC RODABAUGH, P.E.,
Solid Waste Management Division

**Section 2G-A Alternative “A”
LLDPE Geomembrane – Super Grip Net
50 Mil Geomembrane**

SECTION 2G-A – ALTERNATIVE “A”
LLDPE GEOMEMBRANE – SUPER GRIP NET
50-MIL GEOMEMBRANE

1.0 GENERAL

This section sets forth the requirements for installation of the linear low-density polyethylene (LLDPE) geomembrane component of the Final Cover System.

A Construction Quality Assurance (QA) Plan (Appendix A) has been developed in conjunction with this Project and is included with these Technical Specifications for the Contractor's reference. The Contractor shall assure that the Engineer/CQA Monitor or the Engineer/CQA Monitor's designated representative, shall always have safe access to the work for the purpose of monitoring, observation, and QA Plan implementation.

An independent Engineer/CQA Monitoring firm, under contract to the Owner, will conduct Quality Assurance (QA) monitoring, observation, and documentation. The Contractor shall coordinate and cooperate with the Engineer/CQA Monitor during all sampling, testing, and certification required by these Technical Specifications.

1.1 Minimum Contractor Qualifications

"Prime Contractor" shall submit the Alternative "A" LLDPE/CT installation subcontractor's minimum qualifications to SWMD as follows:

1. Minimum qualifications of Closure Turf™ Installation Subcontractor include being an installer as certified by WatershedGeo for installation of Closure Turf™.
2. Sand placement is a specialized activity for which the Geosynthetics Subcontractor may hire an experienced subcontractor. The minimum qualifications for the sand infill placement subcontractor include that the installer must be certified by WatershedGeo for Installation of ballast sand.

1.2 Work Included

The specified LLDPE geomembrane shall be furnished and installed as shown on the Plans and as required herein for proper installation and functioning of a final cover system for partial final closure of a municipal solid waste landfill. The specified geomembrane consists of a 50-mil thick, LLDPE geomembrane, Super Grip Net Material manufactured by Agru America that will be placed in intimate contact with an underlying prepared foundation soil layer constructed in accordance with Section 2D - Earthwork, of these Technical Specifications.

The Contractor is advised that acceptance and approval of the geomembrane is a phased process that includes manufacturer's certifications, manufacturer's quality control testing, conformance testing, and destructive seam testing. In addition, the installation of LLDPE Geomembrane and other geosynthetic components must be performed in conjunction with earthwork phasing, on an iterative basis as described in Section 2D– Earthwork, as such, multiple move-ins, multiple deployments, and multiple piping and collection system installation, geosynthetic operations (i.e. drainage feature construction, LFG vents and LFG trench/collection galleries/wells/vents, anchor trenches/LFG collection trench, LLDPE geomembrane, separator geotextile, LLDPE boots, rock ballast material placement on benches, etc.) over portions of the total LLDPE Geomembrane

installation area are a requirement of this project. This shall require substantial schedule coordination between Contractor and liner installation sub-contractor. By executing the Contract for which these Technical Specifications are Contract Documents, both the Contractor and his designated Liner Sub-Contractor recognize that the responsibility for coordination, scheduling, and cost for the multiple move-ins, multiple deployments, and multiple geosynthetic operations are shared by the Contractor and his designated Liner Sub-Contractor. There will be no schedule adjustments or extension of contract days resulting from failure by either party to perform. Liquidated damages for each calendar day beyond the specified number of working days will be assessed in accordance with Book 1, Section 4-1.02. It is also a requirement of these Technical Specifications that the manufacturer's certification(s), and quality control test results for the geomembrane, raw resin, and extrudate rod or bead shall be received (by official submittal), reviewed, and approved by the Engineer/CQA Monitor prior to shipment of these materials to the site. It is the Contractor's responsibility to provide the Engineer/CQA Monitor with all the required documentation and test results specified herein.

1.3 Quality Control (QC) Testing

Quality Control (QC) testing is the responsibility of the Contractor and shall consist of manufacturer's certification testing, conformance testing, and destructive seam testing. All QC testing and certification shall be performed in accordance with these Technical Specifications and all costs associated with QC testing shall be borne by the Contractor.

1.4 Submittals Required

The Contractor shall thoroughly review the Technical Specifications and identify all required project submittals. The submittals listed below are intended as a general summary of the submittal items contained in this section. This submittal list does not release the Contractor from the responsibility of identifying and providing all information requested.

- Installation schedule for Completion of the Work – Schedule shall address the installation of LLDPE Geomembrane and other geosynthetic components to be performed in conjunction with earthwork phasing, on an iterative basis as described in Section 2D – Earthwork. Installation schedule shall also address any multiple move-ins, multiple deployments, multiple piping and collection system installation, and geosynthetic operations (i.e. Drainage Feature construction, LFG Vents and LFG Trench/Collection Gallery/Well/Vents, Anchor Trench/LFG Collection Trench, LLDPE Geomembrane, Separator Geotextile, LLDPE boots, rock ballast material placement on benches etc.) over portions of the total LLDPE Geomembrane installation area that are a requirement of this project.
- Product Data – LLDPE Geomembrane.
- LLDPE Geomembrane Certification.
- Manufacturer's Certification (Attachment 2G-A-1).
- Manufacturer's Quality Control Testing.
- Identification of independent testing laboratory accredited by the Geosynthetic Accreditation Institute (GAI).
- LLDPE Geomembrane Samples.
- Certified conformance and destructive seam test results.
- Manufacturer's Warranty Sample.

- Manufacturer's Warranty Independent Testing Laboratory GAI Certification.
- Manufacturer's Certification of Extrudate Rod or Bead.
- LLDPE Geomembrane Delivery Notification.
- Subgrade Certification.
- Proposed Panel Layout.
- Contractor's Geomembrane Installation Procedures.
- Contractor's Installer Resume.
- Quality Control Technician Resume.
- Material Conformance Testing.
- Schedule for Completing the Work.
- Survey Verification Drawings as required pursuant to Construction Surveying Section of these Specifications.
- Record Drawings (As-built).
- LLDPE Geomembrane Installer's Daily Documentation.
- Manufacturer's Quality Assurance Plan.
- Manufacturer's Installation Quality Assurance Plan.
- As built panel layout.
- Contractor Final Quality Control Records.
- Contractor's Installation Quality Control Plan.
- Rock Ballast Material Certificates of Compliance

2.0 MATERIALS

2.1 Geomembrane Resin

2.1.1 General

Resin for the geomembrane shall be virgin, first quality LLDPE resin produced in North America and compounded and manufactured specifically for the purpose of producing LLDPE geomembranes for landfill closures. There shall be no intermixing with other resin types. Reclaimed polymer shall not be added to the geomembrane resin. The manufacturer may recycle edge trim from the roll being produced. Edge trim shall be returned immediately to the process but shall not exceed 2 percent of the total resin required. Edge trim which has been stored and edge trim from other manufacturing lines shall not be recycled.

2.1.2 Physical Properties

LLDPE resin shall meet the following minimum specifications:

TEST	TEST METHOD	UNIT	REQUIREMENTS
Density*	ASTM D-1505	g/cc	0.939
Resin Properties	ASTM D1248	% virgin polymers	97
Melt Flow Index	ASTM D-1238 Condition E	g/10 min	<1.0
ASTM - American Society for Testing and Material * Base resin density without carbon black added.			

2.1.3 Resin Manufacturer Certification and Testing

One set of tests shall be performed per batch of resin. At a minimum, the geomembrane manufacturer shall sample and test each compartment of each rail car or truck to ensure that product purity was maintained during shipment. Certified test results shall be submitted to and approved by the Engineer/CQA Monitor at least 15 working days prior to shipping geomembrane to the site.

2.2 Geomembrane Rolls

2.2.1 General

Geomembrane rolls shall be new, first quality seamless linear low-density polyethylene (LLDPE) manufactured in North America specifically for the purpose of this project. The geomembrane rolls shall have no holes, pinholes, bubbles, blisters, gels, nicks, cuts on liner edges, or contamination by foreign matter. Geomembrane shall be supplied in rolls; folding shall not be permitted. All additives shall be thoroughly dispersed throughout the geomembrane.

2.2.2 Geomembrane - Super Grip Net

50-mil LLDPE Super Grip Net shall have physical properties that equal or exceed the minimum average values specified in Table 2.2.2, (and must meet or exceed the most recent GRI GM 17 values). The texturing shall be micro-spike with a minimum Asperity Height of 175 mil (4.45 mm.), and Drainage stud height of 130 mil (3.30 mm.), or approved equivalent, with the texturing and drainage stud uniformly distributed on the surface of the sheet.

TABLE 2.2.2

SUMMARY OF 50-MIL SUPER GRIPNET LLDPE GEOMEMBRANE MANUFACTURER'S QUALITY ASSURANCE (MQA)				
PHYSICAL PROPERTY	METHOD	UNIT	REQUIREMENT	FREQUENCY
Thickness (nominal, min. ave.) Thickness (min. ave.) Thickness (lowest individual – 8 out of 10) Thickness (lowest individual – 10 out of 10)	ASTM D 5994	mils	50 47.5 45 42.5	Per Roll
Drainage Stud Height (min. ave.)	ASTM D 7466	mils	130	Every 2 nd Roll ⁽¹⁾
Spike Height mils (min ave.)	ASTM D 7466	mils	175	Every 2 nd Roll ⁽¹⁾
Formulated Density (max.)	ASTM D 792 Method B	g./cc.	<0.939	Every 500,000 square feet
Tensile Properties (min. ave. both directions) ⁽²⁾ • Break strength– lb/in. (2 in/min) • Break elongation - %	ASTM D 6693 Type IV	lb./in. % (GL=2.0 in.)	75 250	Every 50,000 square feet
2% Modulus (max.)	ASTM D 5323	lb./in.	3000	Per formulation
Tear Resistance (min. ave.)	ASTM D 1004	lb.	27	Every 100,000 square feet
Puncture Resistance (min. ave.)	ASTM D 4833	lb.	55	Every 100,000 square feet
Carbon black content %	ASTM D 4218 ⁽³⁾	%	2.0 to 3.0	Every 100,000 square feet
Carbon black dispersion (Category)	ASTM D 5596	N/A	Note (4)	Every 100,000 square feet
Oxidative Induction Time (OIT) (min. ave.) ⁽⁵⁾ (a) Standard OIT – min.; or (b) High Pressure OIT – min.	ASTM D 8117	min.	100 400	Every 500,000 square feet
Oven Aging at 85°C ⁽⁶⁾ % retained after 90 days (a) Standard OIT (min. ave.) (b) High Pressure OIT (min. ave.)	ASTM D 5721 ASTM D 5885	%	35 60	Per formulation
UV Resistance ⁽⁷⁾ (b) High Pressure OIT (min. ave.) - % retained after 1600 hrs ⁽⁸⁾	ASTM D 7238 ASTM D 5885	%	35	Per formulation

1. Alternate the measurement side for double sided textured sheet.
2. Machine Direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens in each direction.
 - Break elongation is calculated using a gage length of 2.0in. at 2.0 in./min.
3. Other methods such as D1603 (tube furnace) or D 6370 (TGA) are acceptable if an appropriate correlation to D4218 (muffle furnace) can be established.
4. Carbon black dispersion (only near spherical agglomerates) for 10 different views:
 - 10 in Categories 1 or 2 and 0 in Category 3
5. The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.
6. It is also recommended to evaluate samples at 30 and 60 days to compare with the 90-day response.
7. The condition of the test should be 20 hr. UV cycle at 75°C followed by 4hr. condensation at 60°C
8. UV resistance is based on percent retained value regardless of the original HP-OIT value.

2.2.3 Quality Control – Minimum Lot/Batch

Geomembrane shall be monitored throughout the manufacturing process for product integrity and consistency. The manufacturer shall sample rolls for the following physical properties and at the minimum frequency, or per batch of resin, in accordance with GRI –GM 17, whichever results in the greatest number of tests:

- o Geomembrane Density
- o Geomembrane Thickness

- o Carbon Black Content
- o Carbon Black Dispersion
- o Tensile characteristics (break strength, break elongation)
- o Puncture resistance
- o Tear Resistance
- o Asperity Height

To minimize the number of conformance samples and tests, the minimum batch or lot size allowed for geomembrane rolls furnished on this project will be 50,000 square feet.

Certified test results shall be submitted to and approved by the Engineer/CQA Monitor at least fifteen (15) working days prior to geomembrane delivery to site. The Contractor shall submit a list which indicates date of production, plant location, resin batch number, manufacturing line number and identification number and square footage of each geomembrane roll. Rolls shall be listed in the order of production with the status of the roll (rejected or approved for shipment). All rolls shall be included in the list whether or not approved for shipment to the project. This information will be used by the Engineer/CQA Monitor to affix rolls to a specific 50,000 square foot, or smaller, lot for conformance testing per applicable portions of this Section.

2.2.4 Roll Identification

Each roll shall be labeled or tagged with the roll identification number, product identification number, name of manufacturer, date and location of production, product type and grade, lot number, and physical dimensions. The label or tag information shall be affixed or attached to the roll at all times during deployment of the roll.

2.2.5 Geomembrane Samples

The Contractor shall submit for approval by the Engineer/CQA Monitor samples of geomembrane material(s) and field seams prior to the start of construction. The Contractor shall submit six 8-inch x 10-inch samples of geomembrane material(s) and six samples of field seams which have been made in conformance with these Technical Specifications. The field seam samples shall be fabricated by the Contractor using the same materials, equipment, and procedures proposed for the geomembrane installation. Samples shall be 12-inches wide, plus the seam width, and 19-inches long. The samples shall be numbered and dated.

Where optional procedures are noted in the test method, the requirements of the Project Specifications shall prevail. Material property values and/or test methods shall be in accordance with the latest revision of GRI GM17 (or as otherwise noted).

2.2.6 Quality Control (QC) Program

The geomembrane manufacturer and the Contractor, each, shall submit a complete description of their quality control program, as applicable, for manufacturing, handling, installing, testing, repairing, and providing a completed lining in accordance with requirements of these Technical Specifications. The description shall include, but not be limited to:

- o Polymer resin supplier.
- o Product identification.
- o Acceptance testing.
- o Fabrication and production testing.
- o Installation testing.
- o Documentation of changes.

- Alterations and repairs.
- Retests and acceptance.

2.2.7 Plant Inspection

A representative of the Owner or Engineer/CQA Monitor may visit the manufacturing plant at any time during the project to observe and inspect the manufacturing process and quality control monitoring, sampling and testing. The Contractor shall notify the Engineer/CQA Monitor at least five working days prior to the start of manufacturing. The Engineer/CQA Monitor will notify the Contractor at least 48 hours in advance of all visits. The Contractor shall be responsible for making all necessary arrangements for the visits with the manufacturer. All costs of travel, lodging and meals incurred by the Owner or Engineer/CQA Monitor will be borne by the respective party. The purpose of the manufacturing plant inspection will be to observe the manufacturing process and the quality control procedures instituted at the manufacturing plant and not for monitoring or observing conformance sampling.

It is also a requirement of these Technical Specifications that conformance sampling will be performed at the manufacturing plant. Costs associated with conformance sampling at the manufacturing plant shall include travel and per diem expenses incurred by the Engineer/CQA Monitor in the performance of such testing and all costs for transporting the samples to the independent testing laboratory.

In lieu of the Engineer/CQA Monitor witnessing all conformance sampling, the Contractor may utilize the services of an independent laboratory accredited by the Geosynthetic Accreditation Institute (GAI) to perform conformance sampling and inspections at the manufacturing plant.

2.2.8 Sampling and Testing Frequency

Unless otherwise specified above, conformance samples shall be taken and tested as outlined in Table 2.2.2.

2.2.9 Warranty

The geomembrane manufacturer shall furnish a written liner warranty on a prorata basis for a period of five years. The warranty shall be against manufacturing defects or workmanship and against deterioration due to ozone, ultraviolet light rays, and/or other normal weather aging.

The warranty shall be limited to replacement of material only and shall not cover installation of said material. It shall not cover damage due to vandalism, acts of animals, earthquakes, and other unusual acts of God.

2.2.10 Manufacturer's Certification

The Contractor shall submit to the Engineer/CQA Monitor for approval, written Manufacturer's Certification (Attachment 2G-A-1) that the geomembrane:

1. Conforms to the material requirements of these Technical Specifications.
2. Is similar to and of the same formulation as that for which certification is submitted.
3. Has been demonstrated by actual usage to be satisfactory for the intended application.

Manufacturer's certification shall include the minimum average roll values for material to be furnished on this project. The Contractor shall obtain Engineer/CQA Monitor's approval of the geomembrane prior to shipment to the site. The Contractor will not be allowed to unload or store

on site any geomembrane that is delivered prior to obtaining such approval.

2.3 Extrudate Rod or Bead

2.3.1 General

The extrudate rod or bead shall be LLDPE and shall be of the same formulation and same supplier as the resin used to produce the geomembrane. All additives shall be thoroughly dispersed throughout the extrudate rod or bead. There shall be no contamination by foreign matter in the extrudate rod or bead.

2.3.2 Physical Properties

The extrudate rod or bead shall meet the following specifications:

TEST	TEST METHOD	UNITS	REQUIREMENT
Density	ASTM D-1505	g/cc	0.939 (minimum)
Low Temperature Brittleness	ASTM D-746 Procedure B	F	-40
Carbon Black Content	ASTM D-1603 Procedure B	%	2 to 3
Melt Flow Index	ASTM D-1238, Condition E	g/10 min	0.1 - 0.3
ASTM - American Society for Testing and Materials			

2.3.3 Manufacturer Certification and Testing

One set of tests shall be performed per batch of extrudate rod or bead. Certified test results shall be submitted to and approved by the Engineer/CQA Monitor at least fifteen (15) working days prior to shipping the extrudate rod or bead to the site.

3.0 CONSTRUCTION METHODS

3.1 Shipping, Handling and Storage

3.1.1 General

Geomembrane shall be shipped, stored, and handled in accordance with the manufacturer's recommendations and as specified herein. The Contractor shall be completely responsible for shipping, handling, and storage of all geomembrane. The geomembrane rolls shall be delivered to the site only after the Engineer/CQA Monitor receives and approves, in writing, the submittal information required in these Technical Specifications.

3.1.2 Shipping

The Contractor shall notify the Engineer/CQA Monitor at least twenty-four (24) hours prior to scheduled delivery of materials on site. All deliveries shall be made during normal working hours, Monday through Friday, unless specifically authorized by the Engineer/CQA Monitor. No materials shall be unloaded except in the presence of the Engineer/CQA Monitor or the Engineer/CQA Monitor's representative. Geomembrane delivered to the site shall be inspected for damage and unloaded and stored with minimal handling.

After delivery, the Contractor, Geomembrane Installer, and the Engineer/CQA Monitor shall complete a surface observation of all rolls for defects or damage. Damaged rolls shall be

separated from undamaged rolls until proper disposition of material is determined by the Engineer/CQA Monitor. The Engineer/CQA Monitor will be the final authority on the determination of damage.

3.1.3 Handling

No hooks, tongs, or other sharp tools or instruments shall be used for handling geomembrane. Contractor shall use cloth chokers and spreader bars for loading and unloading and spreader bars and roll bars for deployment. Geomembrane shall not be folded or dragged along the ground.

3.1.4 Storage

Geomembrane shall be protected from soil, mud, dirt, debris, puncture, cutting, or other damaging or deleterious conditions. Geomembrane rolls shall not be stored on wooden pallets. Geomembrane shall not be stacked more than three (3) rolls high. Storage shall be in accordance with the manufacturer's recommendations.

3.2 Supporting Surface

3.2.1 Acceptance of Soil Subgrade

No geomembrane shall be installed until the supporting surface has been inspected and approved for geomembrane installation by the Engineer/CQA Monitor. The Contractor shall correct all deficiencies found in the subgrade prior to deployment of the geomembrane at no additional cost to the Owner. In addition, the geomembrane installer shall inspect the subgrade and shall certify, in writing, that the subgrade is acceptable for geomembrane installation. The Contractor shall maintain responsibility for subgrade maintenance in accordance with the Specification requirements until completion of the liner installation.

3.2.2 Maintenance

The Contractor shall maintain the surface suitability and integrity of the foundation soil finished grade until installation of the geomembrane is completed and accepted by the Engineer/CQA Monitor. The foundation soil finished grade shall be maintained in a condition that maintains moisture content and provides for a firm and unyielding condition. Vehicle tracking, disruption of foundation soil finished grade surface, etc., caused by driving of equipment over the prepared foundation soil finished grade shall be repaired by the contractor prior to placement of geomembrane. Once finished grade of the foundation layer is obtained, geomembrane placement over the finished section is required to commence within 24 hours.

3.3 Geomembrane Installation

3.3.1 Installation Submittals

The Contractor shall submit the following:

- Installation drawings.
- Description of installation procedures including subgrade maintenance.
- Installation schedule for Completion of the Work – Schedule shall address the installation of LLDPE Geomembrane and other geosynthetic components to be performed in conjunction with earthwork phasing, on an iterative basis as described in Section 2D – Earthwork. Installation schedule shall also address any multiple move-ins, multiple deployments, multiple piping and collection system installation, and geosynthetic

operations (i.e. multiple move-ins, multiple deployments, and multiple piping and collection system installation, geosynthetic operations (i.e. Geocomposite Drainage Collector, LFG Geocomposite Vents (Below Geomembrane), LFG Passive Vents and LFG Trench/Wells, Vents, LLDPE Geomembrane, ClosureTurf, LLDPE boots, and outlet piping, etc) over portions of the total LLDPE Geomembrane installation area that are a requirement of this project.

Installation drawings shall show a field panel lining sheet layout with proposed size, number, position, and placement sequence of all sheets and indicating the location of all field seams and anchors. Installation drawings shall also show complete details and/or methods for anchoring the liner at its perimeter, making field seams, and making anchors/seals to pipes and structures penetrating the liner.

A field panel (sheet) is an area of geomembrane which is to be seamed in the field (i.e., a field panel is a roll, or a portion of roll cut in the field). The geomembrane installer shall assign each panel over 25 square feet an identification code which shall be agreed to and used by the Engineer/CQA Monitor and the Contractor. The Contractor shall locate the code with roll number near the middle of the panels less than 50 feet in length and at both ends of panels over 50 feet in length.

3.3.2 Material Inspection

Prior to installation, the Contractor shall visually inspect all geomembrane for imperfections, faulty or suspect areas and possible damage. All such defective geomembrane shall be marked, repaired, and/or tested. Geomembrane that cannot be repaired shall be removed from the work area and replaced at no additional cost to the Owner. Contractor shall inspect and replace faulty material that requires more than one patch per 2,000 square feet of geomembrane deployed at no additional cost to the Owner. Patches required for destructive testing will not be included in this tabulation.

3.3.3 General

The Contractor shall thoroughly review the manufacturer's recommendations for proper installation procedures of the specified material. The Contractor shall consult with the manufacturer's representatives regarding site specific and environmental impacts which may affect the installation. Such items as adequate or allowable slack, timing of anchor completion to minimize creep, and temperature considerations shall be reviewed, and appropriate action shall be taken by the Contractor to assure intimate contact between subgrade and geomembrane upon placement of overlying material. Temperature considerations for amount of slack left at the toe of slope at benches shall be evaluated for the time of year (i.e., weather conditions - cold or heat), by the Contractor to avoid "trampolining" (too taught, not enough slack), or folded material (too loose, too much slack) to minimize weather-related material cutting to either eliminate folded material, or having to add material, and the resulting additional welding necessitated thereby.

The number of panels deployed on one day shall be limited to the number of panels which can be seamed, or tack welded on the same day.

Contractor shall use equipment which does not damage geomembrane or the supporting subgrade surface.

All personnel working on geomembrane shall wear shoes that do not damage the geomembrane.

No personnel shall be allowed to engage in activities that could damage the geomembrane.

Clamps and other metal tools used in the work area shall have rounded edges with no sharp corners. Clamps and other metal tools shall not be tossed or thrown.

Panels shall be unrolled using a method that protects geomembrane from scratches and crimps and protects the foundation soil finished grade from damage.

Contractor shall minimize wrinkles, especially differential wrinkles between panels.

Contractor shall place adequate temporary hold-downs to prevent uplift by wind. Hold-downs shall not damage geomembrane and shall be continuous along edges to minimize risk of wind flow under panels.

Contractor shall protect geomembrane in heavy traffic areas using geotextile, extra geomembrane (sacrificial), or other suitable materials. Material used for protection shall be temporary and shall not be used as any part of the permanent installation.

Contractor shall not allow vehicle traffic on geomembrane surface.

3.3.4 Weather Conditions

3.3.4.1 Temperature

Ambient temperature, measured six inches above geomembrane surface, shall be logged every two hours. Geomembrane shall be deployed between ambient temperatures of 40 degrees F to 105 degrees F and when the relative humidity is less than 80 percent. Deployment of geomembrane below 40 degrees F shall only be allowed after it has been verified that the material can be seamed according to these Technical Specifications and is approved by the Engineer/CQA Monitor. When the temperature is below 50 degrees F, preheating by hot air device one inch in front of the extruder shall be provided. Special test welds may be required to verify that weather conditions are not adversely impacting seam quality.

3.3.4.2 Precipitation / Moisture

The geomembrane shall not be deployed during precipitation, in the presence of excessive moisture, or in areas of ponded water. Exceptions to these restrictions may be granted with approval of the Engineer/CQA Monitor and on condition that adequate steps (such as shelters) are taken by the Contractor to produce high quality seams meeting the requirements of this Section.

3.3.4.3 Wind Protection

The geomembrane shall not be deployed in the presence of excessive winds. The Contractor shall protect the geomembrane against adverse effects of high winds (such as uplift). Sandbags may be used for this purpose. Sandbags shall be sufficiently close knit to preclude fines from working free of the bottom, sides, or seams. Paper bags, whether or not lined with plastic, shall not be permitted. Burlap bags, if used, shall be lined with plastic. Sandbags shall contain not less than 40, nor more than 60, pounds of sand having 100 percent passing a #8 screen. Sandbags shall be tied closed after filling, using only plastic ties. Metal or wire ties shall not be allowed. Sandbags that are split, torn, or otherwise losing their contents shall be immediately removed from the work area and replaced and any spills immediately cleaned up.

3.3.5 Miscellaneous Liner Details

Installation of the Final Cover System includes the construction of various terminations, anchors, berms, interceptor trenches, tie-downs, and other appurtenances as indicated on the Plans. All work associated with, and required for, the completion of these items is to be considered as included in the Contractor's unit prices.

3.4 Seams

3.4.1 General

Seams shall be oriented vertically up and down the slopes, not horizontally across the slopes. Each seam shall be numbered and seam numbering system compatible with the panel numbering system shall be used. The number of field seams in corners, off-shaped geometric locations, and outside corners shall be minimized.

Panels shall be overlapped as recommended by the manufacturer. Only procedures that do not damage the geomembrane and that are not detrimental to seam weld material shall be used to temporarily bond adjacent panels together.

All edges, laps, junctions, shall be welded, whether a specific note or detail on the drawings indicates a weld.

3.4.2 Physical Properties

Geomembrane seams shall be tested in accordance with ASTM D-6392 and shall meet or exceed the following minimum requirements and those described in the current GRI-GM19a for LLDPE Geomembranes:

TEST	TEST METHOD	REQUIREMENTS 50-mil LLDPE Geomembrane
Hot Wedge Seams	ASTM D-6392	75
Shear Strength (lb./in)		50
Shear Elongation (%)		63
Peel strength (lb./in)		25
Peel Separation (%)		
Extrusion Fillet Seams	ASTM D-6392	75
Shear Strength (lb./in)		50
Shear Elongation (%)		57
Peel strength (lb./in)		25
Peel Separation (%)		

3.4.3 Seam Preparation

The following steps shall be followed in preparing seams:

- Clean surface of grease, moisture, dust, dirt, debris, or other foreign material.
- Clean surface of oxidation by disc grinder or equivalent not more than 1 hour before seaming (not required for wedge welding).
- Use No. 80 grit sandpaper for disc grinder.
- All areas where grinding is evident shall be repaired with a method approved by the Engineer/CQA Monitor.
- Cover with single extrudate any bead grooves.
- Use soft bristle brush after grinding if brushing required.
- Do not use wire brush after grinding.

- Cut wrinkles and "fishmouths" along ridge.
- Overlap and seam wrinkles and fishmouths.
- Patch wrinkles and fishmouths where overlap is less than three (3) inches.
- Use firm, dry substrate (piece of geomembrane or other material) directly under seam overlap where subgrade is soft.
- Use plywood or other firm material under seam overlap when welding over anchor trench.

3.4.4 Extrusion Welding

As necessary, welding apparatus shall be purged of heat-degraded extrudate before welding if extruder is stopped for longer than three minutes. All purged extrudate shall be disposed of off the geomembrane. Extrudate rod shall be removed from welder when welder is idle for over two hours.

Each extruder shoe shall be inspected daily for wear to ensure that its offset is the same as the liner thickness. Worn shoes, damaged or misaligned armature brushes, nozzle contamination, or other worn or damaged parts shall be repaired or replaced prior to further usage.

Stop-start welding shall be avoided. Existing welds or welds more than five minutes old shall be ground two inches back from point of stoppage or two inches on each side of identified leaks before welding. Weld shall be restarted two inches on each side of identified leaks or two inches back from point of stoppage.

No equipment will be allowed to commence welding on liner until the trial weld, made by that equipment, has been approved by the Engineer/CQA Monitor.

Components shall be mounted on a mobile unit for interface extrudate welding. The following accessories shall be included as a minimum:

- Variable speed control.
- Wheels with non-skid surface on LLDPE.
- Directional control.
- Automatic hot air system for preheating welding surfaces.
- Extruder system with appropriate die.
- Four adjustable contact pressure rollers.

The "hot air system" shall be tested and set up using scrap material each day prior to commencing seaming. Hot air velocity shall be adjusted to account for wind effects. Contact pressure rollers shall be adjusted to prevent surface ripples in sheet.

3.4.5 Hot Wedge Welding

Welding apparatus shall be automated vehicular mounted device equipped with gauges giving applicable temperatures. The welding apparatus shall be equipped with a temperature gauge.

A smooth insulating plate or fabric shall be placed beneath to hold welding apparatus after usage. Protective fabric or piece of geomembrane shall be placed beneath hot welding apparatus when resting on geomembrane.

Moisture build-up between sheets shall be prevented.

No equipment will be allowed to commence welding on liner until the trial seam, made by that equipment, has been approved by the Engineer/CQA Monitor. All welding conducted at the

Contractor's discretion, prior to trial seam results, shall be at the Contractor's risk. Trial seam failures shall be tracked as outlined under "Trial Seams".

A minimum of one spare operable welding apparatus shall be maintained for each three seaming teams.

An electric generator shall be provided that can provide a constant voltage for the anticipated combined line load. The electric generator shall generally be located outside the liner limit. Protective lining and splash pads large enough to catch spilled fuel shall be placed under electric generator when located on the liner.

3.4.6 Trial Seams

Trial seams shall be demonstrated on pieces of geomembrane liner to verify adequate seaming conditions. Trial seams shall be conducted on each piece of equipment in service, at the following frequency:

- At beginning of each seaming shift (5 hours maximum start of day and mid-day).
- Any time a piece of equipment is shut down for more than thirty minutes.
- At least one per shift for each welding technician performing seaming.
- As weather conditions dictate, and at Engineer/CQA Monitor's request.

Welding technicians shall not change parameters (temperature, speed, wheel adjustment) without successfully performing another trial weld.

Trial weld shall be constructed adjacent to the area to be seamed. Trial welds shall be in contact with subgrade or geotextile (same condition as the liner to be seamed).

The trial weld sample shall be at least 3-feet long and 12-inches wide with the seam centered lengthwise. Two 1-inch-wide specimens shall be cut by the Contractor in the presence of the Engineer/CQA Monitor and the specimens obtained near each opposite end of trial weld seam. Specimens shall be quantitatively tested first, for peel adhesion, and then for bonded seam strength (shear).

Seam breaks will be analyzed for shear and peel strength in accordance with the requirements of GRI Test Method GM19 Table 2(a) and the requirements of Section 3.4.2 of these Technical Specifications. A trial weld passes when both test specimens pass peel and shear tests.

Testing shall be repeated in its entirety if one or more of the specimens fails the peel or shear tests. If trial weld testing fails, the seaming apparatus and operator shall not be used for welding until deficiencies or conditions are corrected and two consecutive successful field test seams are achieved (two specimens in peel and two specimens in shear). All weld seams made by seaming apparatus prior to failure of trial weld shall be checked. Starting back from last seam made, check seams at minimum 10-foot intervals until two consecutive seam tests pass. Seam shall be reconstructed to the satisfaction of the Engineer/CQA Monitor.

3.4.7 Repairs

Holes smaller than 1/4-inch shall be repaired by extrusion welding. The surface of the geomembrane shall be ground to a minimum one inch around hole immediately before welding. Seams shall be vacuum tested after each welding. Result of test, date of test, and name of quality control technician shall be marked on the geomembrane adjacent to the seam.

Holes larger than 1/4-inch, tears, blisters, undispersed raw material, and contamination by foreign matter shall be patched. Patches shall be round or oval and made of the same material as the geomembrane. Patches shall extend a minimum of six inches (beyond the edge of defect) and shall be a minimum of 12 inches in diameter. Edge of the patch shall be beveled. Patch shall not be cut with repair sheet in contact with geomembrane. Patch shall be welded to the geomembrane with an approved method and vacuum tested. Result of test, date of test, and name of quality control technician shall be marked on the patch.

Contractor's daily documentation of non-destructive and destructive testing shall be provided to the Engineer/CQA Monitor's on-site representative. The documentation shall identify seams which were repaired and retested successfully.

3.5 Construction Quality Control (QC)

3.5.1 General

The Contractor shall designate a full-time Quality Control (QC) Technician to be responsible for supervising and/or conducting the construction QC program. The QC Technician shall have quality control experience on five million square feet of geomembrane. The resume for the QC Technician shall be included in the qualifications package submitted for the Engineer/CQA Monitor's review. The QC Technician shall not be replaced without written authorization by the Engineer/CQA Monitor. All field QC testing shall be performed in the presence of the Engineer/CQA Monitor.

3.5.2 Visual Inspection

All seams shall be visually evaluated by the Contractor as the installation progresses and again at completion of the installation. Defective and questionable sections shall be clearly marked and repaired as necessary.

3.5.3 Vacuum Box Testing

The continuity of extruded field seams, beads, and patches shall be tested over their entire length using vacuum box test units. The vacuum test shall be performed concurrently with seaming work, not at completion of seaming.

The vacuum box shall be an American Vacuum Seam Tester, Series A100 as manufactured by American Parts and Service Company, Alhambra, California, or an approved equal. The vacuum box assembly shall consist of the following:

- Rigid housing.
- Transparent viewing window.
- Soft rubber gasket attached to bottom of housing.
- Porthole or valve assembly.
- Vacuum gage.

A vacuum pump and tank equipped with pressure controller and pipe connections, rubber

pressure/vacuum hose with fittings and connections, clean, dry, soft rags, plastic bucket and applicator, water, and detergent to produce soapy solution shall also be provided.

The vacuum testing procedure shall be as follows:

- Clean window, gasket surfaces, and check for leaks.
- Energize vacuum pump and reduce tank pressure to a minimum of five (5) psi.
- Wet a strip of geomembrane weld approximately 12-inches by 30-inches (length of box) with soapy solution.
- Place box over wetted area and compress.
- Close bleed valve and open vacuum valve.
- Ensure that a leak-tight seal is created.
- For a period of not less than fifteen seconds, examine length of weld through viewing window for presence of soap bubbles.
- If no bubbles appear after fifteen seconds, close vacuum valve and open bleed valve, move box over next adjoining area with minimum 3-inch overlap of previous test section and repeat process.
- Areas where soap bubbles appear shall be marked, repaired, and retested.

The following procedures shall be used at locations where seams cannot be vacuum tested:

- Where possible and/or required, cap-strip seams with same geomembrane.
- If seam is accessible to testing equipment prior to final installation, vacuum test seam prior to final installation.
- Seaming and cap-stripping operations shall be observed by the Engineer/CQA Monitor for uniformity and completeness.
- Spark testing shall be conducted around all boots and extrusion welding to cast in concrete weld strips.

3.5.4 Air Pressure Testing

The Contractor shall test all dual-hot wedge seams in the LLDPE geomembrane by using the air pressure test which consists of inserting a needle with gauge in the air space between welds. Air shall be pumped to 40 psi within the weld void and held for at least five minutes. If the pressure loss exceeds 2 psi within the weld void during air pressure testing, the outside weld edge (not free edge) shall be sprayed with a soap solution and visually examined for bubbles. If no bubbles appear, the problem is with the inside weld and the seam is acceptable. If any bubbles appear, the defect shall be repaired by extrusion welding and tested by vacuum box and/or spark detector.

If pressure loss is not more than 2 psi, the opposite end of the seam will be punctured to release the air. If a blockage is present, it will be located and tests on both sides of the blockage will be completed. All penetration holes created during testing shall be sealed by patching and extrusion welding.

Equipment shall be as follows:

- Air pumps equipped with pressure gauge capable of generating and sustaining a pressure at 40 psi and mounted on cushion to protect geomembrane.
- Rubber hose with fittings and connections.
- Sharp hollow needle or other pressure feed device approved by the Engineer/CQA Monitor.

The air pressure testing shall be as follows:

- Seal both ends of the seam to be tested.
- Insert a needle or other approved pressure feed device into tunnel created by double hot wedge seaming and insert a protective cushion beneath air pump above geomembrane.
- Pressurize air chamber to 40 psi and sustain pressure for a minimum of five minutes.
- Demonstrate air test seam continuity by puncturing end opposite pressure-feed device.
- If loss of pressure exceeds 2 psi or does not stabilize, locate faulty area and repair as appropriate.
- Retest failed areas as appropriate.
- Remove approved pressure feed device and patch.

3.5.5 Spark Testing

If a fillet weld is used to weld seams, the Contractor may, in lieu of vacuum box testing, test seams and repairs in the geomembrane by using a high voltage spark detector, similar to Tinker and Rasor Holiday Detector (Model AP-W). The setting of the detector shall be 20,000 volts. All seams to be tested shall be provided with 24-30-gauge copper wires properly embedded in the seams and grounded. All spark testing shall be done in the presence of the Engineer/CQA Monitor. All defective areas shall be marked for repair.

3.5.6 Final Seam Inspection

For final seaming inspection, seams and surface of geomembrane shall be checked for defects, holes, blisters, undispersed raw materials, and signs of contamination by foreign matter. The geomembrane surface shall be brushed, blown, and/or washed if dirt inhibits inspection. The Engineer/CQA Monitor shall decide if cleaning of geomembrane surface and welds is needed to facilitate inspection. The Contractor shall distinctively mark, preferably with paint, repair areas and indicate required type of repair.

3.6 Construction Quality Control/Conformance Testing

Conformance and destructive seam testing will be conducted by an independent testing laboratory certified by the Geosynthetic Accreditation Institute (GAI), selected by the Contractor and approved by the Engineer/CQA Monitor. Test results of the independent testing laboratory will be considered final. All costs associated with conformance and destructive seam testing sampling, shipping, and testing by the independent testing laboratory will be borne by the Contractor.

3.6.1 Conformance Sampling, Testing and Reporting

The Contractor shall obtain all conformance samples directly from the manufacturing plant, under the observation of the Engineer/CQA Monitor, or as approved by the Engineer/CQA Monitor, pursuant to Section 2.2.10. Conformance samples shall be taken and tested at a rate of one per lot, or one per 100,000 square feet, whichever results in the greater number of tests.

Samples shall be taken across the entire width of the roll and shall not include the first three (3) feet. Unless otherwise specified, samples shall be three (3) feet long by the roll width. The Engineer/CQA Monitor shall mark the machine direction on the samples with an arrow, and the geomembrane manufacturer's roll identification number.

At a minimum, conformance tests will include determination of the following characteristics for the LLDPE:

- Thickness (ASTM D5994)
- Tensile characteristics (break strength, elongation at break) (ASTM D6693)
- Puncture resistance (ASTM D4833).
- Tear Resistance (ASTM D1004)
- Density (ASTM D1505/D792)
- Carbon black content (ASTM D1603)
- Carbon Black Dispersion (ASTM D5596)
- Asperity (GM 12)

Where optional procedures are noted in the test method, the requirements of the Project Specifications shall prevail.

A conformance sample that yields any tested property less than the specified average minimum roll property will be recorded as a failure. The portion of the manufactured lot represented by the failing conformance sample/test will be considered non-conformant with the Project Specifications and the material rejected for use on the project.

The minimum number of specimens tested will be determined in accordance with ASTM Standards. Certified test results of the independent laboratory shall be submitted for approval by the Engineer/CQA Monitor following the requirements set forth in these Specifications. Final approval of the geomembrane shall be contingent upon certification of test results which meet or exceed the requirements of these Technical Specifications.

3.6.2 Destructive Seam Testing

The Contractor shall visually inspect, mark, and repair suspicious-looking welds before release of a section to the Engineer/CQA Monitor for destructive seam testing. The Contractor shall provide the Engineer/CQA Monitor with a minimum of one destructive sample per 500 linear feet of seam length for destructive seam testing. Destructive seam testing will be performed by the GAI certified, independent testing laboratory, and all testing costs will be paid by the Contractor. The sample location shall be selected by the Engineer/CQA Monitor and the Contractor shall not be informed in advance of the sample location. Samples shall be cut as seaming and non-destructive testing progresses, and prior to completion of liner installation. Samples shall be marked with consecutive number and location seam number. Contractor shall record, in written form, the date, time, location, seam number corresponding roll number, welding apparatus identification number, and ambient temperatures at time seam was welded. This information shall be delivered to the Engineer/CQA Monitor with the destructive samples. The Engineer/CQA Monitor shall observe acquisition of all destructive samples. The Contractor shall immediately repair holes in geomembrane resulting from obtaining destructive samples and vacuum box test the patches.

The size of destructive samples shall be as follows:

- Two 1-inch wide by 12-inch long (plus seam width) for field testing
- One 12-inch wide by 36-inch long for laboratory testing

The sample shall be cut into three equal parts and distributed as follows:

- Independent Lab
- Contractor

- Engineer/CQA Monitor (Archive)

The destructive seam testing will be as follows. The two 1-inch-wide samples shall be tested in the field for peel adhesion and bonded seam strength (shear) by the Contractor and shall pass the strength requirements established in Section 3.4.2. If one or both of the samples fails in either peel or shear, the Contractor can, at his/her discretion, either: (1) reconstruct or cap strip the seam between passed test locations or, (2) take another test sample 10-foot from the point of the failed test and repeat this procedure.

If the second test passes, the Contractor shall reconstruct, or cap strip the seam between the two passed test locations.

If subsequent tests fail, the procedure is repeated until the length of the poor-quality seam is established. Repeated failures indicate that either the seaming equipment and/or operator is not performing properly, and appropriate action shall be taken.

Once the field tests have passed, the lab sample shall be recovered from between passing field sample locations for testing by the independent testing laboratory.

All specimens of a field weld sample tested by the independent testing laboratory shall pass. If any specimen fails, the entire sample shall be considered as a failure and the field weld shall be rejected. In this event, the field seam(s) shall be rejected as being non-conformant with the Technical Specifications and corrective measures shall be implemented.

For destructive samples which have failed, corrective measures shall include a rerun of the weld test using the same sample. If the second test passes, the Engineer/CQA Monitor may assume an error was made in the first test and the field seam may be accepted. If the second test fails, the Contractor shall reconstruct or cap strip the field seam between any two previous passed seam locations which include the failed seam or shall go on both sides of the failed seam location (10-foot minimum), take another sample each side and test both in the independent laboratory.

If both samples pass, the Contractor shall reconstruct, or cap strip the field seam between the two passing locations. If either fails, the Contractor shall repeat the process of taking samples for testing by the independent testing laboratory. In all cases, acceptable field seams must be bounded by two passed test locations. In cases involving more than 50 feet of reconstructed or cap stripped seam, the reconstructed or cap stripped seam shall also be tested. The results of the independent testing laboratory govern seam acceptance. In no case shall field testing of installed seams be used for final acceptance.

Testing shall include peel and shear strength (ASTM D6392). At least five specimens each shall be tested for peel and shear. Minimum test values are presented in Section 3.4.2 of these Technical Specifications.

The Contractor's laboratory test results shall be presented to the Engineer/CQA Monitor for comments.

3.7 Record Drawing

In addition to providing survey data from which final pay quantities shall be determined, the Contractor shall submit information required in the preparation of the record drawings for the final cover system (See Section 2B-Construction Support Tasks, Paragraph 1.11 Survey for additional project survey requirements). This data shall include:

- **Coordinates and elevations of all constructed area finish subgrade, top of foundation soil**

layer placement, (prior to placement of final cover system) and completed final cover surfaces to enable surveyor to verify soil component layer thicknesses and to develop final cover certification drawings.

- Coordinates and elevations of all LFG facilities to properly locate the as-built position on record drawings.
- Coordinates and elevation of all limits of LLDPE Geomembrane to properly locate the as-built position on record drawings.
- Coordinates and elevation of all HDPE Boots to properly locate the as-built position on record drawings.
- Coordinates and elevation of all corners for drainage facilities to properly locate the as-built position on record drawings.
- Coordinates and elevations for flow line of drainage ditches, at a center to center spacing not to exceed 25 feet or otherwise approved by Engineer. The edge of the channel where it adjoins any other structure (e.g., perimeter access road) shall be surveyed at the same spacing.

The survey and record drawing requirement for this project will necessitate that the Contractor be prepared to perform survey work daily during the Geomembrane installation phase of the work, to accurately document the as-built condition of the various components of the system. (See Section 2B – Construction Support Tasks, Paragraph 1.11 Survey and required deliverables under Paragraph 1.11.7).

4.0 MEASUREMENT AND PAYMENT

4.1 50 mil LLDPE Super Grip Net Geomembrane (Alternative “A”) - (Slopes/Benches) Per Detail 1/D1- Item No. 9A

The contract unit price paid per square foot for 50 mil LLDPE Super Grip Net Geomembrane – Slope and Benches shall include full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved with installation of 50 mil LLDPE Super Grip Net Geomembrane - Slope and Benches complete and in place, as shown on the Plans, as specified in the Standard Specifications and these Technical Specifications, and as directed by the Engineer/CQA Monitor

Final pay quantities will be determined by verifying the actual surface area, from approved Record Drawings of the 50 mil LLDPE Super Grip Net Geomembrane - Slope and Benches placed to the limits indicated on the Plans (Overlap at seams and material in the anchor trench will not be measured separately for payment). All transitions shall be included in the contractor’s unit price. The boot for the standpipe shall also be included in the Contractor’s unit price. Work performed outside the limits indicated on the Plans, or reflected in the Technical Specifications, will not be compensated unless previously approved by the Engineer/CQA Monitor. Interim progress payments will be based on the Construction Manager’s evaluation of the estimated percentage of work completed during the subject period.

4.2 50 mil LLDPE Super Grip Net Geomembrane (Alternative “A”) - (Deck) Per Detail 1/D1- Item No. 9B

The contract unit price paid per square foot for 50 mil LLDPE Super Grip Net Geomembrane - Deck shall include full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved with installation of 50 mil LLDPE Geomembrane - Deck, complete and in place, as shown on the Plans, as specified in the Standard

Specifications and these Technical Specifications, and as directed by the Engineer/CQA Monitor Final pay quantities will be determined by verifying the actual surface area, from approved Record Drawings of the 50 mil LLDPE Super Grip Net Geomembrane - Deck placed to the limits indicated on the Plans (Overlap at seams and in anchor trenches will not be measured separately for payment). All transitions shall be included in the contractor's unit price. Work performed outside the limits indicated on the Plans, or reflected in the Technical Specifications, will not be compensated unless previously approved by the Engineer/CQA Monitor. Interim progress payments will be based on the Construction Manager's evaluation of the estimated percentage of work completed during the subject period.

4.3 Anchor Trench Per Detail 3/D2, 4/D2, 2/D7, and 7/D7 (Item 9C)

The contract unit price paid per lineal foot for Anchor Trench shall include full compensation for furnishing all labor, materials, tools, equipment, and incidentals and for doing all work involved in Anchor Trench including and all excavation, grading, geosynthetic materials, backfill, compaction, 1-Foot by 2-Foot Concrete Anchor Trench Cap and other appurtenances as shown on the plans, as specified in the Standard Specifications and these Special Provisions, and as directed by the engineer.

Final pay quantities shall be determined by computing the actual lineal footage of Anchor Trench placed to the limits indicated on the Plans and shall include those Anchor Trenches pursuant to Details 3/D2, 4/D2, 2/D7, and 7/D7 (geosynthetic materials shall not be measured separately for payment).

4.4 Liner Termination Anchor – (Extrusion Welding at Tri-Lock Embedment Strip/Alternative “A” Batten Strip for Closure Turf or Geotextile) Per Details 4/D5, 1/D6, 2/D6, and 3/D6 (Item 9D)

The contract unit price paid per lineal foot for Liner Termination Anchor – (Extrusion Welding at Tri-Lock Embedment Strip/Alternative “A” Batten Strip for Closure Turf or Geotextile– one length for both connections), shall include full compensation for furnishing all labor, materials, tools, equipment, and incidentals and for doing all work involved in Liner Termination Anchor – (Extrusion Welding at Tri-Lock Embedment Strip/ Alternative “A” Batten Strip for Closure Turf or Geotextile – one length for both connections), including and all placement and lay-out of geosynthetic materials, extrusion welding of 50-mil LLDPE Geomembrane to Concrete Embedment Strips, installation of Batten strips and anchor bolts for Closure Turf or geotextile Alternative “A” and other appurtenances as shown on the plans, as specified in the Standard Specifications and these Special Provisions, and as directed by the engineer.

Final pay quantities shall be determined by computing the actual lineal footage of Liner Termination Anchor – (Extrusion Welding at Tri-Lock Embedment Strip/ Alternative “A” Batten Strip for Closure Turf or Geotextile – one length for both connections) placed to the limits indicated on the plans (geosynthetic materials shall not be measured separately for payment).

4.5 Drainage Road Anchors Per Detail 1/D5 (Item 9E)

The contract unit price paid per lineal foot for Drainage Road Anchors shall include full compensation for furnishing all labor, materials, tools, equipment, and incidentals and for doing all work involved in Anchor Trench including and all excavation, grading, geosynthetic materials, backfill, compaction, 2” x 10” Redwood Header and other appurtenances as shown on the plans, as specified in the Standard Specifications and these Special Provisions, and as

directed by the engineer.

Final pay quantities shall be determined by computing the actual lineal footage of Drainage Road Anchors placed to the limits indicated on the Plans (geosynthetic materials shall not be measured separately for payment).

4.6 Easterly Perimeter Road Anchor Per Detail 1/D2 (Item 9F)

The contract unit price paid per lineal foot for Easterly Perimeter Road Anchor Trench shall include full compensation for furnishing all labor, materials, tools, equipment, and incidentals and for doing all work involved in Easterly Perimeter Road Anchor Trench including and all excavation, grading, geosynthetic materials, backfill, compaction, and other appurtenances as shown on the plans, as specified in the Standard Specifications and these Special Provisions, and as directed by the engineer.

Final pay quantities shall be determined by computing the actual linear feet of Easterly Perimeter Road Anchor placed to the limits indicated on the Plans (geosynthetic materials shall not be measured separately for payment).

4.7 Southwest Basin Anchor Trench Per Detail 5/D7 (Item 9G)

The contract unit price paid per lineal foot for Southwest Basin Anchor Trench shall include full compensation for furnishing all labor, materials, tools, equipment, and incidentals and for doing all work involved in Southwest Basin Anchor Trench including and all excavation, grading, geosynthetic materials, concrete backfill, and other appurtenances as shown on the plans, as specified in the Standard Specifications and these Special Provisions, and as directed by the engineer.

Final pay quantities shall be determined by computing the actual linear feet of Southwest Basin Anchor Trench placed to the limits indicated on the Plans (geosynthetic materials shall not be measured separately for payment).

4.8 LFG System Pipe Boots, Wellhead Boots, Vent Boots – Geomembrane Penetrations (See Section 2I – Landfill Gas System)

The contract unit price paid for LFG System Pipe Boots, Wellhead Boots, Vent Boots – Geomembrane Penetrations, any multiple move-ins, multiple deployments, multiple piping and collection system installation, and geosynthetic operations (i.e. multiple move-ins, multiple deployments, and multiple piping and collection system installation, geosynthetic operations (i.e. Geocomposite Drainage Collector, LFG Geocomposite Vents (Below Geomembrane), LFG Passive Vents and LFG Trench/Wells, Wellhead penetrations, Vents, LLDPE boots, and outlet piping, etc.) over portions of the total LLDPE Geomembrane installation area that are a requirement of this project per LFG Plans and Specifications shall be paid pursuant to Section 2I – LFG System, and the LFG Construction Items on the Bid Schedule.

END OF SECTION 2G

ATTACHMENT 2G-A-1 – ALTERNATIVE “A”

SUMMARY OF 50-MIL SUPER GRIPNET LLDPE GEOMEMBRANE (Alternative “A”) MANUFACTURER’S QUALITY ASSURANCE (MQA)				
PHYSICAL PROPERTY	METHOD	UNIT	REQUIREMENT	FREQUENCY
Thickness (nominal, min. ave.) Thickness (min. ave.) Thickness (lowest individual – 8 out of 10) Thickness (lowest individual – 10 out of 10)	ASTM D 5994	mils	50 47.5 45 42.5	Per Roll
Drainage Stud Height (min. ave.)	ASTM D 7466	mils	130	Every 2 nd Roll ⁽¹⁾
Spike Height mils (min ave.)	ASTM D 7466	mils	175	Every 2 nd Roll ⁽¹⁾
Formulated Density	ASTM D 792 Method B	g./cc.	<0.939	Every 500,000 square feet
Tensile Properties (ave. both directions) ⁽²⁾ • Break strength– lb/in. (2 in/min) • Break elongation - %	ASTM D 6693 Type IV	lb./in. % (GL=2.0 in.)	105 300	Every 50,000 square feet
2% Modulus (max.)	ASTM D 5323	lb./in.	3000	Per formulation
Tear Resistance (min. ave.)	ASTM D 1004	lb.	30	Every 100,000 square feet
Puncture Resistance (min. ave.)	ASTM D 4833	lb.	55	Every 100,000 square feet
Carbon black content %	ASTM D 4218 ⁽³⁾	%	2.0 to 3.0	Every 100,000 square feet
Carbon black dispersion (Category)	ASTM D 5596	N/A	Note (4)	Every 100,000 square feet
Oxidative Induction Time (OIT) (min. ave.) ⁽⁵⁾ (a) Standard OIT – min.; or (b) High Pressure OIT – min.	ASTM D 8117	min.	100	Every 500,000 square feet
Oven Aging at 85°C ⁽⁶⁾ % retained after 90 days (a) Standard OIT (min. ave.) (b) High Pressure OIT (min. ave.)	ASTM D 5721 ASTM D 5885	%	35 60	Per formulation
UV Resistance ⁽⁷⁾ (b) High Pressure OIT (min. ave.) - % retained after 1600 hrs ⁽⁸⁾	ASTM D 7238 ASTM D 5885	%	35	Per formulation

1. Alternate the measurement side for double sided textured sheet.
2. Machine Direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens in each direction.
 - Break elongation is calculated using a gage length of 2.0in. at 2.0 in./min.
3. Other methods such as D1603 (tube furnace) or D 6370 (TGA) are acceptable if an appropriate correlation to D4218 (muffle furnace) can be established.
4. Carbon black dispersion (only near spherical agglomerates) for 10 different views:
 - 10 in Categories 1 or 2 and 0 in Category 3
5. The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.
6. It is also recommended to evaluate samples at 30 and 60 days to compare with the 90-day response.
7. The condition of the test should be 20 hr. UV cycle at 75°C followed by 4hr. condensation at 60°C
8. UV resistance is based on percent retained value regardless of the original HP-OIT value.

Manufacturer

Signature

Print Name

BID SCHEDULE ADDENDUM 3

ADDENDUM 3
COLTON SANITARY LANDFILL
FINAL CLOSURE CONSTRUCTION PROJECT

Item No.	Description	QTY	Unit	Cost	Total
BID ITEMS 1 THROUGH 8B - (COMPLETE FOR BOTH ALTERNATIVES)					
1	MOBILIZATION	1	LS		
2	CONSTRUCTION SUPPORT TASKS - SWPPP COMPLIANCE - CONSTRUCTION ACTIVITIES STORMWATER MANAGEMENT PLAN (CASMP) - INTERIM EROSION CONTROL AND BMP'S	1	LS		
3	PROJECT SURVEY (INCLUDES SETTLEMENT MONUMENT SURVEY)	1	LS		
4	RECORD DRAWINGS	1	LS		
SUBTOTAL BID ITEMS 1 THRU 4 - (COMPLETE FOR BOTH ALTERNATIVES)			\$		
5	CLEARING, GRUBBING, AND DEMOLITION	90.0	AC		
6A	EXCAVATE REFUSE, LOAD, AND TRANSPORT, TO RECONSOLIDATION AREA	20,000	CY		
6B	BACKFILL AND COMPACTION OF REFUSE EXCAVATION AREAS USING IMPORT SOIL	20,000	CY		
7A	UNCLASSIFIED EXCAVATION TO FOUNDATION FILL (SOUTH BASIN)	23,000	CY		
7B	UNCLASSIFIED EXCAVATION TO FOUNDATION FILL - COVER SOIL TRIM	4,500	CY		
7C	FOUNDATION FILL SLOPES AND BENCHES (IMPORT)	120,000	CY		
7D	SUBGRADE PREPARATION FOR FINAL COVER GEOSYNTHETICS INSTALLATION	400,000	SF		
8A	CONSTRUCT GABION WALL (TYPE A) (1-FOOT)	840	LF		
8B	CONSTRUCT GABION WALL (TYPE B) (3-FOOT)	906	LF		
SUBTOTAL BID ITEMS 5 THRU 8B - (COMPLETE FOR BOTH ALTERNATIVES)			\$		

CLOSURETURF- ALTERNATIVE "A" - (BID ONLY ONE ALTERNATIVE)					
9A	50 MIL LLDPE SUPER GRIP NET GEOMEMBRANE (SLOPES/BENCHES) (PER DETAIL 1/D1)	4,000,000	SF		
9B	50 MIL LLDPE SUPER GRIP NET GEOMEMBRANE (DECK) (PER DETAIL 1/D1)	100,000	SF		
9C	CONSTRUCT ANCHOR TRENCH (PER DETAIL 3/D2, 4/D2, 2/D7, AND 7/D7)	2,800	LF		
9D	LINER TERMINATION ANCHOR - EXTRUSION WELD AT TRI-LOCK EMBEDMENT STRIP/BATTEN STRIP (PER DETAILS 4/D5, 1/D6, 2/D6, AND 3/D6)	180	LF		
9E	DRAINAGE ROAD ANCHORS (PER DETAIL 1/D5)	800	LF		
9F	EASTERLY PERIMETER ROAD ANCHOR (PER DETAIL 1/D2)	1,500	LF		
9G	SOUTHWEST BASIN ANCHOR TRENCH (PER DETAIL 5/D7)	600	LF		
10A	DOWNDRAIN TO BENCH CROSSING/DOWNDRAIN TRANSITION SUBGRADE (PER DETAIL 5/D1 AND DRAWING SHEET NUMBERS D9, D10, AND D11)	35,000	SF		
10B	DOWNDRAIN GRADING, SUBGRADE PREPARATION, AND SAND OR CMB FILLETS (b=10', D=1.17') (PER DETAIL 4/D1)	40,000	SF		
10C	CLOSURE TURF (SLOPES/BENCHES) (PER DETAIL 1/D1)	4,000,000	SF		
10D	CLOSURE TURF (DECK) (PER DETAIL 1/D1)	100,000	SF		
10E	INSTALL SAND INFILL PER MANUFACTURER'S RECOMMENDATIONS (PER DETAIL 1/D1)	4,000,000	SF		
10F	HYDRO BINDER INFILL	35,000	SF		
SUBTOTAL BID ITEMS 9A THROU 10F - CLOSURETURF (ALTERNATIVE "A" ONLY)			\$		

LITEEARTH - ALTERNATIVE "B" - (BID ONLY ONE ALTERNATIVE)					
9A	40 MIL LLDPE GEOMEMBRANE WITH INTEGRAL TURF (SLOPES/BENCHES) (PER DETAIL 1/D1)	4,000,000	SF		
9B	40 MIL LLDPE GEOMEMBRANE WITH INTEGRAL TURF (DECK) (PER DETAIL 1/D1)	100,000	SF		
9C	CONSTRUCT ANCHOR TRENCH (PER DETAILS 3/D2, 4/D2, 2/D7, AND 7/D7) (NO GEOCOMPOSITE DRAIN)	2,800	LF		
9D	LINER TERMINATION ANCHOR - EXTRUSION WELD AT TRI-LOCK EMBEDMENT STRIP (PER DETAILS 4/D5, 1/D6, 2/D6, AND 3/D6) (NO BATTEN STRIP)	180	LF		
9E	DRAINAGE ROAD ANCHORS PER DETAIL 1/D5 - (NO GEOCOMPOSITE DRAIN)	800	LF		
9F	EASTERLY PERIMETER ROAD ANCHOR PER DETAIL 1/D2 - (NO GEOCOMPOSITE DRAINS)	1,500	LF		
9G	SOUTHWEST BASIN ANCHOR TRENCH PER DETAIL 5/D7 - (NO GEOCOMPOSITE DRAIN)	600	LF		
10A	DOWNDRAIN TO BENCH CROSSING/DOWNDRAIN TRANSITION SUBGRADE (PER DETAIL 5/D1 AND DRAWING SHEET NUMBERS D9, D10, AND D11)	35,000	SF		
10B	DOWNDRAIN GRADING, SUBGRADE PREPARATION, AND SAND OR CMB FILLETS (b=10', D=1.17') (PER DETAIL 4/D1)	40,000	SF		
10G	PLATIPUS ANCHORS	1	LS		
SUBTOTAL BID ITEMS 9A THRU 10B AND 10G - LITEEARTH (ALTERNATIVE "B" ONLY)			\$		

BID ITEMS 10H THROUGH 26C - (COMPLETE FOR BOTH ALTERNATIVES)					
10H	BENCH ROCK BALLAST OVER FINAL COVER SYSTEM (PER DETAIL 1/D7)	500,000	SF		
11A	ASPHALT THICKENED EDGE (PER DETAIL 4/D7)	900	LF		
11B	4" AC OVER 6" CMB ACCESS ROAD/ROADWAY DRAINAGE SWALE (PER DETAIL 3/D1)	140,000	SF		
11C	4" AC OVER 6" CMB EAST PERIMETER ROAD WITH ROADWAY DRAINAGE SWALE (PER DETAIL 1/D2)	33,000	SF		
11D	4" AC OVER 6" CMB PAVED ALL WEATHER ACCESS BENCH WITH CMB KICKERS (PER DETAIL 2/D5)	17,000	SF		
11E	CONSTRUCT 15-FOOT WIDE DRAINAGE ROAD WITH LLDPE/CT ANCHORS (PER DETAIL 1/D5)	8,000	SF		
11F	ITEM INTENTIONALLY LEFT BLANK				
11G	CONSTRUCT 6" CMB OVER 12 OZ/SY GEOTEXTILE SOUTH CHANNEL ACCESS ROAD (PER DETAILS 3/D2 OR 4/D2)	30,000	SF		
11H	CONSTRUCT AC CURB TYPE D-2(6) (PER SPPWC STD PLAN 121-1)	4,750	LF		
11I	4" AC OVER 6" CMB AC ROADWAY TRANSITION FROM DOWNDRAIN TO GABION (PER DETAIL 2/D7)	2,000	SF		
11J	4' AC OVER 6" CMB AC BENCH APRON TRANSITION TO ACCESS ROAD	9,000	SF		
12A	CONCRETE TRAP. CHANNEL INLET TRANS. (b=5.0' D=2.0' Z=1 TO b=1.0' D=2.0' Z=1)	10	LF		
12B	CONCRETE TRAPEZOIDAL CHANNEL/FINAL COVER TERMINATION (b=1.0' D=2.0' Z=1) (PER DETAIL 7/D1)	580	LF		
13A	INSTALL N12 24-INCH DIAMETER HALF-ROUND PIPE DOWNDRAIN BERMS (PER DETAIL 2/D1)	8,200	LF		
13B	INSTALL SOLID HDPE 12-INCH DIAMETER SDR 17 STORM DRAIN PIPE (PER DETAIL 6/D8)	260	LF		
14	CONSTRUCT CONCRETE HEADWALL/OUTLET APRON TO 36" SPIRAL RIB PIPE W/ WARPED WING WALLS PER CALTRANS STD D86B (PER DETAILS 1/D4, 2/D4, 3/D4, AND 1/D6)	3	EA		

15	CONSTRUCT GATE/FENCE/AC PAVEMENT ACCESS/GROUTED RIP RAP ENHANCEMENTS TO DRAINAGE OUTLET 4 (PER DETAIL 4/D5)	1	LS		
16	CONSTRUCT GATE AND FENCE/AC PAVEMENT ACCESS/GROUTED RIP RAP ENHANCEMENTS TO DRAINAGE OUTLET 5 (PER DETAIL 5/D5)	1	LS		
17	INSTALL INCLINED TRASH RACK (PER SPPWC STD PLAN 361-2)	5	EA		
18	GROUTED RIP RAP AND GROUTED GABION ROCK (PER DETAILS 6/D1 AND 2/D7)	600	SF		
19	SETTLEMENT MONUMENTS (PER DETAIL 6/D7)	5	EA		
20	CLASS 1 FLEXIBLE POST DELINEATORS (SURFACE MOUNT) (PER CALTRANS STD A73C)	7	EA		
21A	6-FOOT CHAIN LINK FENCE (PER SPPWC STD PLAN 600-3)	2,500	LF		
21B	6-FOOT CHAIN LINK 15-FOOT SWING GATE (PER SPPWC STD PLAN 600-3)	15	LF		
21C	8-FOOT CHAIN LINK FENCE (PER CALTRANS STD A85)	1,000	LF		
21D	8-FOOT SALVAGED CHAIN LINK SWING GATE (REMOVAL/SALVAGE/RE-INSTALL) (PER CALTRANS STD A85)	66	LF		
22A	CONCRETE APRON/CHANNEL (MATCH EXISTING) 4" CONCRETE W/6" BY 6" - #10 BY #10 WWM REINFORCING	180	SF		
22B	6-INCH THICK CONCRETE ACCESS RAMP/DRAINAGE OUTLET PAVEMENT WITH #4 BARS AT 12-INCHES ON CENTER EACH WAY OVER 4-INCHES CMB AGAINST 10-INCH SUBGRADE KICKER WITH INTEGRAL 8-INCH CONCRETE CURB	1,100	SF		
23A	CONSTRUCT MAINTENANCE ROAD BRIDGE CROSSING (PER DETAILS 4/D5, 1/D6, 2/D6, AND 3/D6)	4	EA		
23B	ADDITIONAL MAINTENANCE ROAD BRIDGE CROSSING SUPPORTS AT ROAD EDGE (PER DETAIL 3/D6)	10	CY		
24A	CONSTRUCT TYPE 1 MAINTENANCE ROAD (PER DETAIL 4/D3)	1,500	LF		
24B	CONSTRUCT TYPE 2 MAINTENANCE ROAD (PER DETAILS 1/D3 AND 3/D3)	1,800	LF		
24C	CONSTRUCT TYPE 3 MAINTENANCE ROAD (PER DETAIL 5/D8)	500	LF		

24D	CONSTRUCT TYPE 3 MAINTENANCE ROAD (8-INCH OR 2-INCH TO 8-INCH CURB FACE TRANSITION PER DETAIL 4/D8)	100	LF		
25	CABLE RAILING PER CALTRANS STD. PLAN B11-47 - ATTACH TO BRIDGE CROSSING SUPPORTS OR CAST 2-FOOT DEEP IN UNDERLYING CONCRETE SURFACE	50	LF		
26	EROSION CONTROL/FINAL STABILIZATION	1	LS		
26A	FIBER ROLLS	1,000	LF	PAID FOR IN BID ITEM 26	
26B	GRAVEL BAG CHEVRONS	21	EA		
26C	HYDROSEED	0.85	AC		
SUBTOTAL BID ITEMS 10H THROUGH 26C - (COMPLETE FOR BOTH ALTERNATIVES)			\$		
LFG BID ITEMS G1 THROUGH G27 - (COMPLETE FOR BOTH ALTERNATIVES)					
G1A	LFG WELL DRILLING AND INSTALLATION PER DETAIL 1/GD11	6,251	VF		
G1B	VERTICAL WELL BORING ABANDONMENT	500	VF		
G2	2-INCH VERTICAL WELLHEAD ASSEMBLY PER DETAIL 5/GD12, 2/GD14	56	EA		
G3A	12-INCH HDPE HEADER, AIR, FORCEMAIN IN COMMON TRENCH PER DETAIL 7/GD7	480	LF		
G3B	12-INCH HDPE HEADER, AIR, FORCEMAIN, 4-INCH PERF PIPE IN COMMON TRENCH PER DETAILS 7/GD1, 1/GD2, 3/GD2, 4/GD2	3,800	LF		
G4	8-INCH HDPE HEADER, AIR, FORCEMAIN, 4-INCH PERF PIPE, IN COMMON TRENCH PER DETAILS 1/GD3, 3/GD3, 4/GD3	3,000	LF		
G5	8-INCH HDPE HEADER, 4-INCH PERF PIPE IN COMMON TRENCH PER DETAIL 5/GD7	400	LF		
G6	4-INCH PERFORATED PIPE PER DETAIL 1/GD5	550	LF		
G7	8-INCH BELOW GRADE HEADER AND GEOCOMPOSITE DRAINAGE STRIP IN ACCESS ROAD PER DETAIL 3/GD1	4,400	LF		
G8	8-INCH BELOW GRADE HEADER ON SLOPE PER DETAIL 6/GD8	750	LF		
G9	CONDENSATE SUMP TYPE 1 PER 1/GD13	2	EA		
G10	CONDENSATE SUMP TYPE 2 PER 2/GD13	3	EA		
G11	CONDENSATE SUMP TYPE 3 PER 3/GD13	1	EA		
G13	WELL ABANDONMENT PER DETAIL 6/GD11	171	EA		
G14	REMOVE AND DISPOSE OF PIPE PER PROJECT LFG TRANSITION SPECIFICATIONS	90	AC		

G15	LFG REMOTE WELL PIPING PER 5/GD12, 1/GD10	1,850	LF		
G16A	GEOCOMPOSITE COLLECTION STRIPS PER PLAN AND DETAIL 5/GD14	4,000	LF		
G16B	SURFACE COLLECTION WELL PER DETAIL 5/GD14, 3/GD14	9	EA		
G17	PRESSURE RELIEF VALVE PER DETAIL 6/GD14	50	EA		
G18	TOE COLLECTOR GAS WELL PER DETAIL 4/GD14	14	EA		
G19	6-INCH HDPE LATERALS PER 1/GD9	7,400	LF		
G20	12-INCH VALVE PER 2/GD12	1	EA		
G21	8-INCH VALVE PER 2/GD12	4	EA		
G22	6-INCH HDPE POLY VALVE 1/GD9	25	EA		
G23	2-INCH AIR ISOLATION VALVE ASSEMBLY PER DETAIL 2/GD15	2	EA		
G24	3-INCH FM ISOLATION VALVE ASSEMBLY PER DETAIL 1/GD15	2	EA		
G25	BELOW GRADE BENCH CROSSING FOR 6-INCH HDPE LATERAL PER DETAIL 1/GD9, 1GD/10	65	EA		
G26	12-INCH TIE-IN TO EXISTING SUMP 1	1	EA		
G27	GEOCOMPOSITE STRIPS IN DOWNDRAIN TRANSITION TO BENCH CROSSINGS PER DETAIL 5/GD1	38	EA		
SUBTOTAL BID ITEMS 1 THRU 4 - (COMPLETE FOR BOTH ALTERNATIVES)			\$		
SUBTOTAL BID ITEMS 5 THRU 8B - (COMPLETE FOR BOTH ALTERNATIVES)			\$		
SUBTOTAL BID ITEMS - CLOSURETURF (ALTERNATIVE "A" ONLY) (ITEMS 9A THRU 10F) <u>OR</u> LITEEARTH (ALTERNATIVE "B" ONLY) (ITEMS 9A THRU 10B AND 10G)			\$		
SUBTOTAL BID ITEMS 10H THROUGH 26C - (COMPLETE FOR BOTH ALTERNATIVES)			\$		
SUBTOTAL BID ITEMS G1 THROUGH G27 - (COMPLETE FOR BOTH ALTERNATIVES)			\$		
TOTAL BASE BID =			\$		
SWMD reserves the right to delete any specific item on the bid schedule in its entirety. Should SWMD elect not to proceed with a specified item of work, it will be deleted from the contract. Section 3-2.1 of the SSPWC shall not apply to Item numbers 6A, 6B, 7A, 7B, 7C and G1B. The Contractor shall have no claim for compensation, or loss of profit, as a result of the deletion or reduction in quantities.					
The Bid Schedule shown above does not constitute agreed-upon costs for the items described. The purpose of this cost breakdown is to provide SWMD with cost allocations for comparison and budgeting purposes only. Final cost allocations for each individual item for the project's schedule of values and progress payments will be established by the Construction Manager in negotiation with the Contractor.					
THE AWARD OF THIS CONTRACT WILL BE BASED ON THE LOWEST RESPONSIBLE BID TOTAL.					

**CONSTRUCTION QUALITY
ASSURANCE PLAN**

**FINAL CLOSURE CONSTRUCTION
COLTON SANITARY LANDFILL**

**GEO-LOGIC ASSOCIATES
JUNE 2022**

Construction Quality Assurance (CQA) Plan

Final Closure Construction Colton Sanitary Landfill

Prepared for:

SWT Engineering, Inc.
800-C South Rochester Ave.
Ontario, CA 91761

and:

San Bernardino County
Solid Waste Management Division
222 W. Hospitality Lane, Second Floor
San Bernardino, CA 92415



Prepared by

Geo-Logic
ASSOCIATES

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Project #SO21.1048

A handwritten signature in blue ink, which appears to be "Robbie Warner", written in a cursive style.

June 2022

Table of Contents

1.	Introduction	1
2.	Responsible Parties and Definitions	2
2.1	Responsible Parties	2
2.2	Definitions	3
3.	Geotechnical CQA Organization	5
3.1	Geotechnical Project Director	6
3.2	Geotechnical CQA Manager	6
3.3	Geotechnical CQA Monitors	7
3.3.1	Field Engineer/Field Geologist	7
3.3.2	Geotechnical CQA Monitors	8
3.4	Independent Testing Laboratory	10
4.	Meetings	10
4.1	Pre-Construction Meetings	10
4.2	Weekly Progress Meetings	11
4.3	Special Meetings	11
4.4	Geosynthetic Material Pre-Installation Meeting	12
4.5	Daily Progress Meetings (If Necessary)	12
4.6	Manufacturing Plant Visit(s)	13
5.	Geotechnical CQA Monitoring for Earth Materials	14
5.1	General	14
5.2	Unclassified Engineered Fill	14
5.3	Acceptance Criteria	15
5.3.1	General	15
5.3.2	Moisture Content and Density	15
5.3.3	Lift Thickness and Processing	16
5.3.4	Geomembrane Subgrade	16
6.	Geotechnical CQA Monitoring for Geosynthetics (Alternatives "A" and "B")	16
6.1	Geomembrane (LLDPE) and Turf/Geomembrane Composite	16
6.1.1	LLDPE Manufacturing	21
6.1.2	Geomembrane Delivery	21
6.1.3	LLDPE Conformance Testing	23
6.1.4	LLDPE Installation	24
6.1.5	Construction Testing	30
6.1.6	Defects and Repairs	35
6.1.7	Wrinkles	36

6.1.8 Anchor Trench	36
6.1.9 LLDPE Acceptance.....	37
6.1.10 Liner Materials.....	37
6.2 Engineered Turf and Geotextiles (Alternative "A").....	38
6.2.1 ClosureTurf®/Geotextile Delivery.....	41
6.2.2 ClosureTurf®/Geotextile Installation.....	42
6.2.3 Repairs.....	46
6.2.4 Sand Infill.....	46
7. Documentation.....	47
7.1 Daily Reports	47
7.2 Observation and Test Data Reports	47
7.3 Construction Problem Reports.....	48
7.4 Design and Specification Revisions	48
7.5 Photographs.....	48
7.6 As Built Plans.....	49
7.7 Final Certification Report.....	49

1. Introduction

A Construction Quality Assurance (CQA) program consists of selected testing, inspection and documentation of a final construction product in order to provide the Owner/Agencies an evaluation of whether the end product is of the specified quality of materials and workmanship. Because of possible conflicts of interest, the Contractor should not undertake the CQA function directly. Rather, CQA inspection and testing should be left under the objective authority of a single team of inspection professionals.

A Construction Quality Control (CQC) program consists of selected tests and inspections performed by the Contractor during production which can assist the Contractor in producing the quality product required. While the CQC function is the sole responsibility of the Contractor, the Project Manager may, at his/her discretion, provide information regarding the ongoing CQA monitoring for the Contractor's use in implementing his/her CQC function. Release of the CQA data to the Contractor would be for convenience only and would, in no way, relieve the Contractor from the responsibility to fulfill the project requirements.

The proposed Final Closure design for the Colton Sanitary Landfill (CSL) includes two different geosynthetic material alternatives for construction. Alternative "A" incorporates the ClosureTurf® cover system patented by Watershed Geosynthetics, LLC, and Alternative "B" incorporates the Solmax LiteEarth™ cover system. The ClosureTurf® cover system includes a sand-ballasted synthetic turf overlying a double-sided SuperGripNet 50-mil linear low-density polyethylene (LLDPE) geomembrane which is placed over prepared subgrade soils consisting of existing cover soils and/or unclassified engineered fill soils to form the cover system foundation layer. Alternative "B" incorporates the Solmax LiteEarth™ system consisting of a 40-mil LLDPE geomembrane bonded to synthetic turf that will be placed in intimate contact with the underlying prepared and approved foundation layer soils constructed in accordance with Section 2D of the Project Specifications.

The ClosureTurf® system (Alternative "A") or the Solmax LiteEarth™ system (Alternative "B") are alternatively proposed for both the main waste fill area, and the smaller, northerly waste fill area, both of which may receive reconsolidated waste generated during grading operations for final closure construction. The Final Closure design also includes construction of bench swales, cementitious-infill-lined downdrains, paved and unpaved perimeter access roads, and the raising of the existing South Channel gabion wall.

Each component of the Final Closure design functions as an integral part of the final closure system and consequently must become a finished product during the course of construction. As a result, it is important that each layer or component of the system be completed to the design specifications prior to construction of successive or overlying layers. For this reason, it is both inefficient and impractical to withhold CQA testing until completion of the project and it is necessary to conduct an ongoing CQA program during construction.

This document presents the Construction Quality Assurance (CQA) Plan for installation of the earthwork and geosynthetic components of the Final Closure System for the Colton Sanitary Landfill in San Bernardino County, California. This CQA Plan is based on the Construction Drawings and Specifications prepared by SWT Engineering (SWT) dated March 2022. This CQA Plan is to be used in conjunction with the Project Construction Drawings and Specifications prepared for the CSL.

2. Responsible Parties and Definitions

2.1 Responsible Parties

The responsible parties for the CSL Final Closure construction, as set forth herein, are as follows:

Owner:

San Bernardino County Solid Waste Management Division
222 W. Hospitality Lane, 2nd Floor
San Bernardino, California 92415
Phone: (909) 386-8735
Contact: Mr. Marc Rodabaugh, P.E.

Landfill Engineer:

SWT Engineering, Inc.
800-C South Rochester Avenue
Ontario, California 91761
Phone: (909) 390-1328
Contact: Mr. Richard Genzel

Construction Manager:

To Be Determined

CQA Consultant:

Geo-Logic Associates
2777 East Guasti Road, Suite 1
Ontario, California
Phone: (909) 626-2282
Contact: Mr. Stacy Baird

2.2 Definitions

"ClosureTurf®" – A proprietary landfill cover system by Watershed Geosynthetics, LLC that includes a sand-ballasted synthetic turf overlying a double-sided textured SuperGripNet 50-mil LLDPE geomembrane placed over prepared subgrade soils.

"Construction Manager" – Person(s) or firm(s) authorized by the San Bernardino County Solid Waste Management Division to manage and oversee the administration of the Construction Contract. The Construction Manager shall be responsible for evaluating lines and grades (survey control) for the individual liner elements as well as verification of payment request, submittal acceptance, and change orders.

"Contractor" – The firm responsible for all elements of construction of the containment system. In this regard, the Contractor's responsibilities include but are not limited to: preparation of subgrade and supporting surfaces (generally soil) for the geosynthetic installation; installation of the geosynthetics; and placing earth and granular materials over the installed geosynthetic systems. The Contractor is further responsible for all activities of Subcontractors including but not limited to the geosynthetics Subcontractor.

"County" – San Bernardino County, Department of Public Works, Solid Waste Management Division.

"CQA Manager" – The individual or firm serving under the direction of the CQA Consultant and responsible for day to day geotechnical Construction Quality Assurance (CQA).

"CQA Monitors" – The individuals working under the direction of the CQA Manager who are routinely involved in the construction process. Such personnel include "Technicians", "Field Engineers" and "Field Geologists" representing the Geotechnical Consultant. CQA Monitors responsible for the geosynthetics and earthwork, shall be experienced in landfill construction monitoring, geosynthetic material installation, engineered fill construction and testing, and compaction testing during grading operations.

"Geosynthetics" – A generic classification given to synthetic (man-made plastic and fabric) materials used in geotechnical and construction applications. Included are geomembrane or flexible membrane liners (LLDPEs), geotextiles, geosynthetic clay liner (GCL), geonets, geogrids, geocomposites and geocells. At the CSL, the term geosynthetics is used to refer to the LLDPE, ClosureTurf®, Solmax LiteEarth™ material, and geotextiles.

"Geosynthetic Subcontractor" – The firm responsible for handling, storing, placing, seaming, and other aspects of the installation of the geosynthetics included in the final closure system.

"Geotechnical Consultant" – Geotechnical firm responsible for the design and specifications for the earthwork and geosynthetic elements of the Project Plans and Specifications. The Geotechnical Consultant or his/her representative is also responsible for observing, testing, and documenting activities related to quality assurance for all geotechnical and geosynthetic aspects of construction except for engineering and survey control. All completed geotechnical work is subject to approval by the Geotechnical Consultant.

"Geotechnical Project Director" – Geological/geotechnical professional registered in the State of California who, under the employ of the Geotechnical Consultant is responsible for earthwork observation, monitoring and testing.

"Geotechnical Construction Quality Assurance for Earthwork" – The protocols to be followed in evaluating the adequacy of the Contractor's work with regard to all elements of earthworks construction with the exception of line and grade (survey) control. Said work shall include but need not be limited to all CQA activities delineated herein and in the Specifications. Geotechnical CQA is to be provided by a party independent of the Contractor.

"Geotextile" – A permeable synthetic fabric used with soil, rock, sand, gravel or any other similar materials as an integral part of the composite liner system. It can provide protection (cushion) to other systems or serve to separate different materials.

"Independent Testing Laboratory" – The firm responsible for conducting selected tests of materials and/or products used for the project, such as conformance and destructive seam testing. The laboratory shall be independent of the County, Manufacturer, Contractor, Geosynthetics Subcontractor and any party involved with the manufacture and/or installation of any product to be tested.

"Landfill Engineer" – The firm responsible for the design and preparation of the Project Plans and Specifications including the containment system that fulfills the regulatory and operational requirements of the permitting agencies and Owner, respectively. The Landfill Engineer, also

known as the Engineer, is also responsible to modify or change the design if unexpected or unanticipated site conditions are encountered during construction.

"LiteEarth™" – A proprietary landfill cover system by Solmax consisting of a single-sided textured 40-mil LLDPE geomembrane bonded to synthetic turf that will be placed in intimate contact with the underlying prepared and approved foundation layer soils.

"LLDPE" – Linear low-density polyethylene

"Project Documents" – Project Documents include all Construction Drawings, Record Drawings, Construction Specifications, CQA Plans, Health and Safety Plans and Project Schedules and Contractor Submittals.

"Project Manager" – The County's designated representative responsible for the Project.

"Project Drawings and Specifications" - All project related Drawings and Specifications including Design Modifications and Record Drawings.

"Quality Assurance" – Actions taken by the Owner or his representative necessary to evaluate whether the earthen and geosynthetic materials and workmanship meet the requirements of the Project Plans and Specifications.

"Quality Control" – Actions taken by the Contractor, Subcontractors and/or Liner Manufacturer(s) to ensure that the earthen and geosynthetic materials and workmanship meet the requirements of the Project Plans and Specifications.

"Work" – All tools, equipment, supervision, labor, and materials or supplies necessary to complete the project as specified in the Project Specifications and as shown on the Project Drawings.

3. Geotechnical CQA Organization

The Geotechnical CQA Team for Closure Construction will be composed of design and field personnel with specific experience in the inspection and Geotechnical CQA monitoring of earthwork and geosynthetic materials specifically related to landfill liner construction. The principal categories of personnel assigned to the Geotechnical CQA Team are presented below.

3.1 Geotechnical Project Director

The Geotechnical Project Director shall be a representative of the Geotechnical CQA Consultant and shall have overall responsibility for all geotechnical CQA activities.

The Geotechnical Project Director will be responsible for reviewing all earthwork or geosynthetic issues which may arise during construction. The Geotechnical Project Director's approval will be required for any earth or geosynthetic material modifications or for any design modifications which may impact the performance of the earth or geosynthetic materials.

3.2 Geotechnical CQA Manager

The Geotechnical CQA Manager will serve as the Geotechnical Project Director's on-site representative. All Geotechnical CQA functions will be his/her direct responsibility. All coordination, reporting and issues related to non-compliance will be directed through the Construction Manager. In addition, he/she will participate with the County, Engineer and Geotechnical Project Director in all decisions related to design issues which arise during the course of construction.

The Geotechnical CQA Manager shall be responsible for overall review, observation, sampling, and testing of activities utilized for Construction Quality Assurance (CQA). Specific duties of the CQA Manager include:

- Review of all designs, Project Plans, and Specifications;
- Implementation of the Geotechnical CQA program including: assignment and management of all Geotechnical CQA personnel; review of all field reports; and review of all Geotechnical CQA related issues;
- Review of design changes and coordination of such changes with the Engineer;
- Serving as the on-site representative of the Geotechnical Project Director;
- Familiarization of all Geotechnical CQA Monitors with the site and the Geotechnical CQA requirements of the project;
- Attendance at all Geotechnical CQA related meetings (i.e., preconstruction, progress, and special meetings as required);
- Review of all Liner Manufacturer and Liner Subcontractor certifications and documentation and development of appropriate recommendations;

- Designation of a senior Geotechnical CQA Monitor to act on his/her behalf at the site while he/she is absent and operations are ongoing;
- Notation of any on-site activities that could result in damage to the geosynthetics;
- Review of the Liner Subcontractor's personnel qualifications for conformance with project requirements;
- Selection of locations for destructive test sampling;
- Oversight of the ongoing preparation of "As Built" Plan(s);
- Review of all Geotechnical CQA Monitors daily reports and logs;
- Reporting to the Construction Manager and logging in his/her daily report any relevant observations reported to him by the Geotechnical CQA Monitors;
- Oversight of the marking, packaging and shipping of all laboratory test samples;
- Review of the results of laboratory testing and presentation of appropriate recommendations;
- Preparation of a monthly summary of Geotechnical CQA activities;
- Reporting of any unresolved deviations from the Geotechnical CQA Plan to the Construction Manager;
- Preparation of the final "As-Built" report for all completed geosynthetic construction activities;

3.3 Geotechnical CQA Monitors

3.3.1 Field Engineer/Field Geologist

- The Field Engineer/Field Geologist will be a representative of the Geotechnical CQA Consultant and will be responsible for evaluating whether earth and/or synthetic materials conform to the requirements of the Project Drawings and Specifications. Duties of the Field Engineer/Field Geologist will include the following:
- Subgrade inspection, review, testing and documentation.
- Review of the adequacy of all clearing, grubbing, stripping and preparation of areas to receive fill.
- Monitoring and evaluation of any soil blending, mixing and processing operations.

- Evaluation of the engineering characteristics of the processed and constructed earth materials.
- Observation and evaluation of all excavations which may be impacted by geologic conditions.

3.3.2 Geotechnical CQA Monitors

Geotechnical CQA Monitors will be representatives of the Geotechnical CQA Consultant and will continuously observe all grading and geosynthetic operations to provide a basis for concluding that construction is carried out in conformance with the Project Drawings and Specifications. The duties of the Geotechnical CQA Monitors include monitoring, observing and testing all earthwork as well as monitoring, logging and documenting all geosynthetic installation operations.

The operations to be monitored observed and/or tested for the earthwork include:

- Observation of subgrade surface preparation.
- Verification that soils are derived from appropriate sources.
- Visual evaluation of the soil physical properties for consistency with the Project Drawings and Specifications.
- Evaluation of all moisture conditioning and processing operations to evaluate uniformity of material and moisture content.
- Evaluation of the constructed engineered fill material for conformance with the Project Drawings and Specifications.
- Identification of deleterious materials or other deficiencies in soil characteristics to minimize the possibility that these materials are incorporated into the composite liner system.
- Monitoring of activities for the removal and/or disaggregation of all oversize material.
- Observation of uniformity of coverage of compaction equipment, especially at fill edges, turnaround areas and on slope faces.
- Monitoring of lift thickness.
- Observation of the active fill pad at the beginning of each grading day and establishment of requirements for wetting/drying and/or processing of exposed surfaces prior to placement of additional fill.

- Undertaking field tests including but not limited to field moisture/density testing at the minimum frequencies noted herein or at any time that a deficiency is suspected.
- Recovery of samples for laboratory testing.
- Confirmation that the test results are in accordance with the Project Specifications (including retests of any previously failed areas).

The operations to be observed and monitored for all geosynthetics include:

- Material delivery.
- Unloading and on-site transport and storage.
- Placement/deployment operations.
- Joining and/or seaming operations.
- Repair operations.

Specifically, the seaming operations to be monitored include:

- Trial seams.
- Seam preparation.
- Seaming.
- Nondestructive seam testing.
- Sampling for destructive seam testing.
- Laboratory test sample marking.
- Repair operations.
- Reviewing the final certification of seams.

In addition to these specific duties, the Geotechnical CQA Monitors shall be responsible for:

- Observing the condition of geosynthetic materials as placed.
- Selecting samples for conformance testing by the Independent Testing Laboratory.
- Marking samples for conformance testing.
- Notation of any on-site activities that could result in damage to the geosynthetics.

All observations shall be reported in a timely manner to the Construction Manager.

3.4 Independent Testing Laboratory

The Independent Testing Laboratory shall be certified by the Geosynthetic Accreditation Institute (GAI) in the specific tests to be performed and will perform all conformance testing of geosynthetics and all destructive laboratory testing of field seams.

4. Meetings

In order to facilitate Closure Construction, close coordination between the Construction Manager, Engineer, Geotechnical CQA Consultant, Contractor, Liner Subcontractor and Geotechnical CQA personnel is essential. To this end the following meetings will be scheduled.

4.1 Pre-Construction Meetings

A Pre-construction Meeting will be held at the site. At a minimum, the meeting shall be attended by the County (or designated representative), the Construction Manager, the Landfill Engineer, the Geotechnical Consultant (or designated representative), the Contractor and appropriate Geotechnical CQA staff.

Specific items to be considered at this meeting will include:

- Any appropriate modifications to the Geotechnical CQA requirements.
- Development of a format for site specific documentation.
- Review of the responsibilities of each party.
- Review of the lines of authority and communication.
- Review of work area security and safety protocol.
- Review of the procedures for project documentation and reporting, and distribution of documents and reports.
- Review of procedures for submittals, change orders and extra work efforts.
- Review of the Contractor's proposed methods of construction, (including equipment), with specific emphasis on methods of select grading, soil mixing, stockpiling, processing, moisture conditioning and compaction.
- Review of the procedures for field and laboratory CQA testing.
- Establishment of procedures for correcting and documenting construction deficiencies.

- Conducting an initial site inspection to discuss work areas, stockpile areas, mixing tables, laydown areas, access roads, haul roads, and related items.
- Review of the project schedule.

The meeting shall be documented by the Construction Manager and minutes shall be distributed to all parties.

4.2 Weekly Progress Meetings

Progress Meetings shall be held weekly. At a minimum, these meetings shall be attended by the County (or designated representative), the Construction Manager, the Geotechnical CQA Manager and/or the Geotechnical CQA Monitors, and the Contractor. Weekly progress meetings shall be documented by the Construction Manager or his/her representative and minutes shall be distributed to all parties. The purpose of these meetings is to:

- Discuss any health and safety related issues.
- Review scheduled work activities.
- Discuss project related problems.
- Review laboratory and field test data.
- Discuss the Contractor's personnel and equipment assignments.
- Review the previous week's activities and accomplishments.

4.3 Special Meetings

Special meetings will be conducted as required to discuss any problems or deficiencies. At a minimum, these meetings will be attended by the County (or designated representative), Construction Manager, appropriate Geotechnical CQA staff and the Contractor. If correction of a problem requires a design modification, the Landfill Engineer and the Geotechnical Project Director will also be present. The purpose of these meetings is to:

- Define and discuss any problems or deficiencies in the Project.
- Review possible corrective actions or solutions.
- Implement an action plan to resolve the problems or deficiencies.

Special meetings shall be documented by the Construction Manager or his/her representative and minutes shall be distributed to all parties.

4.4 Geosynthetic Material Pre-Installation Meeting

A Geosynthetic Material Pre-installation Meeting may be held at the site before installation of the geosynthetics. At a minimum, the meeting shall be attended by the Construction Manager, the Engineer, the Contractor, the Liner Subcontractor, and Geotechnical CQA staff. The Pre-Installation Meeting will not be conducted until all Manufacturer Certifications required by the Project Specifications and this document are received, reviewed and approved.

Specific items to be addressed at this meeting include:

- Submittal and review of relevant documents.
- Definition of appropriate modifications to the Geosynthetic Geotechnical CQA requirements.
- Development of a format for site specific documentation.
- Definition of the responsibilities of each party.
- Definition of lines of authority and communication.
- Review of work area security and safety protocol.
- Definition of methods for documenting and reporting, including distributions.
- Selection of welding equipment and procedures.
- A field welded seam(s) demonstration.
- Identification of testing equipment and procedures, including peel and shear tests, and procedures for communicating laboratory test results.
- Identification of procedures for correcting and documenting construction deficiencies.
- A site inspection to discuss storage areas, work areas, stockpile areas, laydown areas, access roads, haul roads, and related items.
- Review of the project schedule.

The meeting shall be documented by the Construction Manager and minutes shall be distributed to all parties.

4.5 Daily Progress Meetings (If Necessary)

Daily Progress Meetings may be held in the field before the start of work each day. At a minimum, these meetings shall be attended by the Geotechnical CQA Manager or his/her

representative, Geotechnical CQA Monitors, the Contractor and the Liner Subcontractor. The purpose of these meetings is to:

- Review and coordinate scheduled work activities between the Geotechnical CQA monitors and the Liner Subcontractor's crew.
- Discuss any problems.
- Review test data.
- Discuss the Liner Subcontractor's personnel and equipment assignments for the day.
- Review the previous day's activities, accomplishments and/or deficiencies.

4.6 Manufacturing Plant Visit(s)

The Liner Subcontractor shall arrange with the Liner Manufacturer(s) to allow the Geotechnical CQA Manager or his/her designee to visit the geosynthetics manufacturing plant(s) during manufacture of the liner material for this project and to observe manufacturing methods and quality control of manufactured materials. If appropriate, the Geotechnical CQA Manager or his/her designee shall review the manufacturing process, quality control, laboratory facilities and testing procedures.

During the plant visit, those visiting shall:

- Observe that the geosynthetic properties presented in the Liner Manufacturer's certification documents meet the Project Specifications.
- Verify that the measurements of properties by the Liner Manufacturer are properly documented and test methods used are acceptable.
- Spot inspect some of the geomembrane rolls and verify that they are free of holes, blisters, or any sign of contamination by foreign matter.
- Review packaging and transportation procedures to verify that these procedures are not damaging the geosynthetics.
- Observe that roll packages have a label indicating the name of the Liner Manufacturer, type of geosynthetic, its roll/panel number and other required information.
- Verify that extrusion rods and/or beads are derived from the same base resin type as the geomembrane.

5. Geotechnical CQA Monitoring for Earth Materials

5.1 General

Closure Construction shall be performed in accordance with the Project Drawings and Specifications and shall be continuously observed, and routinely sampled and tested by the Geotechnical CQA Monitors for the physical parameters described in this section.

Earth materials for Closure Construction will include unclassified engineered fill to form the foundation fill on the slopes and benches for installation of the ClosureTurf® or LiteEarth™ Final Cover Systems. The testing frequency presented herein is a minimum. Additional tests will be conducted by the Geotechnical CQA Monitor for retests and at any time that in the opinion of the Geotechnical CQA Monitor, additional testing is required and/or a deficiency is suspected. Retests of previously failed areas will be performed at the discretion of the Geotechnical CQA Monitor when, in his/her opinion, sufficient reworking of the area has been performed to warrant a retest.

5.2 Unclassified Engineered Fill

Unclassified engineered fills will be placed at the locations indicated on the Drawings to bring the liner subgrade to the design line and grade. Unclassified engineered fill will be generated from the on-site borrow areas, stockpiles, and/or approved local import sources as indicated on the Drawings, processed to remove particles in excess of 4-inches, moisture conditioned to + 2 percent of optimum moisture content, and compacted in 6-to 8-inch lifts to a minimum of 90 percent density when compared to the maximum dry density (ASTM D1557). Prior to unclassified engineered fill placement, the subgrade soils will be properly moisture conditioned to provide an adequate bond between the fill and underlying subgrade materials.

Select soils from the approved borrow area shall be screened (if necessary to remove rock or rock fragments in excess of four (4) inches in maximum dimension), dried, and/or moisture conditioned until uniformly blended material characteristics and moisture condition are attained. Field and laboratory testing for moisture content, in-place dry density, and engineering properties during construction of the unclassified engineered compacted fill layer of the cover system will be completed according to the following minimum schedule:

Unclassified Engineered Fill

Test Description	Test Designation	Minimum Test Frequency
Moisture-Density Relationship	ASTM D1557	One per 5,000 cubic yards or per change in material type
In-Place Moisture-Density (Nuclear and/or Drive Ring)	ASTM D6938; or ASTM D2937	One per 500 cubic yards placed
In-Place Density and Moisture Content (Sand-Cone)	ASTM D1556	One per 5,000 cubic yards placed or 10 percent of nuclear gauge tests
Visual Inspection	ASTM D2488	Daily

Anchor trench backfill shall be composed of the same unclassified engineered fill soils with the exception that anchor trench backfill soils will only be evaluated for in-place moisture content and density. No soils other than those obtained from the approved borrow source and/or approved by the Geotechnical Consultant are to be used in closure construction.

5.3 Acceptance Criteria

5.3.1 General

Where test results indicate that the lift thickness, maximum particle size, homogeneity of material, moisture content, or density, of any portion of the work is below the project requirements, that particular portion shall be retested and/or reworked or replaced until the required condition has been attained and the resulting product meets or exceeds the requirements of the Project Specifications. No additional fill shall be placed over an area until the existing fill has been tested horizontally and vertically and determined by the Geotechnical CQA Monitor to meet the Project Earthwork Specifications. The area to be reworked will be verified by survey if in the opinion of the Geotechnical CQA Monitor conditions warrant.

5.3.2 Moisture Content and Density

If in the opinion of the Geotechnical CQA Manager or the Senior Geotechnical CQA Monitor, engineered fill materials including the unclassified fill, or anchor trench backfill, which have been placed and/or are ready to be placed, do not visually have a uniform and homogeneous moisture content throughout the material in question, these materials will be removed, without testing, and will be reprocessed and/or reworked until, in the opinion of the Geotechnical CQA Manager or his/her designated representative, they meet the Project Specifications.

For all unclassified fill materials placed, the minimum compaction shall be 90 percent of the maximum dry density (ASTM D1557), and the moisture content shall be plus or minus 2 percent of optimum moisture content as determined by ASTM D1557 and D6938. If test results indicate a relative dry density of less than that required, or a moisture content outside the limits specified, then the area will be considered inadequate and will be reworked. Any reworked areas will be retested by the Geotechnical CQA Monitor to verify the reworked area meets the density and moisture content requirements.

5.3.3 Lift Thickness and Processing

If at any time the CQA Monitor observes an uncompacted lift thickness in excess of eight inches or observes material being placed without meeting the requirements for processing, stockpiling and curing, the Contractor shall immediately discontinue placing additional fills in that area. For an over thick lift, the Contractor shall immediately blade the surface to reduce the lift thickness to the Project Specifications prior to compaction. If inadequately mixed materials are placed, the Contractor shall immediately remove these materials and return them to the stockpile/processing area where they will be reprocessed.

5.3.4 Geomembrane Subgrade

The CQA Monitor and the geomembrane installation Contractor will observe and approve the geomembrane subgrade prior to geosynthetic material deployment. The finish surface shall be free of abrupt breaks, sharp objects, or other foreign material which may damage the overlying geomembrane. The subgrade shall be unyielding, smooth and uniform and the surface shall not be pebbly or tracked and rutted by equipment.

Immediately prior to geomembrane deployment, all subgrade surfaces (i.e., base liner and slopes), will be proof-rolled with a steel drum roller weighting not less than 200 pounds per lineal inch of drum width. Geomembrane deployment shall not proceed until the surface has been approved by the CQA Monitor and accepted by the geomembrane installation Contractor.

6. Geotechnical CQA Monitoring for Geosynthetics (Alternatives “A” and “B”)

6.1 Geomembrane (LLDPE) and Turf/Geomembrane Composite

Delivery of geomembrane to the site will not be allowed until all required documentation and/or certifications are approved by the CM/Geotechnical CQA Team. It is the responsibility of the

Contractor/Subcontractor to ensure that all required documentation and/or certifications are approved prior to shipment.

The LLDPE Geomembrane will meet the requirements specified in the following Tables for Alternative "A" and Alternative "B":

LLDPE GEOMEMBRANE MATERIAL PROPERTIES AND TESTING FREQUENCIES

ALTERNATIVE "A"

SUMMARY OF 50-mil SUPER GRIPNET LLDPE GEOMEMBRANE (Alternative "A") MANUFACTURER'S QUALITY ASSURANCE (MQA)				
PHYSICAL PROPERTY	METHOD	UNIT	REQUIREMENT	FREQUENCY
Thickness (nominal) Thickness (min. ave.) Thickness (lowest individual – 8 out of 10) Thickness (lowest individual – 10 out of 10)	ASTM D5994	mils	50 47.5 45 42.5	Per Roll
Drainage Stud Height (min. ave.)			130	
Spike Height mils (min ave.)			175	
Formulated Density (max.)			<0.939	
Tensile Properties (min. ave. both directions) ⁽²⁾ • Break strength – lb/in. (2 in/min) • Break elongation - %	ASTM D6693 Type IV	lb./in. % (GL=2.0 in.)	105 300	Every 50,000 square feet
2% Modulus (max.)			3000	
Tear Resistance (min. ave.)	ASTM D1004	lb.	30	Every 100,000 square feet
Puncture Resistance (min. ave.)	ASTM D4833	lb.	55	Every 100,000 square feet
Carbon black content %	ASTM D4218 ⁽³⁾	%	2.0 to 3.0	Every 100,000 square feet
Carbon black dispersion (Category)	ASTM D5596	N/A	Note (4)	Every 100,000 square feet
Oxidative Induction Time (OIT) (min. ave.) ⁽⁵⁾ (a) Standard OIT – min.; or (b) High Pressure OIT – min.	ASTM D8117 ASTM D5885	min.	100 400	Every 500,000 square feet
Oven Aging at 85°C ⁽⁶⁾ - % retained after 90 days (a) Standard OIT (min. ave.) (b) High Pressure OIT (min. ave.)			35 60	
UV Resistance ⁽⁷⁾ (b) High Pressure OIT (min. ave.) - % retained after 1600 hrs ⁽⁸⁾	ASTM D7238 ASTM D5885	%	35	Per formulation

- (1) Alternate the measurement side for double sided textured sheet.
- (2) Machine Direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens in each direction.
 - Break elongation is calculated using a gage length of 2.0 in. at 2.0 in./min.
- (3) Other methods such as D1603 (tube furnace) or D6370 (TGA) are acceptable if an appropriate correlation to D4218 (muffle furnace) can be established.
- (4) Carbon black dispersion (only near spherical agglomerates) for 10 different views:
 - 10 in Categories 1 or 2 and 0 in Category 3
- (5) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.
- (6) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90-day response.
- (7) The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.
- (8) UV resistance is based on percent retained value regardless of the original HP-OIT value.

LLDPE GEOMEMBRANE MATERIAL PROPERTIES AND TESTING FREQUENCIES
ALTERNATIVE "B"

SUMMARY OF 40-MIL LLDPE GEOMEMBRANE WITH INTEGRAL TURF COMPONENT (Alternative "B") MANUFACTURER'S QUALITY ASSURANCE (MQA)				
PHYSICAL PROPERTY	METHOD	UNIT	REQUIREMENT	FREQUENCY
Thickness (nominal) Thickness (min. ave.) Thickness (lowest individual – 8 out of 10) Thickness (lowest individual – 10 out of 10)	ASTM D5994	mils	40 38 36 34	Per Roll
Asperity Height mils (min ave.)	ASTM D7466	mils	16	Every 2 nd Roll ⁽¹⁾
Melt Index	ASTM D1238	g/10 min.	1.0	1/Batch
Formulated Density (max)	ASTM D1505 or ASTM D792 Method B	g./cc.	<0.939	Every 500,000 square feet
Tensile Properties (min. ave. both directions) ⁽²⁾ • Break strength – lb/in. (2 in/min) • Break elongation - %	ASTM D6693 Type IV	lb./in. % (GL=2.0 in.)	100 250	Every 50,000 square feet
2% Modulus (max.)	ASTM D5323	lb./in.	2400	Per formulation
Tear Resistance (min. ave.)	ASTM D1004	lb.	25	Every 100,000 square feet
Puncture Resistance (min. ave.)	ASTM D4833	lb.	56	Every 100,000 square feet
Carbon black content %	ASTM D4218 ⁽³⁾	%	2.0 to 3.0	Every 100,000 square feet
Carbon black dispersion (Category)	ASTM D5596	N/A	Note (4)	Every 100,000 square feet
Oxidative Induction Time (OIT) (min. ave.) ⁽⁵⁾ (a) Standard OIT – min.; or (b) High Pressure OIT – min.	ASTM D8117 ASTM D5885	min.	100 400	Every 500,000 square feet
Oven Aging at 85°C ⁽⁶⁾ - % retained after 90 days (a) Standard OIT (min. ave.) (b) High Pressure OIT (min. ave.)	ASTM D5721 ASTM D5885	%	35 60	Per formulation
UV Resistance ⁽⁷⁾ (b) High Pressure OIT (min. ave.) - % retained after 1600 hrs ⁽⁸⁾	ASTM D7238 ASTM D5885	%	35	Per formulation
Dimensional Stability	ASTM D1204	%	32	Certified by Manufacturer
Multi-Axial Tensile (min.)	ASTM D5617	%	30	Per formulation
Low Temperature Brittleness	ASTM D746	Degrees F	-106	Certified by Manufacturer

- (1) Alternate the measurement side for double sided textured sheet.
- (2) Machine Direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens in each direction.
 - Break elongation is calculated using a gage length of 2.0 in. at 2.0 in./min.
- (3) Other methods such as D1603 (tube furnace) or D6370 (TGA) are acceptable if an appropriate correlation to D4218 (muffle furnace) can be established.
- (4) Carbon black dispersion (only near spherical agglomerates) for 10 different views: 9 in Categories 1 or 2 and 1 in Category 3.
- (5) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.
- (6) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90-day response.
- (7) The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.
- (8) UV resistance is based on percent retained value regardless of the original HP-OIT value.

SYNTHETIC TURF AND PRIMARY BACKING PROPERTIES
ALTERNATIVE "B"

SUMMARY OF SYNTHETIC TURF AND PRIMARY BACKING PROPERTIES (Alternative "B") MANUFACTURER'S QUALITY ASSURANCE (MQA)				
PHYSICAL PROPERTY	METHOD	UNIT	REQUIREMENT	FREQUENCY ⁽¹⁾
Grass Fiber Density	ASTM D792	g/cc	0.948	Every 720,000 square feet
Grass Fiber Tensile Properties <ul style="list-style-type: none"> • Break strength • Elongation • Tenacity 	ASTM D2256	lb (kg) % oz/(g)/denier	31.7 (14.3) 77.2 0.05 (1.47)	Every 720,000 square feet
Grass Fiber UV Resistance	ISO 4892-2:2006(E)	% Retained	50% > 34,000 hrs	Every 720,000 square feet
Grass Fiber Denier	ASTM D1577	Denier	10,800	Every 720,000 square feet
Grass Fiber Diameter (PE Monofilament)	ASTM D3218	microns	300	Every 720,000 square feet
Grass Pile Height	ASTM D5823	in (mm)	1.125 (28.5)	Every 720,000 square feet
Stitch Gage	ASTM D5793	in (mm)	0.5 (12.7)	Every 720,000 square feet
Pile Mass	ASTM D5848	oz/sy (g/sm)	27 (946)	Every 720,000 square feet
Total Mass	ASTM D5848	oz/sy (g/sm)	31.5 (1,064)	Every 720,000 square feet
Tuft Bind	ASTM D1335	lb (N)	3 (13.4)	Every 720,000 square feet
Grab Tear (Width)	ASTM D5034	lb (N)	275 (1,223)	Every 720,000 square feet
Grab Tear (Length)	ASTM D5034	lb (N)	225 (1,000)	Every 720,000 square feet
Primary Backing Textile Mass	ASTM D5848	oz/sy (g/sm)	3.4 (118)	Every 720,000 square feet
Pill Burn Test	ASTM D2859		Pass	Every 720,000 square feet
Primary Backing UV Resistance after 1000 hours	ASTM D4355/D5035	% Retained	95%	Every 720,000 square feet

(1) Testing frequency based on standard roll dimension and LLDPE density and is equivalent to approximately one test per 720,000 SF (i.e. about one test per railcar).

6.1.1 LLDPE Manufacturing

Prior to the delivery of any geosynthetic material, the Liner Manufacturer shall provide the Construction Manager with the following:

- A properties sheet for the rolls to be delivered including all specified properties measured using test methods indicated in the specifications.
- The sampling procedure and results of testing.
- A certification for each roll stating that property values given in the properties sheet are guaranteed by the Liner Manufacturer.

The Geotechnical CQA Manager shall verify that:

- The property values certified by the Liner Manufacturer meet the project specifications.
- The measurements of properties by the Liner Manufacturer are properly documented and that the test methods used are acceptable.

Prior to shipment, the Liner Manufacturer shall provide the Construction Manager with a quality control certificate for each roll of geomembrane. The quality control certificate(s) shall be signed by a responsible person employed by the Liner Manufacturer and shall include:

- Lot and roll numbers and identification.
- Sampling procedures and results of quality control tests. At a minimum, results shall be given for those properties identified in the Project Specifications.

The Geotechnical CQA Manager shall:

- Verify that the quality control certificates have been provided at the specified frequency for all rolls, and that each certificate identifies the rolls related to it.
- Review the quality control certificates and verify that the certified roll properties meet the specifications.

6.1.2 Geomembrane Delivery

Prior to delivery, all individual roll manufacturer certifications required by this document and/or the Project Specifications must be received and approved by the Construction Manager.

Delivery of any unapproved roll will not be allowed and unapproved rolls will be transported off-site at the Contractors expense.

6.1.2.1 *Transportation and Handling*

All transportation and on-site handling of the geomembrane is the responsibility of the Contractor and Liner Subcontractor.

The Geotechnical CQA Manager shall observe the handling equipment used on the site and provide comment on whether it poses any risk of damage to the geomembrane. The Geotechnical CQA Manager will also observe the Contractor and Liner Subcontractor personnel's handling of the geomembrane and provide comment on whether appropriate care is being taken. Finally, the Geotechnical CQA monitor shall verify that all documentation required upon delivery has been received.

Upon delivery at the site, the Contractor, Liner Subcontractor and the Geotechnical CQA Monitor shall complete a surface observation of all rolls for defects and damage. This inspection shall be conducted without unrolling rolls unless defects or damage are found or suspected. The Geotechnical CQA Manager shall report the following to the Construction Manager:

- Rolls, or portions thereof, which should be rejected and removed from the site because they have severe flaws.
- Rolls which visually include minor repairable flaws.

Any damaged rolls shall be rejected and removed from the site or be stored at a location separate from accepted rolls as designated by the Construction Manager. All rolls which do not have proper Liner Manufacturer's documentation shall be removed from the site at the Contractors expense until all required documentation has been received and approved.

A log of all LLDPE received shall be maintained by the Geotechnical CQA Monitor(s).

6.1.2.2 *Geomembrane Storage*

The Contractor and Liner Subcontractor shall be responsible for storage of the LLDPE on-site and shall ensure the storage is consistent with the Manufacturer's recommendations. The Contractor shall coordinate with the County to ensure that storage space is provided in a location (or several locations) such that on-site transportation and handling are minimized. Storage space shall be protected by the Contractor and Liner Subcontractor from theft, vandalism, and damage from actions of man, weather, animals and other sources. The Geotechnical CQA Monitors shall observe that the materials are not stored directly on the ground and storage of the LLDPE is completed in a fashion that protects against damage.

6.1.3 LLDPE Conformance Testing

6.1.3.1 Tests

Upon delivery of the LLDPE, the Contractor or Liner Subcontractor shall ensure that conformance samples are obtained and forwarded to the Independent Testing Laboratory at the frequency required for testing to ensure conformance with the Project Specifications. All conformance samples will be obtained in the presence of the Geotechnical CQA Monitor or his/her designated representative.

At a minimum, conformance tests will include determination of the following characteristics for the HDPE:

- Density (ASTM D1505/D792).
- Thickness (ASTM D5994).
- Tear Resistance (ASTM D1004 Die C).
- Carbon black content (ASTM D4218).
- Carbon Black Dispersion (ASTM D5596).
- Tensile characteristics (yield strength, elongation at yield, break strength, elongation at break) (ASTM D6693).
- Puncture resistance (ASTM D4833).
- Asperity Height (ASTM D7466).

Where optional procedures are noted in the test method, the requirements of the Project Specifications shall prevail.

6.1.3.2 Sampling and Testing Frequency

Unless otherwise specified, conformance samples shall be taken and tested at a rate of one per lot or one per 100,000 square feet, whichever results in the greater number of tests.

6.1.3.3 Sampling Procedures

Samples shall be taken across the entire width of the roll and shall not include the first three feet. Unless otherwise specified, samples shall be 3 ft. long by the roll width. The Geotechnical CQA Monitors shall mark the machine direction on the samples with an arrow, and the Liner Manufacturer's roll identification number.

6.1.3.4 Test Results

The results of Conformance Testing shall be submitted to the Geotechnical CQA Manager who shall examine all conformance test results and report any non-conformance to the Construction Manager, the Contractor and the Lining Subcontractor.

The Geotechnical CQA Manager shall examine all results from the laboratory conformance testing. All specimens tested shall pass. If any specimen fails, the entire sample shall be considered as a failure and rejected. In this event, the material represented by the sample shall be considered nonconformant with the Specifications, and corrective measures shall be implemented. Corrective measures shall include a rerun of the conformance testing using a portion of the same sample. If the second test passes, the Geotechnical CQA Manager may assume an error was made in the first test and the LLDPE material can be accepted. If the second test fails, the Liner Subcontractor shall remove all material represented by the sample from the work area.

All conformance test results must be approved by the Construction Manager prior to the LLDPE represented by the test being approved for deployment/installation. The decision of the Construction Manager shall be final.

6.1.4 LLDPE Installation

6.1.4.1 Earthwork

Surface Preparation

The Contractor shall be responsible for preparing the supporting soil according to the Project Specifications.

Prior to LLDPE installation, the Contractor and Liner Subcontractor shall verify and the Construction Manager and Geotechnical CQA Monitor shall observe that:

- All lines and grades have been checked by survey and approved by the Construction Manager.
- The subgrade has been prepared in accordance with the Project Specifications.
- The surface has been rolled and compacted to be free of surface irregularities, loose soil, and protrusions.
- The supporting soil surfaces do not contain stones or other sharp protrusions which could damage the LLDPE.

- There are no excessively soft areas which could result in LLDPE damage.
- All construction stakes, hubs or other items used for grade control and/or verification have been removed.
- The Liner Subcontractor has certified in writing that the surface on which the LLDPE will be installed is acceptable.

The certificate of acceptance shall be given by the Liner Subcontractor to the Contractor and the Construction Manager prior to commencement of LLDPE installation in the area under consideration. The Geotechnical CQA Monitors shall have a copy of this certificate before installation of LLDPE commences in any given area.

After the supporting surface has been accepted by the Contractor and Liner Subcontractor, it shall be the Contractor and Liner Subcontractor's responsibility to indicate to the Construction Manager any change in the supporting soil condition that may require repair work. If the Construction Manager concurs with the Contractor and Liner Subcontractor, then the Construction Manager shall coordinate the repair of the supporting surface. The subject area will also be observed by the Geotechnical CQA Monitors who shall have the authority to reject an area even after it has been accepted by the Contractor and Liner Subcontractor.

Anchor Trench

Anchor trenches shall be excavated to the lines and widths shown on the Project Drawings, prior to LLDPE placement. The Geotechnical CQA Monitors shall observe that the anchor trenches have been constructed according to the project documents.

Slightly rounded corners shall be provided where the LLDPE adjoins the trench so as to avoid sharp bends in the LLDPE. No loose soil shall be allowed to underlie the LLDPE in the anchor trench.

Anchor trench backfill shall consist of select on-site soils screened to exclude particles in excess of 1-inch and shall be compacted to at least 90 percent relative compaction (ASTM D1557) as outlined in the Specifications.

Care shall be taken when backfilling the trenches to prevent any damage to the geosynthetics. The Geotechnical CQA Monitors shall observe the backfilling operation and advise the Construction Manager of any problems.

6.1.4.2 LLDPE Placement

Field Panel Identification

A field panel (sheet) is a discrete and integral area of LLDPE which is to be seamed in the field along the edges to other field panels (i.e., a field panel is a roll or a single portion of a single roll). The Contractor or Liner Subcontractor shall assign each panel over 25 sq. feet. an identification code which shall be agreed to and used by the Geotechnical CQA Monitors, Construction Manager, Contractor and the Liner Subcontractor. The Contractor or Liner Subcontractor shall locate the code with identifying roll number near the middle of panels less than 50 feet in length and at both ends of any panel over 50 feet in length. The Geotechnical CQA Monitors shall establish a chart showing correspondence between roll numbers, certification reports, and the panel identification code. The field panel identification code shall be used for all Geotechnical CQA records. An LLDPE panel placement log will be maintained by the Geotechnical CQA Monitors.

Field Panel Placement

The Geotechnical CQA Monitors shall record the identification code, location and date of installation of each field panel.

During panel placement, the Geotechnical CQA Monitors shall:

- Verify that field panels are installed in general accordance with the panel layout plan, as approved or modified by the Construction Manager/Engineer.
- Observe the panel surface as it is deployed and record all panel defects and disposition of the defects. All repairs are to be made in accordance with the Specifications.
- Observe that the equipment used does not damage the LLDPE by handling, trafficking, leakage of hydrocarbons, or by other means.
- Observe that the surface beneath the LLDPE has not deteriorated since previous acceptance.
- Observe that there are no stones, construction debris, or other items beneath the LLDPE which could cause damage.
- Observe that the LLDPE is not dragged across an unprepared surface. If the LLDPE is dragged across an unprepared surface, it shall be inspected for scratches and repaired or rejected, if necessary.
- Observe that the method used to unroll the panels does not cause scratches or crimps in the LLDPE and does not damage the supporting soil surface.

- Record weather conditions including temperature, wind, and humidity. The LLDPE shall not be deployed in the presence of excess moisture (fog, dew, mist, etc.), high winds and extreme temperatures as determined by the Geotechnical CQA Manager.
- Observe that people working during the installation of LLDPE do not smoke, wear shoes which could damage the LLDPE, or engage in activities which could damage the LLDPE.
- Observe that the method used to deploy the panel minimizes wrinkles and that the panels are anchored to prevent movement by the wind.
- Observe that direct contact with the LLDPE is minimized; (i.e., the LLDPE is protected by geotextiles, extra LLDPE, or other suitable materials, in areas where excessive traffic may be expected).

The Geotechnical CQA Monitors shall inform the Contractor, the Liner Subcontractor and the Construction Manager if the above conditions are not met.

After placement and prior to seaming, the Geotechnical CQA Monitors shall inspect each panel for damage. The Geotechnical CQA Monitors shall advise the Construction Manager which panels, or portions of panels, should be rejected, repaired, or accepted. Damaged panels or portions of damaged panels which have been rejected shall be marked and their removal from the work area recorded by the Geotechnical CQA Monitors.

6.1.4.3 Field Seaming

The Contractor shall provide the Construction Manager and Geotechnical CQA Manager with a seam and panel layout plan and shall update this plan daily as the job proceeds. No panels shall be seamed until the panel layout plan has been approved by the Construction Manager. A seam numbering system shall be agreed to by the Geotechnical CQA Monitors, Construction Manager, Contractor and Liner Subcontractor prior to the start of seaming operations.

Prior to seaming, each seaming apparatus (welder) shall be tested in accordance with the Specifications to determine if the equipment is functioning properly. The Geotechnical CQA Monitors shall observe all trial weld operations and record the results. It is important that the trial welds be completed under conditions similar to those under which the panels will be seamed. If at any time the Geotechnical CQA Monitor believes that an operator or seaming apparatus is not functioning properly, a test shall be performed on a trial weld. If there are large changes in temperature, humidity, or wind speed, the trial weld test shall be repeated.

Laboratory tests may be carried out at the discretion of the Geotechnical CQA Monitors to verify field test results.

During seaming operations, the Geotechnical CQA Monitors shall observe that:

- The Liner Subcontractor has the number of welders and spare parts agreed to in the pre-construction meeting.
- Equipment used for seaming will not damage the LLDPE.
- The extruder is purged prior to beginning a seam until all the heat-degraded extrudate is removed (extrusion welding only).
- Seam grinding has been completed less than 1 hour before seam welding (extrusion welding only).
- The ambient temperature measured 6 inches above the LLDPE surface is between 40 and 105 degrees Fahrenheit and relative humidity is less than 80 percent.
- The end of welds more than 5 minutes old, are ground to expose new material before restarting a weld (extrusion welding only).
- The weld is free of dust and other debris.
- For cross seams, the seam is ground to a smooth incline prior to welding.
- The seams are overlapped in a downgradient direction with a minimum overlap of 4 inches.
- No solvents or adhesives are present in the seam area.
- The procedure used to temporarily hold the panels together does not damage the panels and does not preclude Geotechnical CQA testing.
- The panels are being seamed in accordance with the Project Plans and Specifications using approved equipment with gauges giving applicable temperatures.
- There is no free moisture in the weld area.
- The electric generator is placed on a smooth base such that no damage occurs to the LLDPE.
- A smooth insulating plate or fabric is placed beneath the hot welding apparatus after use.
- The geomembrane is protected from damage in heavily trafficked areas.

The Geotechnical CQA Monitors shall log all appropriate temperatures and conditions, and shall log and report to the Geotechnical CQA Manager any non-compliance.

Trial Seams

Trial seam samples are not removed from installed seams, but are made alongside the seaming work area by the Liner Subcontractor using a fragment of the same LLDPE sheet and the same

installation procedures as for the LLDPE installation itself. As such, they are considered nondestructive samples. Such trial seams shall be made at the beginning of each seaming period (start of day, mid-day, and anytime the equipment is shut down or the seaming operation is suspended for more than 1/2 hour) for each piece of seaming equipment used that day. In addition, each welder shall make at least one trial seam each day. Trial seams shall be made under the same conditions as those anticipated for actual seams.

The trial seam sample shall be at least 3 ft. long by 1 ft. plus the seam width wide (after seaming) with the seam centered lengthwise. Seam overlap shall be as per the Specifications. Two opposite specimens, each 1 inch wide, shall be cut from the trial seam sample by the Contractor and/or Liner Subcontractor. Under the observation of a Geotechnical CQA Monitor, the specimens shall be tested by the Liner Subcontractor in shear and peel using a field tensiometer to verify that seams satisfy peel and tensile strength requirements. If a specimen fails, the seaming equipment and seamer shall not be accepted and shall not be used for seaming until the deficiencies are corrected and two consecutive successful full trial welds are achieved. After completing a successful trial/nondestructive sample, the Contractor and/or Liner Subcontractor shall cut a 2' x 2' remnant from the sample and mark the welder number, date, time, ambient temperature, welder temperature, and speed and submit it to the Geotechnical CQA Monitor who will assign an identification number and enter the information on the non-destructive sample form.

The results of field tests carried out on trial seams shall be documented by the Geotechnical CQA Monitors.

General Seaming Procedure

Unless otherwise specified, the general seaming procedure to be used by the Contractor and/or Liner Subcontractor shall be as follows:

- All LLDPE seams shall be overlapped a minimum of four (4) inches.
- "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 LLDPE extending a minimum of 6 inches beyond the cut in all directions. All corners of the patch shall be rounded with a 1-inch minimum radius.
- Adjacent to anchor trenches, seaming shall extend up the panels a minimum of 12 inches past the crest of the anchor trench.

- All cross seams shall be offset at least two feet from the cross seam of the adjacent panel and be extrusion or wedge welded where they intersect.

The Geotechnical CQA Monitors shall observe that the above seaming procedures are followed, and shall inform the Construction Manager if they are not.

6.1.5 Construction Testing

6.1.5.1 Nondestructive Seam Testing

The Contractor and/or Liner Subcontractor shall non-destructively test all field seams over their full length using a vacuum test unit, spark detector, or an air pressure test (for double wedge fusion seams only), as described below. The purpose of nondestructive tests is to check the continuity of seams. It does not provide any information on seam strength. Continuity testing shall be carried out as the seaming work progresses, not at the completion of field seaming.

Visual Inspection

All seams shall be visually evaluated by the Contractor and/or Liner Subcontractor as the installation progresses and again at completion of the installation. Defective and questionable sections shall be clearly marked and repaired as necessary.

Vacuum Box Testing

If the fillet weld, extrusion lap weld or single hot-wedge fusion lap weld technique is used to weld seams, the Contractor and/or Liner Subcontractor shall further test all seams and repairs in the LLDPE by vacuum box. The vacuum box shall be an American Vacuum Seam Tester, Series A100 as manufactured by American Parts and Service Company, Alhambra, California, or an approved equal. All vacuum box testing shall be done in the presence of the Geotechnical CQA Monitor. The area to be tested shall be cleaned of all dust, debris, dirt and other foreign matter. A soap solution shall be applied to the test area with a brush, paint roller or spray bottle and a minimum vacuum of 10 inches of mercury (Hg) (5 psi) shall be induced and held as long as necessary to visually inspect and mark for repair any suspicious areas as evidenced by bubbles in the soap solution.

Spark Testing

If the fillet weld is used to weld seams, the Contractor and/or Liner Subcontractor may, in lieu of vacuum box testing, test all seams and repairs in the LLDPE liner by using a high voltage spark detector, similar to Tinker and Rasor Holiday Detector (Model AP-W). The setting of the

detector shall be 20,000 volts. In order to conduct this test, all seams to be tested shall be provided with 24-30 gauge copper wires properly embedded in the seams and grounded. All spark testing shall be done in the presence of the Geotechnical CQA Monitor. All defective areas shall be marked for repair.

Air Pressure Test

If the double hot-wedge welding technique is used, the Contractor and/or Liner Subcontractor shall further test all seams in the LLDPE lining by using the air pressure test which consists of inserting a needle with gauge in the air space between welds. Air shall be pumped to 35 psi within the weld void and held for at least 5 minutes. If the pressure loss exceeds 2 psi within the weld void during air pressure testing, the outside weld edge (not free edge) shall be sprayed with a soap solution and visually examined for bubbles. If no bubbles appear, the problem is with the inside weld and the seam is acceptable. If any bubbles appear, the defect shall be repaired by extrusion welding and tested by vacuum box and spark detector.

If pressure loss is not more than 2 psi, the opposite end of the seam will be punctured to release the air. If a blockage is present, it will be located and tests on both sides of the blockage will be completed. All penetration holes created during testing shall be sealed by patching and extrusion welding.

Responsibilities of the Geotechnical CQA Monitors

The Geotechnical CQA Monitor/Manager shall:

- Observe and record the continuity of all testing.
- Record the location seam/panel number, date, time, equipment number, Geotechnical CQA Monitor name, test number, welding technician's name, weld, sheet and ambient temperatures and results of all testing.
- Mark the failed areas with a waterproof marker compatible with the lining material and inform the Contractor and/or Liner Subcontractor and the Construction Manager of any required repairs.
- Observe that all testing is completed in accordance with the Project Specifications.
- Observe that all repairs are completed and tested in accordance with the Project Specifications.

6.1.5.2 Destructive Seam Testing

Destructive seam tests shall be performed at selected locations. 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.

Destructive sampling involves samples which have been removed from the installed field seams by the Contractor/Liner Subcontractor. Test locations shall be determined at the discretion of the Geotechnical CQA Monitors and the Contractor/Liner Subcontractor shall not be informed in advance of the locations where the seam samples will be made or will be removed.

Destructive samples shall be shipped by the Contractor/Liner Subcontractor to the Independent Testing Laboratory. All costs associated with the collection, repair, shipping and testing of destructive samples will be borne by the Contractor/Liner Subcontractor.

A minimum of one destructive sample per 500 feet of field seam shall be obtained. This average frequency will be used for the entire installation with the actual frequency of samples based on performance as determined by the Geotechnical CQA Manager.

Additional samples may be removed if the Geotechnical CQA Monitor observes a suspect seam.

6.1.5.3 Sampling Procedures

Samples shall be made or removed by the Contractor/Liner Subcontractor at locations selected by the Geotechnical CQA Monitors as the seaming operation progresses. The Geotechnical CQA Monitor shall:

- Observe making and/or removal of samples.
- Mark each sample with an identifying number which contains the seam number. (For nondestructive samples the seam number welded just prior to making a sample will be marked on the sample).
- Record sample location on the panel layout drawing and enter the information on a Destructive Sample Log Form.
- Record the sample location, date and time taken, weather conditions, and reason the sample was made and/or taken (e.g., random sample, visual appearance, result of a previous failure, etc.).
- Mark sample identifying number on LLDPE adjacent to the location where the sample was taken.

All holes in the LLDPE resulting from destructive seam sampling shall be immediately repaired in accordance with repair procedures described herein. The continuity of the new seams in the repaired area shall be tested according to procedures described herein.

6.1.5.4 *Size of Samples*

Two types of samples shall be made or removed at each location. First, two samples shall be removed for field testing. Each of these samples shall be 1 inch wide with a length of 12 inches plus the seam width. For destructive sampling, the sample shall be taken perpendicular to the seam and the distance between these two samples shall be 38 inches. Samples designated for laboratory testing shall be that portion of seam located between the two samples taken for field testing. The samples for laboratory testing shall be 36 inches long with a width of 12 inches plus the seam width. The seam shall be centered lengthwise. The samples for laboratory testing shall be cut into three equal parts and distributed as follows:

- One part for the Independent Testing Laboratory for testing.
- One part to the Contractor/Liner Subcontractor.
- One part to the Construction Manager for archive storage.

6.1.5.5 *Field Testing*

The two 1-inch wide samples shall be tested in the field for peel adhesion and bonded seam strength (shear) by the Contractor/Liner Subcontractor, and shall not fail in the seam. If one or both of the samples fails in either peel or shear, the Contractor/Liner Subcontractor can, at his/her discretion, (1) reconstruct or cap strip the seam between passed test locations, or (2) take two additional test samples 10 feet on either side of the point of the failed test and repeat this procedure. If the second test passes, the Contractor/Liner Subcontractor shall reconstruct or cap strip the same between the two passed test locations. If subsequent tests fail, the procedure is repeated until the length of the poor-quality seam is established. Repeated failures indicate that either the seaming equipment and/or operator is not performing properly, and appropriate action shall be taken.

6.1.5.6 *Laboratory Testing*

Once the field tests have passed, a sample shall be recovered from between passing field sample locations for testing by the Independent Testing Laboratory. Destructive test samples shall be packaged and shipped to the laboratory by the Contractor/Liner Subcontractor and will be handled in a manner which will not damage the test sample. The Construction Manager will be responsible for storing the archive samples.

Destructive seam samples will be tested by the Independent Testing Laboratory in accordance with ASTM D6392 and the test results evaluated in accordance with GRI Test Method GM 19. Destructive seam testing shall include peel adhesion and bonded seam strength (shear). At least five specimens each shall be tested for peel and shear. Minimum test values are as follows:

Test Description	Test Method	Minimum Requirements	Minimum Requirements
		40-mil LLDPE Geomembrane	50-mil LLDPE Geomembrane
<u>Hot Wedge Seams</u>			
Shear Strength (lb./in)	ASTM D6392	60	75
Shear Elongation (%)		50	50
Peel strength (lb./in)		50	63
Peel Separation (%)		25	25
<u>Extrusion Fillet Seams</u>			
Shear Strength (lb./in)	ASTM D6392	60	75
Shear Elongation (%)		50	50
Peel strength (lb./in)		44	57
Peel Separation (%)		25	25

In accordance with GRI Test Method GM 19, the strength of four out of five 1-inch wide specimens (coupons) tested in shear and peel should meet or exceed the specified strength. The fifth specimen must meet or exceed 80 percent of the specified strength. In addition, the shear percent break elongation should exceed the specified values, and the peel separation (or incursion) should not exceed the specified values. In regard to the locus-of-break patterns of the different seaming methods in shear and peel, the following are unacceptable break codes per their description in ASTM D6392:

Wedge/Fusion Weld: AD and AD-Brk > 25%

Extrusion/Fillet Weld: AD1, AD2, and AD-WLD (unless strength is achieved).

The Independent Testing Laboratory shall provide test results within 24 hours after receipt of samples for testing. Certified test results shall be provided within 5 days. The Geotechnical CQA Monitor shall document all test results on the appropriate forms and shall immediately notify the Geotechnical CQA Manager, Construction Manager, and/or Contractor/Liner Subcontractor in the event of a failed test.

For destructive samples which have failed, corrective measures shall include a rerun of the weld test using the same sample. If the second test passes, the Geotechnical CQA Monitor may assume an error was made in the first test and the field seam may be accepted. If the second test fails, the Contractor/Liner Subcontractor shall reconstruct or cap strip the field seam between any two previous passed seam locations which include the failed seam or shall go on both sides of the failed seam location (10-feet minimum), take another sample each side, and test both in the independent laboratory.

If both samples pass, the Contractor/Liner Subcontractor shall reconstruct or cap strip the field seam between the two passing locations. If either fails, the Contractor/Liner Subcontractor shall repeat the process of taking samples for testing by the Independent Testing Laboratory. In all cases, acceptable field seams must be bounded by two passed test locations. In cases involving more than 50 feet of reconstructed or cap stripped seam, the reconstructed or cap stripped seam shall also be tested. The results of the Independent Testing Laboratory govern seam acceptance. In no case shall field testing of installed seams be used for final acceptance.

The Contractor/Liner Subcontractor's laboratory test results shall be presented to the Geotechnical CQA Manager for comments.

6.1.6 Defects and Repairs

6.1.6.1 Identification

All seams and non-seam areas of the LLDPE shall be examined by the Geotechnical CQA Monitors for identification of defects, holes, blisters, undispersed raw materials and any sign of contamination by foreign matter. Because light reflected by the LLDPE helps to detect defects, the surface of the LLDPE shall be clean at the time of examination. The LLDPE surface shall be cleaned by the Contractor/Liner Subcontractor if the amount of dust or mud inhibits examination.

Each suspect location as identified by the Geotechnical CQA Monitors, both in seam and non-seam areas, shall be non-destructively tested using the methods described herein, as appropriate. Each location which fails the nondestructive testing shall be marked by the Geotechnical CQA Monitor and then repaired and re-tested by the Contractor/Liner Subcontractor. Work shall not proceed with any materials which will cover locations which have been repaired until laboratory test results with passing values have been obtained.

6.1.6.2 Repair Procedures

Any portion of the LLDPE with a flaw or which fails a nondestructive or destructive test shall be repaired in accordance with the Specifications. The Geotechnical CQA Monitor shall locate and describe all repairs on the appropriate forms. Repair procedures include:

- Patching - used to repair large holes, tears, large panel defects, and destructive sample locations which are less than 25 sq. feet in total area.
- Extrusion - used to repair relatively small defects in panels and seams.
- Capping - used to repair failed welds or liner seams where welds cannot be non-destructively tested.
- Removal - used to replace areas with large defects where the preceding methods are not appropriate. Also used to remove excess material (wrinkles) from the installed HDPE.

6.1.6.3 Seam Test Summary

Documentation of all nondestructive and destructive seam testing results, including repairs, shall be summarized by the CQA Monitor on the appropriate forms.

6.1.7 Wrinkles

When placing materials over the HDPE, temperature changes or creep may cause wrinkles to develop in the LLDPE. Any wrinkles which can fold over shall be repaired either by cutting out excess material or, if possible, allowing the LLDPE to contract due to temperature reduction. In no case shall material be placed over the LLDPE which could result in the LLDPE folding. All folded LLDPE shall be removed. No material shall be placed in areas where liner is not in contact with the supporting subgrade.

6.1.8 Anchor Trench

The anchor trench shall be adequately drained to prevent ponding or softening of the adjacent soils while the trench is open. The anchor trench shall be backfilled and compacted as outlined in the Specifications. Fill soils shall consist of on-site granular soil essentially free of organic and deleterious material and approved by the Geotechnical CQA Monitor and Construction Manager. The material shall have a maximum particle size of 1 inch.

Care shall be taken when backfilling the trenches to prevent any damage to the geosynthetics. The Geotechnical CQA Monitor shall observe the bottom of the trenches prior to fill placement to ensure they are free of loose and disturbed materials. The Geotechnical CQA Monitor shall

also observe the backfilling and compaction operation, and shall notify the Geotechnical CQA Manager and the Construction Manager of work performed not in accordance with the Project Specifications.

6.1.9 LLDPE Acceptance

The Contractor/Liner Subcontractor shall retain all ownership and responsibility for the LLDPE until acceptance by the Owner. The LLDPE shall be accepted by the Owner when:

- The installation is finished and approved.
- All seams have been inspected and approved.
- All required laboratory tests have been completed and approved.
- All required Contractor/Liner Subcontractor supplied documentation has been received and approved.
- All record drawings have been completed and approved.

6.1.10 Liner Materials

The Geotechnical CQA procedures indicated in this section are intended to allow the installation of materials in contact with the geosynthetics without causing damage to the LLDPE.

Important points for Quality Assurance of materials in contact with LLDPE include:

- A geotextile or drainage medium approved by the Construction Manager shall be installed above the LLDPE.
- Equipment used for placing soil shall not be driven directly on the LLDPE/geotextile.
- In heavily trafficked areas, such as access ramps, soil thickness should be at least three (3) feet over the geosynthetics.
- Placement of soils, gravels, sand or other types of earth materials on top of the LLDPE/geotextile shall not be performed until all destructive and nondestructive testing has been performed and accepted.
- Placement of overlying earth materials shall be performed in a manner to minimize wrinkles. Equipment operators shall be briefed on methods of placement relative to thermal expansion and contraction of the LLDPE.
- Soil material(s) placed on top of the LLDPE/geotextile shall be stockpiled and displaced off the stockpile to create a cascading effect of the material on top of the LLDPE/geotextile.

The Geotechnical CQA Monitors shall inform the Geotechnical CQA Manager if the above conditions are not fulfilled.

6.2 Engineered Turf and Geotextiles (Alternative “A”)

Engineered Turf, a propriety component of the ClosureTurf® cover system by Watershed Geosynthetics, LLC, is a synthetic structured material consisting of one or more geotextiles tufted with polyethylene yarns that resembles grass blades. The Engineered Turf material will be installed over the textured LLDPE geomembrane and ballasted with infill sand infill as detailed in Section 2H of the Project Specifications. Cushion non-woven geotextiles will be installed as shown on the Construction Drawings for separation of the gravel around the drainage collection piping, the CMB or gravel roads from subgrade soils, and separating the geocomposite drains from adjacent soils. The Engineered Turf and cushion geotextiles shall meet the following specified material properties:

**ENGINEERED TURF AND SAND BALLAST (Alternative "A")
MATERIAL PROPERTIES AND TESTING FREQUENCIES**

SUMMARY OF ENGINEERED TURF COMPONENT (CT) AND SAND BALLAST MANUFACTURER'S QUALITY ASSURANCE (MQA)				
PHYSICAL PROPERTY	METHOD	UNIT	REQUIREMENT	FREQUENCY
CRB Puncture	ASTMD D6241	lb.	1,500	Every 100,000 square feet
Tensile Product Machine Direction (MD) Cross Machine Direction (XMD)	ASTM D4595	lb./ft. lb./ft.	2,100 1,600	Every 100,000 square feet
Rainfall Induced Erosion	ASTM D6459	%	0.05 ⁽¹⁾	One (1) Test for Entire Project
Aerodynamic Evaluation	GTRI Wind Tunnel	lb./sf. of uplift @ 120 mph	0.12	Manufacturers Certification ⁽²⁾
Engineered Turf Fiber Tuft UV Stability	ASTM G147	%	>60 (retained tensile strength) ⁽³⁾	Three (3) Tests for Entire Project
Backing System UV Stability Index Test (Single Geotextile Fully Exposed)	ASTM G1545 Modified Cycle 1 UVA340	lb./ft.	110 (retained tensile strength) ⁽⁴⁾	Three (3) Tests for Entire Project
Steady State Hydraulic Overtopping	ASTM D7277 ASTM D7276	(Note 5)	(Note 5)	Manufacturers Certification ⁽²⁾
Full Scale Wave Overtopping Test Cumulative Volume	Colorado State University Wave Simulator	cu. ft./ft.	165,000	Manufacturers Certification ⁽²⁾
Full Scale Wave Overtopping Test Discharge	Colorado State University Wave Simulator	cu. ft./s./ft.	4.0	Manufacturers Certification ⁽²⁾
Internal Friction of Combined Components	ASTM D5321	min. degrees	35°	Five (5) Tests for Entire Project ⁽⁶⁾
Sand Infill	ASTM D6931	(Note 7)	(Note 7)	One Test every 2,000 tons (min.)
Yarn Weight Total Product Weight	ASTM D5261	oz./sq. yd. oz./sq. yd.	≥20 ≥32	Every 500,000 square feet
Tensile Strength of Yarn (min.)	ASTM D2256	lbs.	15	Every 250,000 square feet

- (1) Infill Loss of 0.05% at rainfall intensities of 6 in./hr.
- (2) Manufacturers Certification of these test results will be accepted.
- (3) Retained tensile strength at 100 years. (projected).
- (4) Retained tensile strength at 6500 hrs. (projected).
- (5) 5 ft. overtopping resulting in 29 ft/s velocity and 8.8 psf. shear stress for manning's N value of 0.02.
- (6) Interface shear test normal loads: 100 psf, 200 psf, 400 psf.
- (7) Particle Size distribution (ASTM C33) shall meet the gradation below (per article 2.6 Sand Infill of the technical specifications):

Sieve	Percent Passing	Sieve	Percent Passing
9.5 mm (3/8 in.)	100	600 µm (No. 30)	25 to 60
4.75 mm (No. 4)	95 to 100	300 µm (No. 50)	5 to 30
2.36 mm (No. 8)	80 to 100	150 µm (No. 100)	0 to 10
1.18 mm (No. 16)	50 to 85		

GEOTEXTILE MATERIAL PROPERTIES AND TESTING FREQUENCIES

GEOTEXTILE MANUFACTURING QUALITY ASSURANCE (MQA)					
PHYSICAL PROPERTY	TEST METHOD	FREQUENCY	UNITS	REQUIREMENT	
				12 oz. Cushion	16 oz. Cushion
Weight (mass/unit area)	ASTM D5261	100,000 ft ² or 1 per lot	oz/yd ²	12*	16
Trapezoidal Tear	ASTM D4533	100,000 ft ² or 1 per lot	lbs.	115	145
Mullen Burst Strength	ASTM D3786	100,000 ft ² or 1 per lot	psi	N/A	N/A
Puncture Resistance	ASTM D4833	100,000 ft ² or 1 per lot	lbs.	140	170
Permittivity	ASTM D4491	100,000 ft ² or 1 per lot	sec ⁻¹	N/A	N/A
Grab Tensile	ASTM D4632	100,000 ft ² or 1 per lot	lbs.	300	370
Grab Elongation	ASTM D4632	100,000 ft ² or 1 per lot	%	50	50
AOS	ASTM D4751	100,000 ft ² or 1 per lot	U.S. Standard Sieve	N/A	N/A
UV Resistance	ASTM D4355	See Note (2)	% strength retained	N/A	70
Notes: 1. * - Minimum values. 2. Evaluation to be on 2.0-inch strip tensile specimens after 500 hours exposure.					

The Contractor/Liner Manufacturer shall provide the Construction Manager with the following documentation for the ClosureTurf® and geotextile as detailed in Section 2H of the Project Specifications:

- A properties sheet which includes all specified properties measured using test methods indicated in the specifications.
- A description of the sampling procedure and appropriate test results.

- A certification that values given in the properties sheet are guaranteed by the Liner Manufacturer.

The Geotechnical CQA Manager shall verify that:

- The property values certified by the Liner Manufacturer meet or exceed the project specifications (Section 2H, Tables 2.1.2 and 2.2.2).
- The measurement of properties by the Liner Manufacturer are properly documented and the test methods used are acceptable.

Prior to shipment, the Contractor/Liner Manufacturer shall provide the Construction Manager with a quality control certificate for each roll of geotextile. The quality control certificate shall be signed by a responsible person employed by the Liner Manufacturer, and shall include roll number and identification.

The Geotechnical CQA Manager shall:

- Verify that the quality control certificates have been provided at the specified frequency for all rolls, and that each certificate identifies the rolls to be delivered.
- Review the quality control certificates and verify that the certified roll properties meet the project specifications.

6.2.1 ClosureTurf®/Geotextile Delivery

The Contractor/Liner Subcontractor shall submit for approval by the Construction Manager, method(s) for handling and storage of ClosureTurf®/geotextile material(s) prior to installation. The Geotechnical CQA Monitor shall observe that:

- Equipment used to unload the rolls will not damage the material.
- Care is used to unload the rolls.
- All ClosureTurf®/geotextile rolls shall be wrapped in plastic to prevent UV degradation.
- All documentation required by the Specifications has been received.

Upon delivery to the site, the Geotechnical CQA Monitors shall conduct a surface inspection of all rolls for defects and damage. This inspection shall be conducted without unrolling rolls unless defects or damage are found or suspected. The Geotechnical CQA Monitors shall indicate to the Geotechnical CQA Manager any rolls, or portions thereof, which should be

rejected and removed from the site because they have severe flaws. These rolls shall be clearly marked as rejected.

Any damaged rolls shall be rejected and removed from the site or stored at a location, designated by the Construction Manager separate from accepted rolls. All rolls which do not have proper documentation from the manufacturer shall also be stored at a separate location until all documentation has been received and approved. A log of the geotextile material(s) received shall be maintained by the Geotechnical CQA Monitor(s).

The Construction Manager shall designate storage space in a location (or several locations) on-site. Storage space shall be protected by the Contractor from theft, vandalism, damage from the actions of man, weather, animals and other sources. The Geotechnical CQA Monitors shall observe that the material is not stored directly on the ground and that storage of the geotextile provides protection against damage pursuant to ASTM D4873.

6.2.2 ClosureTurf®/Geotextile Installation

6.2.2.1 Surface Preparation

Prior to installation, the Construction Manager and Geotechnical CQA Monitors shall observe that:

- All lines and grades have been verified.
- The subgrade has been prepared in accordance with the Project Specifications and the supporting surface does not contain rocks or irregular surfaces which could damage the geotextile.
- There are no excessively soft areas which could result in damage to the geotextile.
- All construction stakes and hubs have been removed.
- The Contractor/Liner Subcontractor has certified in writing that the surface on which the geotextile will be installed is acceptable.

6.2.2.2 Placement

The Contractor/Subcontractor shall give each ClosureTurf®/geotextile panel an identification number which shall be agreed to and used by the Geotechnical CQA Monitors and the Contractor/Liner Subcontractor. The Geotechnical CQA Monitor shall establish a chart showing correspondence between roll numbers, certification reports, and panel numbers.

During panel placement, the Geotechnical CQA Monitor shall:

- Observe the ClosureTurf®/geotextile as it is placed and record all defects and disposition of the defects (panel rejected, patch installed, etc.). All repairs are to be made in accordance with the Specifications.
- Observe that equipment used does not damage the ClosureTurf®/geotextile by handling, traffic, leakage of hydrocarbons, or other means;
- Observe that people working during installation of geotextile do not smoke, wear shoes that could damage the ClosureTurf®/geotextile, or engage in other activities that could damage the geotextile
- Observe that the ClosureTurf®/geotextile is anchored to prevent movement by the wind.
- Observe that adjacent panels of ClosureTurf®/geotextile are overlapped a minimum of 18 inches where the fabric is not seamed (welded or sewn). When seamed, a three-inch minimum overlap will be required.

The Geotechnical CQA Monitors shall inform both the Contractor/Liner Subcontractor and the Geotechnical CQA Manager if the above minimum conditions are not met.

The Contractor/Liner Subcontractor shall provide the Construction Manager with a panel layout plan, and shall update this plan daily as the job proceeds. No geotextile shall be placed until the panel layout plan has been approved by the Construction Manager. During geotextile placement, the Geotechnical CQA Monitors shall observe that:

- The ClosureTurf®/geotextile is cut only with approved cutters, and is not torn or ripped.
- The thread and sewing machinery meet the Project requirements (if sewing is the elected method of joining panels).
- The panels are being overlapped or joined in accordance with the Project Plans and Specifications.
- Any roll of ClosureTurf®/geotextile with a tear exceeding 10 percent of roll width is removed and replaced.

6.2.2.3 *ClosureTurf®/Geotextile Seams*

All geotextile seams shall be formed by welding, or by mating the edges of the geotextile panels, and sewing together with continuous stitches located a minimum of three (3) inches from the mated edges. A 2-thread, double-locked stitch shall be used. Sewing procedures

shall conform to the latest procedures recommended by the geotextile manufacturer, Spot sewing shall not be allowed. Seams shall provide seam strength which equals or exceeds 60 percent of required material strength when tested in accordance with ASTM D4595 (required material strength) and ASTM D4884 (seam strength).

A minimum of one (1) destructive seam strength sample will be obtained for each geotextile material. Sample locations will be determined by the Engineer from the installed production seams and tested by the Contractor's independent testing laboratory.

Horizontal seams on slopes shall not be allowed.

Adjacent geotextile panels in pipe trenches shall be overlapped a minimum of 18-inches unless otherwise shown on the plans."

The methods for the seaming or joining of ClosureTurf® panels will follow the procedures detailed in Section 2H-3.2.1 of the Project Specifications and the manufacturer recommendations, and the following procedures will be added to Section 6.2.2 of the revised CQA Plan.

Installation – Engineered Turf – Sewn Seam Method

- A single stitch prayer type seam is constructed using an American Newlong sewing machine or equivalent.
- The tread will be Polyester or equivalent.
- Sewing will occur between the 1st and 2nd row of tufts from the edge.

Installation – Engineered Turf – Fusion Seaming Method

- "Engineered Turf fusion seaming device will be a DemTech VM20/4/A fusion welder only.
- Fusion seams require a minimum of 5 inches of overlap.
- Frayed or loose geotextile strands will be cut off or removed.
- Prior to starting the production fusion seaming, trial seams must be performed as outlined in Section 3.2.1.3.
- Demonstrate the preparation methods and equipment utilized for removal of the salvage from the outside edge of the rolls of turf (i.e. trimming and cutting devices).
- Mechanical trimming cutting devices will be utilized for salvage trimming.
- Demonstrate and control the fraying of geotextile strands when performing the removal of salvage.

- Any damage that occurs due to production seaming will be repaired as outlined in WG Installation Guidance Documents.

Installation – Engineered Turf – Fusion Seaming Method Trial Seam Requirements

1. Prior to turf component welding, CQA personnel shall observe and document the following:
 - a. Turf welding apparatus are tested;
 - b. at daily start-up; and
 - c. immediately after any break; or anytime the machine is turned off for more than 30 minutes.
2. Procedures:
 - a. The turf trial weld will be completed under conditions similar to those under the panels that will be welded.
 - b. If at any time, the CQA Personnel believe that an operator or fusion welding apparatus is not functioning properly, a Field Trial Seam Test must be performed.
 - c. Any dispute concerning proper installation techniques or the proper function of fusion welding equipment will be resolved by the OWNER'S REPRESENTATIVE.
 - d. The trial weld must be allowed to cool to ambient temperature before seam snapping or panel adjustments are applied.
3. Trial Sample Test Results:
 - a. Trial weld samples must comply with "VISUAL PASSING CRITERIA" Visual passing criteria is verified when a manual peel/pull test is performed and the top turf panel tufts transfer to the bottom turf panel. The transfer of approx. 75% of the tufts constitutes a passing trial weld.
4. Field Seam Test Failure:
 - a. Less than approx. 75% of the top turf panel tufts do not transfer to the bottom turf panel.
5. Additional Trial Sample Testing Requirements:
 - a. Two consecutive trial welds meet the visual passing criteria.
6. The trial weld sample must be a minimum of 3 feet long and 12 inches wide, with the seam centered lengthwise.
7. If a welding apparatus exceeds 5 hours in the second half of the day, another trial seam must be performed.
8. CQA documentation of trial seam procedures will include the following:
 - a. The names of the seaming personnel;

- b. The name of the fusion seaming technician;
- c. the welding apparatus number, time, date;
- d. ambient air temperature; and
- e. welding apparatus temperature & speed setting.

6.2.3 Repairs

Any necessary repairs to the ClosureTurf®/geotextile shall be made with the approved undamaged material itself, using approved overlaps or sewing systems, equipment and techniques. The patch size shall be 18 inches or larger in all directions than the area to be patched and all corners shall be rounded.

When repairs and/or tie-ins to the geotextile and Engineered Turf are necessary, the CQA Monitor will observe the following:

- Tie-in's to the Engineered Turf or geotextile will be used by using a fusion welder or approved seaming method.
- Seaming equipment for the Engineered Turf will be Dem Tech VM 20/4/A welder.
- A handheld heat gun should be used in smaller/concentrated areas.

6.2.4 Sand Infill

Once the ClosureTurf® installation is complete and approved by the CQA Monitor, sand infill will be placed to ballast the ClosureTurf®. The sand infill will meet the following grain-size distribution as tested by ASTM C-33:

Sieve Size	Percent Passing
3/8-inch	100
No. 4	95 to 100
No. 8	80 to 100
No. 16	50 to 85
No. 30	25 to 60
No. 50	5 to 30
No. 100	0 to 10

6.2.4.1 Placement

The sand infill will be placed using a conveyor system and/or Express Blower and the CQA Monitor will verify the thickness of the sand infill by taking measurements with a digital caliper with a depth rod, at a frequency of 20 measurements per acre. The minimum thickness of the sand infill will be 0.5-inches and the maximum thickness will be 0.75-inches.

7. Documentation

The Geotechnical CQA Plan depends on thorough monitoring and documentation of all construction activities. Therefore, the Geotechnical CQA Manager shall document that all Geotechnical CQA requirements have been addressed and satisfied. Documentation shall consist of daily reports, construction problem reports, photographs, design and specification revisions, and a certification report.

7.1 Daily Reports

Daily reports shall consist of field notes, summary of the daily meeting with the Contractor/Liner Subcontractor, observation and data sheets and construction problem reports, and a minimum of four photographs that are representative of the work completed each day. The Daily Reports shall be submitted daily to the Construction Manager for review and approval and emailed to the RWQCB within 48 hours of the end of each workday. The summary of the daily meeting with the Contractor/Liner Subcontractor shall include:

- Date, project name, and location.
- Names of parties attending.
- Scheduled activities.
- Items discussed.
- Signature of Geotechnical CQA Monitor.

7.2 Observation and Test Data Reports

Observation and test data reports shall include:

- Date, project name, and location.
- Weather data.

- A reduced-scale site plan showing work areas, including sample and test locations.
- A description of ongoing construction.
- A summary of test results identified as passing, failing, or, in the event of a failed test, retest.
- Test equipment calibrations, if applicable.
- A summary of decisions regarding acceptance of the work and/or corrective actions taken.
- The signature of the Geotechnical CQA Monitor.

A summary of observation and test data reports shall be submitted on a schedule mutually agreeable to the Construction Manager and Geotechnical CQA Manager.

7.3 Construction Problem Reports

- These reports identify and document construction problems and solutions. They are intended to document problems involving significant rework, and are not intended to document problems which are easily corrected unless the problems are recurring. Each report shall include:
 - A detailed description of the problem.
 - The location and cause of the problem
 - The solution to the problem.
 - The personnel involved.
 - Signatures of the Geotechnical CQA Manager and Construction Manager.

7.4 Design and Specification Revisions

Design and specification revisions may be required during construction. In such cases, the Geotechnical CQA Manager shall notify the Construction Manager. Design and specification revisions shall become official only after written approval of the Construction Manager.

7.5 Photographs

Construction activities will be photographed, including significant problems and remedial actions. The photographs will be identified by location, time, date, and photographer.

7.6 As Built Plans

As-built plans shall be prepared by the Contractor/Subcontractor from surveying and base maps prepared by a Registered Land Surveyor. The Geotechnical CQA Monitors shall observe on a daily basis that the "As-Built" plans include:

- Dimensions of all field panels;
- Location of each panel relative to the surveyor's plan;
- Identification of all panels and seams (including manufacturer's roll identification numbers);
- Location of all patches and repairs;
- Location of all nondestructive and destructive test sampling;
- Identification of problems or unusual conditions.

7.7 Final Certification Report

At completion of the work, the Geotechnical CQA Manager shall submit a final certification report. This report shall render an opinion as to whether the work was performed in compliance with the project plans and specifications.

As a minimum, the final certification report shall include:

- A summary of all construction activities;
- Laboratory and field test results;
- Observation and test data sheets;
- Sampling and testing location plans;
- A description of significant construction problems and the solutions of these problems;
- A list of revisions from the construction plans and specifications, and the justification for these revisions;

A certification statement signed and sealed by a Civil Engineer or Certified Engineering Geologist registered in the State of California.