

**CONSTRUCTION QUALITY ASSURANCE
IMPLEMENTATION PLAN
for the
CELLS 1 AND 2 LINER SYSTEM
at the
LAYON LANDFILL**

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**Project No. 101601.00
March 2010**

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1.0 CONSTRUCTION QUALITY ASSURANCE

1.1 Introduction and Scope

This CQA Implementation Plan (Plan) describes the tasks involved with the construction quality assurance (CQA) for the Layon Landfill. CQA refers to the duties of a third party CQA Consultant to monitor, observe, and evaluate materials and workmanship during construction.

The CQA activities document the compliance of the Contractor with the Drawings and Specifications for the construction. For the purposes of this Plan, the term Contractor refers to the company or individual that is responsible for performing the specific work item being examined to complete the excavation and liner construction at the site. This includes but is not limited to the earthwork contractor(s), geosynthetic installer(s), or their subcontractor(s).

The overall goal of this Plan is to assure that proper construction techniques and procedures are used and that the project is built in accordance with the project Construction Drawings and Specifications. The intent is to identify and define problems that may occur during construction and to observe that these problems are corrected before construction is complete. A written final report prepared by the CQA Consultant will be prepared summarizing the construction activities and observing that the installation was performed in general accordance with the Project Construction Drawings and Specifications. Where discrepancies between this document and the Specifications exist, the Specifications shall govern the Contractor.

1.2 Duties of CQA Personnel

It is the duty and responsibility of the CQA Consultant to implement the elements of this Plan in order to ensure that the construction and installation of the composite liner system at the Project Site is performed in accordance with the Construction Drawings and Specifications and the appropriate Regulations specified to govern this work. CQA duties for this project will be in accordance with Title 27 of the California Code of

Regulations. The CQA personnel shall make every effort to communicate in an efficient and effective manner to the Contractor's representatives on issues concerning testing and observation procedures and results of materials or *in situ* tests performed. The CQA personnel shall attend all preconstruction meetings for the work covered by this plan.

The CQA Consultant is not in a position to direct construction activities, but is encouraged to give advice to the Contractor, Winzler & Kelly (Project CM), or Gershman, Brickner & Bratton, Inc. (GBB), (Receiver) on items which may improve the quality or speed progress of the construction. The CQA Consultant and its representatives shall make every effort to furnish test results to the Contractor in a prompt manner. The representatives of the CQA Consultant shall report to the Project CM and Owner any nonconformance items, which cannot be resolved promptly.

The specific definition and duties of the organizations and personnel associated with the CQA activities are described in the following sections.

1.2.1 Soil Quality Assurance Consultant

The Soil Quality Assurance Consultant (Soil QAC) is the firm which observes and documents activities related to the quality assurance of the installation of the soil components of the lining system on behalf of the Owner. The Soil QAC and Geosynthetic QAC may be the same party.

The Soil QAC is responsible for observing and documenting activities related to the quality assurance of the construction of the soil components of the lining systems. The Soil QAC is responsible for the implementation of the project QAP prepared by the Project Manager. The Soil QAC is also responsible for issuing a final Quality Assurance Report, sealed by a qualified Professional Engineer. Other duties of the Soil QAC shall include overseeing the soil laboratory testing.

1.2.2 Soil Quality Assurance Engineer (QAE)

The term Soil Quality Assurance Engineer (Soil QAE) refers to the engineer employed by the QAC who is personally in charge of the quality assurance work. Duties of the Soil QAE included the following.

1. Reviews all project plans and specifications.
2. Reviews other site-specific documentation.
3. Develops site-specific addenda for quality assurance of soil components with the assistance of the Project Manager as necessary.
4. Administers the soil portions of the QAP, including assigning and managing all soil quality assurance personnel, reviews all field reports, and provides engineering review of all quality assurance related issues.
5. Familiarizes himself with all applicable changes to project plans and specifications as issued by the Designer.
6. Acts as on-site (resident) representative of the Soil QAC.
7. Familiarizes all Soil QA Monitors with the site and the project QAP.
8. Assigns Soil QA Monitors to observe and document all activities requiring monitoring.
9. Attends all quality assurance related meetings, including resolution, pre-construction, daily, weekly meetings.
10. Reviews the calibration certification of the on-site soil testing equipment.
11. Manages the preparation of the record drawings.
12. Reviews the Soil QA Monitors' daily reports, logs, and photographs.
13. Notes any on-site activities that could result in damage to the installed soil components.
14. Reports to the Project Manager, and logs in the daily report, any relevant observations reported by the Soil QA Monitors.
15. Prepares his own daily report.
16. Prepares a daily summary of the soil component quantities estimates installed each day of construction activity.

17. Prepares a weekly summary of soil quality assurance activities at the end of each week of the construction activity.
18. Oversees marking, packaging and shipping of all laboratory test samples.
19. Reviews the results of laboratory testing and makes appropriate recommendations.
20. Recommends the approval of the final soils acceptance to the Project Manager.
21. Designates a Soil QA Monitor to represent the QAE whenever he is absent from the site while operations are ongoing.
22. Reports any unapproved deviations from the QAP to the Project Manager.
23. Maintains field files of all logs and reports.
24. Maintains qualifications of all personnel and calibration of equipment.
25. Prepares the final Quality Assurance Report.

1.2.3 The Soil CQA Monitor:

The personnel of the Soil QAC also include Soil Construction Quality Assurance Monitors (Soil CQA Monitors) who are located at the site for construction observation and documentation. Duties of the Soil CQA Monitors included the following.

1. Monitors, logs, photographs and/or documents all soil component installation operations. Photographs shall be taken routinely and in critical areas of the installation sequence. These duties shall be assigned by the Soil QAE.
2. Monitors and documents the following operations for all soil components:
 - Material delivery
 - Unloading and on-site transport and storage
 - Sampling and conformance testing
 - Deployment operations
 - Condition of the soil components as placed
 - Visual observation, by walkover, of the finished soil components
 - Sampling and field testing of the finished soil components
 - Repair operations, if and when necessary

3. Conducts soil sampling and testing.
4. Documents any on-site activities that could result in damage to the constructed soil components. Any problems notes shall be reported as soon as possible to the Soil QAE.

1.2.4 Geosynthetic Quality Assurance Consultant

The Geosynthetic Quality Assurance Consultant (Geosynthetic QAC) is the firm which observes and documents activities related to the quality assurance of the production and installation of the geosynthetic components of the lining systems on behalf of the Owner. The Geosynthetic QAC and Soil QAC may be the same party.

The Geosynthetic QAC is responsible for observing and documenting activities related to the quality assurance of the production and installation of the geosynthetic components of the lining systems. The Geosynthetic QAC is responsible for reviewing work products of the Geosynthetic Quality Assurance Laboratory. The Geosynthetic QAC is also responsible for issuing a final Quality Assurance Report, sealed by a Professional Engineer.

1.2.5 The Geosynthetic QAE

The term Geosynthetic Quality Assurance Engineer (Geosynthetic QAE) shall be used to designate the engineer working for the Geosynthetic QAC in charge of the quality assurance work. Duties of the Geosynthetic QAE included the following.

1. Familiarizes himself with all project plans and specifications.
2. Reviews other site-specific documentation, including proposed layouts, and manufacturer's and installer's literature.
3. Develops site-specific addenda for quality assurance of geosynthetics with the assistance of the Project Manager, as necessary.
4. Administers the geosynthetic portions of the QAP, including assigning and managing all geosynthetic quality assurance personnel, reviewing all field reports, and providing engineering review of all quality assurance related issues.

5. Reviews for familiarity all appropriate changes to design drawings and project specifications as issued by the Designer.
6. Acts as the on-site (resident) representative of the Geosynthetic QAC.
7. Familiarizes all Geosynthetic Quality Assurance Monitors with the site and the project QAP.
8. Assigns Geosynthetic Quality Assurance personnel to observe and document geosynthetic installation activities requiring certification.
9. Attends all quality assurance related meetings, including resolution, pre-construction, daily, weekly.
10. Reviews all manufacturer and Installer certifications and documentation and makes appropriate recommendations.
11. Reviews the Installer's personnel qualifications for conformance with those qualifications pre-approved for work on site.
12. Manages the preparation of the record drawings.
13. Reviews the calibration certification of the on-site testing equipment, as required.
14. Reviews all Geosynthetic Quality Assurance Monitor's daily reports, logs and photographs.
15. Notes any on-site activities that could result in damage to the geosynthetics.
16. Reports to the Project Manager, and logs in the daily report, any relevant observations reported by the Geosynthetic Quality Assurance Monitors.
17. Prepares his own daily report.
18. Prepares a daily summary of the quantities estimates of geosynthetics installed that day.
19. Prepares the weekly summary of geosynthetic quality assurance activities.
20. Oversees the marking, packaging and shipping of all laboratory test samples.
21. Reviews the results of laboratory testing and makes appropriate

recommendations.

22. Recommends the approval of the final liner acceptance to the Project Manager.
23. Designates a Geosynthetic Quality Assurance Monitor to represent the QAE whenever he is absent from the site while operations are ongoing.
24. Reports any unapproved deviations from the QAP immediately to the Project Manager.
25. Prepares the final Quality Assurance Report.

1.2.6 Geosynthetic Construction Quality Assurance Monitor

Duties of the Geosynthetic Construction Quality Assurance (CQA Monitor) include the following.

1. Monitors, logs, photographs and/or documents all geosynthetic installation operations. Photographs shall be taken routinely and in critical areas of the installation. These duties shall be assigned by the Geosynthetic QAE.
2. Monitors the following operations for all geosynthetics:
 - Material delivery, as required
 - Unloading and on-site transport and storage
 - Sampling for conformance testing
 - Deployment operations
 - Joining and/or seaming operations
 - Condition of panels as placed
 - Visual inspection by walkover
 - Repair operations
3. Monitors and documents the geomembrane seaming operations, including:
 - Trial seams
 - Seam preparation
 - Seaming
 - Nondestructive seam testing
 - Destructive seam testing

- Field tensiometer testing
- Laboratory sample marking
- Repair operations
- Measurements of uninstalled quantities
- Documents and on-site activities that could result in damage to the geosynthetics. Any problems noted shall be reported as soon as possible to the Geosynthetic QAE.

1.2.7 Soil Quality Assurance Laboratory

The Soil Quality Assurance Laboratory (Soil QAL) is the firm which conducts tests on soil samples taken from the site. The Soil QAL and Geosynthetic QAL may be the same party. The Soil QAL is responsible for conducting the appropriate laboratory tests as directed by the Soil QAE. The test procedures shall be done in accordance with the test methods outlined in these specifications.

1.2.8 Geosynthetic Quality Assurance Laboratory

The Geosynthetic Quality Assurance laboratory (Geosynthetic QAL) is the firm which conducts tests on samples of geosynthetics taken from the site. The Geosynthetic QAL and the Soil QAL may be the same party.

The Geosynthetic QAL is responsible for conducting the appropriate laboratory tests as directed by the Geosynthetic QAE. The test procedures shall be done in accordance with the test methods outlined in these specifications.

2.0 EARTHWORK

2.1 General

This section outlines the requirements for earthwork operations for the construction of Cells 1 and 2 at the Layon Liner Landfill. Earthwork includes, but is not limited to:

4. Preparation of Subgrade;
5. Placement of soil material over subdrain geocomposite;
6. Placement of low permeability soil layer;
7. Excavation and backfill of the synthetic liner anchor trenches;
8. Placement of the LCRS gravel, pipe, and geotextile materials;
9. LCRS sump construction;
10. Installation of landfill gas collection system;
11. Protective cover layer material placement; and
12. Installation of surface water drainage structures.

Specifically excluded from this section are the geomembrane, geocomposite drainage layer and geotextile installation which are addressed within Sections 3, 4, and 5 of this CQA Implementation Plan.

2.2 Soil over Subdrain Geocomposite

The soil layer over the subdrain geocomposite will consist of 12-inches of general fill placed; moisture conditioned and compacted to 95% of the maximum dry density as determined by standard Proctor (D698).

The CQA activities on the soil placed over the subdrain geocomposite will consist of but will not be limited to, the following:

1. Proctor laboratory testing of soil material per Table 1;
2. Field moisture and density testing using nuclear gauge per Table 1;
3. Monitoring of moisture conditioning, mixing, blending, and processing for uniformity of material and moisture content; and

4. General observation of placement procedure to ensure that:
 - Folding does not occur in the geocomposite, and
 - Geocomposite and underlying materials are not damaged, minimal slippage occurs between the geocomposite and underlying materials, excessive stresses are not produced in the geocomposite.

**TABLE 1
COMPACTED SOIL OVER GEOCOMPOSITE**

MATERIAL	QUANTITY	TEST DESIGNATION	SPECIFIED FREQUENCY	NO. REQ'D	SPEC
Compacted Soil Over Geocomposite	40,000 cy	Standard Proctor (D698)	1/5,000 cy	8	N/A
		Moisture/Density –Nuclear Method (D2922/D3017)	1/1,000 cy	40	95% max dry density- +3% of opt. moist of D698.
		Moisture Content -Oven (D2216)	1/1,000 cy	40	+3% of opt. moist.

2.3 Low Permeability Soil

2.3.1 General

The low permeability layer will consist of 24-inches of soil material placed, moisture conditioned and compacted to 95% of maximum dry density at +3% of optimum as determined by standard Proctor (ASTM D698).

The CQA Consultant's shall observe the activities associated with construction of the low permeability soil layer. These activities have been divided into preconstruction, construction, and post-construction activities. Testing shall be performed as detailed in the Specifications.

2.3.2 Preconstruction

Preconstruction activities must be performed to provide an understanding of the work activities, design and construction requirements, material properties, and construction

methods that will meet the design requirements prior to full production of the low permeability soil layer. Low permeability soil materials will be tested and evaluated for performance properties and construction procedures will be established with the goal of meeting or exceeding the design requirements.

Preconstruction activities include:

1. Review all design criteria, Construction Drawings, and Specifications associated with construction of the low permeability soil layer.
2. Inspect the soil stockpile for uniformity and the presence of non-suitable materials.
3. Review evaluation testing performed by the Contractor.
4. Review and approve the Contractor's proposed construction methods and equipment to be used for placement of the low permeability soil test fill.
5. Review all test and construction results and determine the acceptability of the construction procedures in meeting the performance goals of the Specifications. If necessary, an additional test fill will be constructed and tested using modified construction procedures.

2.3.3 Construction

The CQA Monitor shall follow the guidelines set forth within the Specifications for the low permeability soil layer.

The construction inspection activities of the CQA Monitors to be performed during low permeability layer placement to help meet the design objectives are as follows:

1. Laboratory testing of low permeability layer material including soil classifications, particle size analyses, Atterberg limits, flex-wall permeability tests and Proctor tests per Table 2.
2. Field moisture and density testing using a nuclear gauge per Table 2.
3. Field hydraulic conductivity tests per Table 2.
4. Monitoring of moisture conditioning, mixing, blending, and processing for uniformity of material and moisture content.
5. General observation of placement procedures including scarification depth, lift thickness placement, compaction equipment usage, and

- number of passes with equipment.
6. Detection and removal of oversized material or deleterious material.
 7. Visually inspect the low permeability material characteristics such as gradation, clod size, excessive organic material, and other characteristics that do not meet the Specifications.
 8. Measure compacted lift thickness. This thickness must not exceed the thickness required in the Specifications.
 9. Record any damage to the compacted low permeability soil layer resulting from the operation of equipment.
 10. Observe that all cracks, depressions, and irregularities in the low permeability soil layer are filled in and compacted to the specified moisture content and relative compaction.
 11. Identify any changes in material used in constructing the low permeability soil layer.
 12. Observe all phases of the construction and document the Contractor's compliance or noncompliance with the Construction Drawings and Specifications.

**TABLE 2
LOW PERMEABILITY MATERIAL TESTING REQUIREMENTS**

MATERIAL	QUANTITY	TEST DESIGNATION	SPECIFIED FREQUENCY	NO. REQ'D	SPEC
Low Permeability Layer	80,000 cy	Standard Proctor (D698)	1/5,000 cy	16	N/A
		Atterberg Limits (D4318)	1/5,000 cy	16	SC, CL or CH
		Particle Size Analysis (D422)	1/5,000 cy	16	<u>% Passing</u> <u>Sieve No</u> 100 ½" 30 No. 200
		Moisture/Density - Nuclear Method (D2922/D3017)	1/1,000 cy	80	95% max dry density- +3% of opt. moist.
		Moisture Content - Oven (D2216)	1/1,000 cy	80	+3% of opt. moist.
		Flex-Wall Permeability Test (D5084)	1/5,000 cy	16	< 1.0 x 10 ⁻⁶ cm/sec
		BAT Permeability/ Boutwell Method Falling Head Permeability	1/15,000 cy	6	< 1.0 x 10 ⁻⁶ cm/sec
		Moisture/Density - Sand Cone Method (D1556)	1/15,000 cy	6	95% max dry density- +3% of opt. moist.

2.3.4 Post-Construction

Upon completion of the low permeability soil layer, a post-construction inspection shall be conducted by the CQA Officer and Monitor. The purpose of this inspection will be to identify those areas that require corrective action by the Contractor. This will occur prior to placement of the geomembrane over the low permeability soil layer. All areas that pass the inspection will immediately be approved for covering with the geomembrane to minimize exposure of the low permeability soil layer.

The CQA Monitor will inspect the low permeability soil layer for the following:

1. Low spots or depressions that would cause water to pond on the low permeability soil layer or geomembrane;
2. Areas that are damaged or improperly mixed or compacted.;
3. Areas that have been excessively eroded by rainfall during the construction period or as a result of construction activities;
4. Large irregularities or protrusions resulting from rocks, sticks, grade stakes, cracks, and excess material placement that would damage the geomembrane or make placing of geosynthetics difficult;
5. Desiccation of the low permeability soil layer; and
6. Unrepaired damage from density tests, field permeability tests, or laboratory permeability tests.

2.4 Anchor Trench Excavation and Backfilling

The CQA Consultant's CQA Monitor shall observe that the anchor trenches are excavated to the approximate lines and grades shown on the Construction Drawings. The CQA Consultant's CQA Monitor shall observe the trench excavation to ensure it has been excavated only the distance required to carry out the synthetic liner installation in an expeditious manner. The CQA Consultant's CQA Monitor shall observe that the following anchor trench conditions are met.

1. The leading edge of the anchor trench is rounded to minimize sharp bends in the liner material;
2. The anchor trench is adequately drained to prevent ponding or otherwise softening of the adjacent soils while the trench is open;
3. No loose soil is underlying the geomembrane in the anchor trenches; and
4. The geomembrane is seamed completely to the end of the panels to minimize the potential of tear propagation along the seam.

In addition, the CQA Consultant's CQA Monitor shall observe the placement and compaction techniques employed by the Contractor to ensure that damage to the liner is prevented or kept to a minimum. Any damage to the synthetic materials shall be immediately repaired in accordance with the Specifications.

2.5 Subdrain and Leachate Collection and Removal System (LCRS)

2.5.1 General

This section sets forth the requirements for the CQA testing and observation requirements for installing the subdrain and LCRS components (with the exception of the geocomposite and geotextile materials) detailed on the Construction Drawings and Specifications. This work includes the materials for the leachate collection laterals, the sump, and subdrain. The Contractor shall furnish submittals in compliance with the Specifications and conditions of warranty prior to construction for review by the CQA Officer and CQA Monitor. The Contractor shall also prepare and submit a time schedule for installation, including complete testing and acceptance of materials prior to construction.

2.5.2 Granular Drainage Material

Granular drainage material is utilized in the trenches and sump as part of the subdrain and LCRS systems (both primary and secondary). The Contractor shall provide a copy of the certificate of compliance and the QC testing data to the CQA Consultants.

The CQA activities on the granular drainage material will consist of, but will not be limited, to the following:

1. Observing that the Contractor places the material during cooler parts of the day (or night, if necessary) in the event of warm weather in order to avoid placement of materials when the liner is wrinkled;
2. Observing that only low ground pressure wide-tracked bulldozers are used for placement, spreading, and final grading operations and that no damage occurs to the geosynthetics; and
3. Review laboratory testing including particle size analyses and hydraulic conductivity testing of aggregate material performed by Contractor.

2.5.3 Subdrain and Leachate Collection Piping

2.5.3.1 Pre-Construction

The CQA Consultant's CQA Monitor will inspect the HDPE pipe and pipe fittings upon delivery for compliance with the requirements of the specifications. The CQA Consultant's CQA Monitor will check the quantity of piping and pipe fittings delivered to assure that the required amount is onsite to complete construction of the pipeline.

The CQA Consultant's CQA Monitor and Contractor will select a storage location in which the HDPE pipe and pipe fittings are protected from excessive heat and cold, construction traffic, hazardous chemicals, solvents, and theft. If the HDPE pipe and pipe fittings are stored at a location with other construction materials, the CQA Consultant's CQA Monitor will assure that stacking or insertion of the other construction materials onto or into the HDPE pipe and pipe fittings is prohibited. The installer will arrange the storage area to provide access for easy inspection. The CQA Consultant's CQA Monitor must periodically inspect to assure HDPE pipe and pipe fittings are undamaged and have been protected as stated above. Neither the CQA Monitor, Installer, nor others will remove HDPE pipe and pipe fittings from shipping package until construction of the force main is initiated.

2.5.3.2 Construction

Upon transporting HDPE pipe and pipe fittings from the storage location to the construction site, all contractors handling the pipe are to wear gloves and use pliable straps, slings, or rope to lift the pipe. Do not use steel cables or chains to transport pipe. The CQA Consultant's CQA Monitor will assure that any pipe greater than 20 feet in length will be lifted with two support points spaced 15 feet apart. The installer will not drop, impact, or bump the pipe, especially at the pipe ends. Pipe and fitting ends must be cleaned of all dirt, debris, oil, or other contaminant that may prohibit making a sound joint.

Out-of-round pipe cannot be properly joined and will be placed in an unstressed position and given time to normally round out.

The installer will construct the HDPE pipeline in a properly graded and sloped trench as is specified. All underground segments of the HDPE pipeline will be installed per the installation guidelines specified by the manufacturer. The installer will join the HDPE pipe into continuous lengths using the butt fusion method. The butt fusion welding will be performed in strict accordance with the manufacturer's recommendations. The CQA Consultant's CQA Monitor will inspect the butt fusion equipment during construction. Inspection will ensure that the joining procedures can meet all the conditions recommended by the pipe manufacturer, including but not limited to, temperature requirements, and alignment and fusion pressures. Before laying the pipe into a trench or on supports, the CQA Consultant's CQA Monitor will conduct a visual inspection of each fusion weld to ensure a proper double roll-back-bead has formed.

2.6 Protective Soils (Operations) Layer

The protective soil layer consists of a 36- inch layer of general fill material placed over the primary geocomposite.

The CQA Consultant's CQA Monitor and CQA Officer shall review the Contractor's list of proposed equipment and Contractor's description of the construction methods to place the protective operations layer over the geosynthetic materials in accordance with the Specifications.

The CQA Consultant's CQA Monitor shall be present during placement and spreading of the protective operations layer material. The CQA Consultant's CQA Monitor will observe placement so that no materials are placed over wrinkles in the underlying geosynthetics and to ensure that the liner and leachate collection system is not damaged. In addition, the CQA Consultant's CQA Monitor will observe that the spreading of the material will be in the direction of the overlap.

The CQA activities on the operations layer will consist of by will not be limited to the following:

1. Perform particle size analyses testing of soil material per Table 3;
2. Observe that the Contractor places the material during cooler parts of the day (or night, if necessary) in the event of warm weather in order to avoid placement of materials when the liner is wrinkled;
3. Observe that the Contractor constructs thick haul roads, turnouts, staging, and dump areas for all rubber tired transport vehicles and loaders;
4. Observe that only low ground pressure wide-tracked bulldozers are used for placement, spreading, and final grading operations; and
5. Observe that the Contractor does not make tight radius turns with track-mounted or rubber-tired equipment.

All observed damage shall be recorded by the CQA Consultant's CQA Monitor, promptly reported to the Contractor, and the location clearly marked for scheduled repair. The Contractor shall promptly repair the underlying geosynthetics in accordance with the Specifications.

**TABLE 3
PROTECTIVE SOIL TESTING REQUIREMENTS**

MATERIAL	QUANTITY	TEST DESIGNATION	SPECIFIED FREQUENCY	NO. REQ'D	SPEC
Protective Soil Cover	97,000 cy	Particle Analysis	1 / 20,000 cy	5	<p style="text-align: center;">Sideslope</p> <p style="text-align: center;"><u>% Passing</u> <u>Sieve No</u></p> <p style="text-align: center;">100 1"</p> <p style="text-align: center;">Cell Floor</p> <p style="text-align: center;"><u>% Passing</u> <u>Sieve No</u></p> <p style="text-align: center;">100 2"</p>

2.7 Surface Water Drainage Structures

The CQA Consultant's CQA Monitor shall observe the installation of the surface water drainage structures for the proposed work in accordance with the Specifications and Construction Drawings. Surface water drainage structures may include, but would not be limited to, drainage channels, ponds, culverts, and diversion berms. The CQA Consultant's CQA Monitor shall review the test data for materials to be supplied by the

Contractor in accordance with the Specifications.

2.8 Landfill Gas Collection System

A landfill gas collection system consisting of slotted HDPE pipe placed within a granular trench encapsulated with geotextile will be installed in the protective soil layer as shown on the construction drawings. The CQA Consultant's CQA Monitor shall observe that the installation of the landfill gas collection system is in accordance with the Specifications and Construction Drawings. CQA activities for the geotextile component and granular drainage material will be similar to the activities described in Sections 5.5 and 3.5.2, respectively.

3.0 GEOMEMBRANE QUALITY ASSURANCE

3.1 General

This section sets forth the requirements for the CQA testing and observation requirements for installing the geomembrane materials detailed on the Construction Drawings and Specifications. This work includes the examination of the Manufacturer's and Contractor's QC testing, conformance testing, shipping and handling, deployment, seaming, repairs, and non-destructive and destructive testing of the geomembrane liner. The CQA Consultant's CQA Monitor and the CQA Officer shall review the submittals furnished by the Contractor to ensure their compliance with the Specifications and conditions of warranty prior to construction. They shall also review the time schedule for installation submitted by the Contractor prior to construction.

3.2 Shipping and Handling

The Contractor shall provide a copy of the QC certificates for production of each geomembrane roll manufactured for this Project prior to construction for review by the CQA Consultant's CQA Monitor and CQA Officer. Materials shall be delivered to the site only after the CQA Consultant's CQA Monitor receives and approves the required submittals.

The Contractor is responsible for the transportation, off-loading, and storage of the geomembrane. The materials shall be packaged and shipped by appropriate means so that no damage is caused and shall be delivered to the site only after the CQA Consultant's CQA Monitor receives and approves the required submittals. Off-loading shall be performed in the presence of the CQA Consultant's CQA Monitor to ensure that damage, if any, during off-loading is properly documented. The CQA Consultant's CQA Monitor shall keep a log of all geomembrane delivered to the Project Site on the appropriate form for review by the CQA Officer.

The CQA Consultant's CQA Monitor shall observe that damaged materials are separated from undamaged materials until proper disposition of the material is determined by the Owner or CQA Officer. Final authority on the determination of damage shall be the CQA Monitor.

3.3 Geomembrane Conformance Testing

After production, the geomembrane shall be sampled for conformance. Sampling shall be performed at the manufacturing plant prior to shipment. One geomembrane sample shall be obtained for every 100,000 square feet produced. The CQA Officer shall review all test results and report any non-conformance test results to the Contractor and the CQA Consultant's CQA Monitor.

The conformance testing shall include the following parameters:

1. Thickness (ASTM D-5994);
2. Sheet Density (ASTM D-1505);
3. Tensile Properties (ASTM D-6693);
4. Carbon Black (ASTM D-1603); and
5. Carbon Dispersion (ASTM D-5596).

3.4 HDPE Geomembrane Placement

Prior to placing the secondary geomembrane panels, the Contractor and CQA Consultant's CQA Monitor shall observe that the low permeability layer has been properly placed and accepted. Once the low permeability liner has been approved by the CQA Monitor, deployment of the secondary geomembrane may begin. For the primary geomembrane, the Contractor and CQA Consultant's CQA Monitor shall observe that the underlying geosynthetics have been properly placed and accepted. Once each layer of material has been approved by the CQA Monitor, deployment of the primary geomembrane may begin.

The CQA Consultant's CQA Monitor shall observe that the Contractor's QC Technician has given each panel an identification number that shall be used by all parties. The CQA Consultant's CQA Monitor shall record the placement of each panel on a geomembrane panel deployment log form to be reviewed by the CQA Officer. As the geomembrane panels are deployed in the field, the CQA Consultant's CQA Monitor shall observe the following:

1. That the low permeability layer has not deteriorated between acceptance and placement of the secondary geomembrane liner;
2. That any underlying geosynthetics have been repaired and approved as necessary;
3. That the equipment used to transport and deploy the geomembrane does not damage it or the low permeability soils;
4. That there are no significant defects present in the sheet. Small defects shall be marked, along with the type of repair required (extrudate, patch, etc.);
5. That the sheet is not deployed under adverse weather conditions such as fog, rain, or high winds;
6. That the equipment and deployment methods do not cause excessive wrinkling of the geomembrane and that the sheet is not dragged along a rough surface. If the liner is dragged, the CQA Consultant's CQA Monitor shall inspect the underside of the material for damage;
7. That personnel do not engage in activities that could damage the geomembrane; and
8. That the Contractor's QC personnel properly record identification information including roll number, panel number, seam number, date, etc.

The CQA Consultant's CQA Monitor shall record all of the above information in daily reports and log sheets and shall inform all parties of any deviations.

3.5 HDPE Geomembrane Test Welds

The CQA Consultant's CQA Monitor shall observe that the Contractor conducts test welds on pieces of scrap liner to observe seam strength prior to field production at the following frequency:

1. At the start of the seaming period;
2. Once every five (5) hours of seaming;
3. Once for every seaming device used; and
4. If the welding machine has been out of service for more than 30 minutes.

The CQA Consultant's CQA Monitor shall record the peel test results for the test weld coupons on a geomembrane start-up trial weld log form. The Contractor shall not begin welding of field seams unless the CQA Consultant's CQA Monitor has observed that the trial welds are acceptable. The CQA Consultant's CQA Monitor shall observe that once a welding technician has been approved on a specific welding apparatus, he does not change machines without first passing a test weld on the new equipment.

3.6 Seaming of the HDPE Geomembrane

The CQA Consultant's CQA Monitor shall observe that the HDPE liner is seamed between the ambient temperatures described within the Specifications. The CQA Consultant's CQA Monitor shall measure and record the temperature 6 inches above the liner surface on an hourly basis. If ambient temperatures are below the project-specified value, then the liner must be preheated prior to seaming. No seaming shall be performed outside of the specified temperature range without written authorization. The CQA Consultant's CQA Monitor shall observe that the geomembrane is not being deployed during precipitation, in the presence of excessive moisture, in areas of ponded water, or in the presence of excessive winds.

The Contractor's QC Technician and the CQA Consultant's CQA Monitor shall observe that the geomembrane seams are oriented parallel to the maximum slope direction and that a seam numbering system compatible with the panel numbering system is used. The CQA Consultant's CQA Monitor shall observe that the Contractor has taken the following steps prior to seaming the HDPE liner:

1. That the liner surface has been cleaned of all foreign material including dirt, dust, debris, moisture, or oil;

2. That a disc grinder has been used perpendicular to seams to remove the oxidation surface in accordance with the project specifications before seaming on extrusion welds.
3. That areas where the sheet thickness has been significantly reduced from grinding are patched by the Contractor;
4. That any bead grooves are covered with single extrudate;
5. That wrinkles and fishmouths are cut out and the edges overlapped. Where the overlap is less than the project specifications, the area shall be patched;
6. That all seaming takes place over a firm, dry surface;
7. That when the ambient temperature is below the specified value, a hot air device is used for preheating in front of the welder;
8. That the approved type and quantity of welding devices are used on the job;
9. That extrusion welders are purged of heat degraded material prior to use;
10. That for cross or tee seams, the edge of the seam is ground to a smooth incline; and
11. That the seam numbering system and welding procedures agreed upon at the preconstruction meeting are strictly followed.

The CQA Consultant's CQA Monitor shall record the above information in his daily reports along with panel placement and seaming log forms to be reviewed by the CQA Officer and promptly notify all parties of any deviations from requirements.

3.7 Extrusion Welding

For extrusion welding, the CQA Consultant's CQA Monitor shall observe that the welding devices are being purged of heat-degraded extrudate, as necessary, before welding following all work stoppages longer than specified. The CQA Consultant's CQA Monitor shall observe that all purged extrudate is disposed of off the liner. The CQA Consultant's CQA Monitor shall observe that no equipment is allowed to begin welding until the test weld, made by that equipment, passes the weld test. All test weld results shall be reviewed and recorded by the CQA Monitor.

3.8 Hot Wedge (Fusion) Welding

For hot wedge (fusion) welding, the CQA Consultant's CQA Monitor shall observe that the welding devices are automated, vehicular mounted, and equipped with gauges giving applicable speed and temperatures. The CQA Consultant's CQA Monitor shall observe that the speed, temperature, and pressure of the welding device is adjusted appropriately during the test welding conducted prior to seaming of the panels. In the event that field conditions require adjustment to the device, the CQA Consultant's CQA Monitor shall observe that additional test welds are performed prior to resuming activities.

3.9 Nondestructive Testing of Geomembrane Seams

3.9.1 General

Prior to the start of construction, the CQA Consultant's CQA Monitor and the CQA Officer shall observe that the Contractor has submitted his QC program manual that describes the procedure for nondestructive testing of all field seams. When the seaming begins in the field, the CQA Consultant's CQA Monitor shall record the results of the geomembrane QC conducted by the Contractor on a geomembrane installer's field QC log form.

3.9.2 Vacuum Box Testing

For nondestructive seam testing, all extrusion welded field seams shall be tested over their full length using vacuum box test units. The vacuum testing shall be performed by the Contractor's QC Technician under the observation of the CQA Monitor. The CQA Consultant's CQA Monitor shall observe that the tests are conducted concurrently with the field seaming and that the vacuum box assembly consists of a rigid box with a transparent viewing window and a vacuum gage. The CQA Consultant's CQA Monitor shall observe that the Contractor's procedure for vacuum testing is as follows:

1. Clean window, gasket surfaces, and check box for leaks;
2. Energize vacuum pump and reduce pressure to the specified value;

3. Place soapy solution on section of seam to be tested;
4. Place box over wetted area and press down;
5. Close bleed valve, open vacuum valve, and ensure that a leak tight seal is created;
6. Examine the length of weld through the viewing window for bubbles for the specified time period;
7. If no bubbles appear, the vacuum valve should be closed, the bleed valve opened, and the box should be moved to the next adjoining area with the specified overlap; and
8. Areas where soap bubbles are detected shall be marked, repaired, and retested.

3.9.3 Air Pressure Testing

If the double hot wedge seaming system is employed, air pressure testing shall be used. The CQA Consultant's CQA Monitor shall observe that air pressure testing is conducted by the Contractor as follows:

1. Seal both ends of the seam to be tested;
2. Insert a hollow needle or other approved pressure feed device into the tunnel created by the double hot wedge and insert a protective cushion between the air pump and geomembrane;
3. Energize the air pump to the specified pressure, close the valve, and sustain the pressure for the specified time limit;
4. Check the entire seam being tested for indications that it has been fully pressurized. This shall be accomplished by opening the air channel at the opposite end of the seam and observing a loss of pressure;
5. If a loss of pressure exceeds the specified value, or does not stabilize, locate the faulty area and repair; and
6. Remove the approved pressure feed device and seal.

Should a loss of pressure be detected along a seam, the faulty area shall be identified, repaired, and re-tested as provided within the Specifications. If blockage occurs along the seam, the area shall also be identified, repaired and re-tested. The Contractor shall be responsible for all costs associated with the seam repair. The results of both vacuum

box and air pressure testing shall be recorded on the seam and panel QC form by the CQA Consultant's CQA Monitor for review by the CQA Officer.

3.10 Destructive Testing of Geomembrane Seams

The location of all destructive tests shall be determined by the CQA Monitor. A minimum of one sample per 500 feet of seam shall be obtained by the Contractor's QC Technician. The Contractor shall repair any suspicious looking welds before release of a seam for destructive sampling. Destructive samples shall be cut by the Contractor as the installation progresses and not at the completion of the project. Destructive samples shall be marked by the CQA Consultant's CQA Monitor with consecutive numbers, the seam number, the date, time, seaming technician, apparatus, and temperature.

Destructive samples shall be cut by the Contractor's QC Technician at locations selected by the CQA Monitor. The CQA Consultant's CQA Monitor shall:

1. Mark each sample with the seam number, and the adjoining panel numbers;
2. Record the sample location on the geomembrane panel deployment log form and the geomembrane field seaming log form;
3. Record the sample location and reason for taking the sample (random sample, poor welding, etc.); and
4. Record the results of the testing on the appropriate form.

A log of the destructive testing shall be kept by the CQA Consultant's CQA Monitor with the date, time, location, seaming technician, apparatus, temperature, and pass or fail criteria. The CQA Consultant's CQA Monitor shall determine that the results of the seam testing meet the project specifications. The CQA Consultant's CQA Monitor shall observe that destructive sample holes are repaired immediately by the Contractor.

3.11 Repairs to the Geomembrane

For final seaming inspection, the CQA Consultant's CQA Monitor and Contractor shall check the seams and surface of the geomembrane for defects, holes, blisters, undispersed raw materials, or signs of contamination by foreign matter. If dirt inhibits inspections, the Contractor shall brush, blow, or wash the geomembrane surface as required. The CQA Consultant's CQA Monitor shall decide if cleaning the geomembrane surface and welds is needed to facilitate inspection. Repair areas shall be distinctively marked with a description of the required type of repair.

The CQA Consultant's CQA Monitor shall observe that identified holes, tears, blisters, undispersed raw materials, and contamination by foreign matter is patched. The CQA Consultant's CQA Monitor shall observe that patches are not cut with the repair sheet in contact with the geomembrane and that the patches are extrusion welded to the geomembrane and then vacuum tested. The result of the vacuum test for the repair shall be marked by the Contractor's QC Technician with the date of the test and name of the tester on the sheet. Holes shall be repaired as described in the Specifications. Repair areas shall be recorded on the repair log form by the CQA Monitor.

3.12 Geomembrane Final Walk-through

The Contractor shall be responsible for maintaining the geomembrane (or portions thereof) until final acceptance by the CQA Monitor. The CQA Consultant's CQA Monitor shall recommend final acceptance only when all seams have passed destructive testing, the Contractor has supplied all documentation, and all field and laboratory testing is complete and satisfactory. Prior to final acceptance, the Contractor, QA Engineer, CQA Monitor shall complete a field review of the installation of the geomembrane (or portions thereof) for completeness. Any areas that are found to deviate from the intended design, are incomplete, or in need of repair shall be recorded by the CQA Consultant's CQA Monitor for correction by the Contractor. When the repairs have been completed, the CQA Consultant's CQA Monitor shall release the

geomembrane (or portions thereof) for installation of overlying materials. The Contractor shall retain ownership of the liner throughout the installation of overlying materials as defined within the Contractor's scope of work.

4.0 GEOCOMPOSITE QUALITY ASSURANCE

4.1 General

This section sets forth the requirements for the CQA testing and observation requirements for installing the geocomposite materials detailed on the Construction Drawings and Specifications. This work includes the examination of the Manufacturer's and Contractor's QC testing, conformance testing, shipping and handling, and deployment, seaming, and repairs of the geocomposite. The CQA Consultant's CQA Monitor and CQA Officer shall review the submittals furnished by the Contractor to ensure their compliance with this program and conditions of warranty prior to construction. They shall also review the time schedule for installation submitted by the Contractor prior to construction.

4.2 Shipping and Handling

Materials shall be delivered to the site only after the CQA Consultant's CQA Monitor receives and approves the required submittals. The Contractor is responsible for the transportation, off-loading, and storage of the geocomposite. The materials shall be packaged and shipped by appropriate means so that no damage is caused and shall be delivered to the Project Site only after the CQA Consultant's CQA Monitor receives and approves the required submittals. Off-loading shall be performed in the presence of the CQA Consultant's CQA Monitor to ensure that any damage during off-loading is properly documented. The CQA Consultant's CQA Monitor shall keep a log of all geocomposite delivered to the site on the appropriate form

The CQA Consultant's CQA Monitor shall observe that damaged materials are separated from undamaged materials until proper disposition of the material is determined by the Owner or CQA Officer. Final authority on the determination of damage shall be the CQA Monitor.

4.3 Geocomposite Conformance Testing

After production, the geocomposite shall be sampled for conformance testing. Sampling shall be performed at the manufacturing plant. One geocomposite sample shall be obtained for every 100,000 square feet produced. The CQA Officer shall review all test results and report any non-conformance test results to the Contractor and the CQA Monitor.

The conformance testing of the geocomposite shall include the following parameters:

1. Transmissivity (ASTM D4716);
2. Peel Strength (GRI GC7).

4.4 Geocomposite Installation

Prior to geocomposite installation, the CQA Consultant's CQA Monitor shall observe that all underlying materials have been repaired, tested, and approved in accordance with the Construction Drawings and Specifications. During geocomposite placement, the CQA Consultant's CQA Monitor shall:

1. Observe the geocomposite as it is deployed and record all defects and disposition of the defects (panel rejected, patch installed, etc.);
2. Observe that equipment used does not damage the geocomposite;
3. Observe that people working on the geocomposite do not engage in activities that could damage it;
4. Observe that the geocomposite is anchored to prevent movement by the wind (the Contractor is responsible for any damage resulting to or from wind blown geocomposite);
5. Observe that the seams are overlapped in accordance with the project Specifications;
6. Observe that the Contractor has repaired any holes or tears in the geocomposite; and
7. Observe that the materials and methods used to fasten the panels together meet the Specification requirements.

The CQA Consultant's CQA Monitor shall record all of the above information on log sheets and in daily reports.

5.0 GEOTEXTILE QUALITY ASSURANCE

5.1 Geotextile Quality Control, Shipping, and Handling

The Manufacturer shall provide a copy of the certificate of compliance and the QC certificates for production of each geotextile roll manufactured for this project prior to construction for review. The Manufacturer's QC shall include visual inspection of the geotextile materials for foreign matter and needles. The Manufacturer's QC shall also provide proof that he has performed detection for broken needles at the manufacturing plant using magnets and continuous metal detectors permanently installed on-line at the factory. Materials shall be delivered to the site only after the CQA Consultant's CQA Monitor receives and approves the required submittals.

The CQA Consultant's CQA Monitor shall ensure that the materials were packaged and shipped by appropriate means so that no damage was caused to the materials delivered to the Project Site. Off-loading shall be done in the presence of the CQA Consultant's CQA Monitor and any damage during off-loading shall be documented by the CQA Consultant's CQA Monitor and the Contractor. The CQA Consultant's CQA Monitor shall keep a log of all geotextile delivered to the site on a log of geotextile received form.

Damaged materials shall be separated from undamaged materials until proper disposition of material is determined by the CQA Monitor. Final authority on the determination of damage shall be the CQA Monitor. The Contractor shall replace damaged or unacceptable material at no cost to the Owner.

The geotextile shall be stored on a prepared surface approved by the CQA Consultant's CQA Monitor and shall be protected from puncture, precipitation, dirt, grease, water, mechanical abrasions, ultraviolet light exposure or other damage. The CQA Consultant's CQA Monitor shall observe that the Contractor uses appropriate handling

equipment to load, move or deploy the material to ensure that no damage is caused to the materials during handling of the geotextile.

5.2 Geotextile Conformance Testing

After production, the geotextile shall be sampled for conformance testing. Sampling shall be performed at the manufacturing plant. One geotextile sample shall be obtained for every 100,000 square feet produced. The QA Engineer shall review all test results and report any non-conformance test results to the Contractor and the CQA Monitor.

The geosynthetics laboratory shall conduct the following conformance tests on the geotextile:

1. Mass per Unit Area (ASTM D-5261);
2. Grab Tensile (ASTM D-4632);
3. Puncture Resistance (ASTM D-4833); and
4. Tear Resistance (ASTM D-4533).

5.3 Geotextile Installation

The CQA Consultant's CQA Monitor shall not allow installation of the geotextile wrap until all conformance testing has been completed and adequate results have been obtained. During geotextile placement, the CQA Consultant's CQA Monitor shall:

1. Observe the geotextile as it is deployed and record all defects and disposition of the defects (panel rejected, patch installed, etc.);
2. Observe that equipment used does not damage the geotextile;
3. Observe that people working on the geotextile do not engage in activities that could damage it;
4. Observe that the geotextiles are anchored to prevent movement by the wind (the Contractor is responsible for any damage resulting to or from windblown geotextiles);
5. Observe that the seams are overlapped in accordance with the project Specifications;
6. Observe that the Geosynthetic Contractor has repaired any holes or tears in the geotextile; and

7. Observe that the thread used to sew the panels together meets the specification requirements.

During installation, the Contractor and CQA Consultant's CQA Monitor shall inspect the geotextile as it is deployed for the presence of foreign materials and needles. If any needles or other materials which the CQA Consultant's CQA Monitor feels may be detrimental to the underlying synthetic liner are present within the geotextile, the roll shall be rejected and not used and the Contractor shall replace any rejected material at no additional cost to the Owner. The CQA Consultant's CQA Monitor shall notify the Contractor of any problem areas and observe and inspect the repair. The CQA Consultant's CQA Monitor shall record all of the above information on log sheets and in daily reports.

6.0 WORK DEFICIENCIES

When deficiencies are discovered, the CQA Consultant's CQA Monitor shall immediately determine the nature and extent of the problem, notify the Contractor of the problem, and complete the required documentation. The CQA Consultant's CQA Monitor shall notify the Contractor within a 1/2 hour of discovering any deficiency. If the deficiency will cause significant construction delays or require substantial rework, the CQA Consultant's CQA Monitor shall notify the CM and the QA Engineer.

The Contractor shall correct the deficiency to the satisfaction of the CQA Monitor. If the Contractor is unable to correct the problem, the CQA Consultant's CQA Monitor shall be asked to develop and recommend a solution to the QA Engineer for his approval.

The corrected deficiency shall be retested before additional work is performed by the Contractor. All retests and the steps taken to correct the problem shall be documented by the CQA Consultant's CQA Monitor on a field construction inspection report and on construction problem and solution data sheet forms.

7.0 DOCUMENTATION

7.1 Daily Records

At a minimum, daily records shall consist of field notes, a summary of the daily construction activities, associated testing activities, and observation and data sheets. All project records shall be maintained in a well organized hardcopy and electronic project file at the job site and shall be available for review. PDF's of all project records shall be routinely created for storage in the electronic project file. The CQA Monitor's daily summary report shall include at a minimum the following information:

1. Date, project name, and location;
2. Weather data;
3. A description of on-going construction;
4. A summary of test results identified as passing, failing, or in the event of a failed test, retests;
5. Off-site materials received, including geosynthetics or drainage materials, plus status of certificates or off-site testing for the materials;
6. A listing of all deviations from required procedures, methods, and/or techniques for any and all worked performed;
7. A summary of decisions regarding acceptance of the work and/or corrective actions taken; and
8. The signature or initials of the CQA Monitor.

7.2 Observation and Test Data Sheets

The CQA Consultant's CQA Monitor shall prepare observation and data sheets during all phases of construction. Copies of Field Forms are included in Appendix A. Observation and data sheets for this project may include, but would not be limited to the following:

1. Nuclear Density Data Sheets
3. Field Density Summary
4. Moisture Density Curve Data Sheets
5. Oven Moisture Content/Drive Tube Density Data Sheets
6. Sand Cone Density Data Sheets

7. Sieve Analysis and Atterberg Limits Data Sheets
8. Acceptance of Prepared Subgrade Forms
9. Geomembrane Received Log
10. Geotextile Received Log
11. Geocomposite Received Log
12. Geomembrane Panel Deployment Log
16. Geomembrane Start-up Trial Weld Log
17. Geomembrane Field Seaming and Nondestructive Testing Log
18. Geomembrane Repair Log
19. Geomembrane Seam Strength Destructive Test Results
20. Photograph Log

Additional observation and data sheets may be required. All entries shall be clear and legible. All documentation should be dated and signed or initialed clearly by the CQA Monitor.

7.3 Certification/CQA Final Documentation Report

At the completion of the Project, the CQA Consultant shall prepare a CQA Final Documentation Report to be submitted to the Owner, GBB as the Owner's Representative, and the Project CM. . The final report will consist of a summary of the CQA operations, construction, results and observations of conformance testing, and any actions taken to resolve construction problems. The conformance testing data will be provided in table form with a minimum - maximum range as well as an arithmetic mean provided in the text of the report.

In addition, the report will include a construction summary, as-built details, field notes, and a detailed discussion of the CQA activities for the liner earthworks and geosynthetic components. All observations, findings, and test results will be discussed in a technically sound manner and will be presented in appendices to the report . The report will be signed and sealed by a Registered Engineer observing that the project

was constructed in general accordance with the Construction Drawings, Specifications, and CQA Implementation Plan.