CONSTRUCTION QUALITY ASSURANCE PLAN

PLANT MCINTOSH EXISTING COAL COMBUSTION RESIDUALS (CCR) LANDFILL NO. 4 EFFINGHAM COUNTY, GEORGIA

FOR

Georgia Power

September 2022

GEORGIA
DEPARTMENT OF NATURAL RESOURCES
ENVIRONMENTAL PROTECTION DIVISION

Approved

Solid Waste Management Program

Approved By: Keith Stevens Digitally signed by Keith Stevens Date: 2023.02.13 12:11:59 -05'00'

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1. CONSTRUCTION QUALITY ASSURANCE PLAN

This Construction Quality Assurance (CQA) Plan establishes procedures to document construction of the final cover system and repairs to specific landfill components to ensure that construction meets the design criteria for Landfill No. 4. This CQA Plan provides the minimum level of activities that provides assurance that construction is completed in accordance with the plans and permit. Technical Specifications will be developed and included in the contract documents for construction that will provide the detailed qualifications, processes, inspections, and controls that will assure compliance with the CQA Plan, the construction drawings, and the permit. Procedures are established to develop the necessary documentation for submittal to the regulatory agency.

CQA services will be provided by a consulting engineering firm, reporting to Georgia Power Company/Southern Company Services (Georgia Power /SCS), specializing in the inspection and testing of soils and geosynthetics. Resumes and qualifications including experience with projects of similar type, size and complexity shall be provided to Georgia Power for their review and approval.

A documentation report(s) will be prepared upon completion of any construction phase or significant repair. The report will include information generated through the CQA program and will document the extent to which construction or repairs were performed in accordance with the intent of the contract documents and design.

Georgia Power /SCS and the consulting engineering firm has the primary responsibility of implementing and managing the CQA program described in this manual and will document to the appropriate regulatory agencies that construction of the facility was performed in accordance with the design and the contract documents.

1.1 Reference Documents

The following reference documents provide background information and support this CQA Plan for cover repairs:

1. Part B – Supporting Documents, Section 3 - Engineering Report, Plant McIntosh – Coal Combustion Residuals Landfill No. 4, Permit No. 051-010D (LI), dated October 2018

2. Part A – Permit Documents, Section 8 - Closure Plan, Plant McIntosh – Coal Combustion Residuals Landfill No. 4, Permit No. 051-010D (LI), dated October 2018

3. Part A – Permit Documents, Section 9 - Post-Closure Plan, Plant McIntosh – Coal Combustion Residuals Landfill No. 4, Permit No. 051-010D (LI), dated October 2018

4. Permit Drawings:

5. ASTM International (ASTM) Annual Book of ASTM Standards, Section 4 Construction

6. Volume 04.02 Concrete and Aggregates

7. Volume 04.08 Soil and Rock(I)

8. Volume 04.09 Soil and Rock (II)

9. Volume 04.13 Geosynthetics

10. ASTM International (ASTM) Annual Book of ASTM Standards, Section 8 Plastics

11. Volumes 08.01 Plastics (I)

12. Volume 08.02 Plastics (II)

13. Volume 08.03 Plastics (III)

Daniel, D.E. AND R.M. Koerner. (1993). *Technical Guidance Document: Quality Assurance and Quality Control for Waste Containment Facilities.* EPA/600/R-93/182 (NTIS PB94-159100), 1993.

Occupational Safety and Health Administration (OSHA), Occupational Safety and Health Act of 1970

1.2 Definitions

Whenever the terms listed below are used, the intent and meaning shall be interpreted as indicated.

ASTM: ASTM International.

Construction Quality Assurance (CQA or QA): A planned, and systematic pattern of procedures and documentation designed to provide confidence that items of work or services meet the requirements of the contract documents. Construction quality assurance includes verifying that the Contractor is performing quality control requirements of the Contract Specifications.

Construction Quality Control (CQC or QC): Those actions which provide a means to measure and regulate the characteristics of an item or service to comply with the requirements of the contract documents. CQC documentation will be performed by a third-party CQC Engineer and Surveyor, acceptable to the owner, retained and paid by the Contractor.

CQA Engineer: Responsible for implementing the quality assurance requirements as stated in the project plans, this CQA plan and the project objectives; verifying basic data as reasonable and complete; outlining procedures to process data; developing statistical procedures for the analysis of test data; and preparing quality assurance memoranda and quality assurance reports. The CQA Engineer shall report to Georgia Power/SCS. This CQA Engineer shall be a registered professional engineer licensed in Georgia. Reference to the CQA Engineer, for this document, shall include the CQA Engineer or their designated representative.

CQA Technician: A designated representative of the CQA Engineer responsible for field observations, testing, and inspection when the CQA Engineer is not at the project site. The CQA Engineer or Technician shall be on site during all construction activities. The CQA Technician shall have sufficient experience in landfill construction and be acceptable to Georgia Power.

CQC Engineer: Third party engineer retained by the Contractor responsible for soils and materials testing performed during the construction of the facility. The CQC Engineer shall be qualified and acceptable to Georgia Power/SCS. CQC Engineer shall be a registered professional engineer licensed in Georgia and shall be responsible for soils and materials testing performed. Reference to the CQC Engineer, for this document, shall include the CQC Engineer or their designated representative.

CQC Technician: A designated representative of the CQC Engineer responsible for field and laboratory testing of soils and materials of construction. The CQC Technician shall have sufficient experience in landfill construction and be acceptable to Georgia Power.

Design Engineer: The individuals or firms responsible for the design and/or preparation of the project construction drawings and specifications in accordance with the permit. The Design Engineer shall be responsible for providing interpretations and clarifications of the Contract Documents, reviewing and approving shop drawings, authorizing minor variations in the work from the requirements of the Contract Documents, and rejecting defective work. The Design Engineer shall be a registered professional engineer licensed in Georgia.

Surveyor: As-built certification surveys shall be performed on the components of the composite cover system by a Professional Land Surveyor licensed in Georgia. The surveyor will be acceptable to the Owner, retained and paid by the Contractor.

1.3 Surveying

Surveying shall be performed to provide documentation for record drawings in addition to surveying required for the execution of the contract and for construction. Surveying will be performed under the direct supervision of a Professional Land Surveyor, licensed in the State of Georgia. Surveying personnel will be experienced in the provision of these services, including detailed, accurate documentation.

When required, surfaces shall be surveyed to determine the as-built lines, grades, and soil layer thicknesses achieved during construction. Preparation of as-built record drawings and surveys shall be prepared and sealed by a Registered Land Surveyor in the State of Georgia. Georgia Power has established vertical and horizontal control points for Landfill No. 4 to be referenced on the record drawings.

1.4 Earthwork

This section describes CQA procedures for earthwork operations pertinent to the final cover construction for Landfill 4. The scope of earthwork and related CQA includes the following elements:

1. Subgrade preparation and structural fill
2. Final cover soil layer
3. Vegetative support layer

1.5 Subgrade Preparation and Fill

The following tasks will be completed as part of the subgrade preparation, geomembrane protective cover, and topsoil layer for the final cover system. The observations will be performed by the CQA Engineer or CQA Technician. Testing of soils and materials properties will be performed by the CQC Engineer or CQC Technician. The test results will be submitted and reviewed by the CQA Engineer for confirmation that the materials supplied and installed adhere to the Technical Specifications and this CQA Plan.

1. Observe source material for protective soil cover fill to ensure that it is free of organic and oversized materials and meets the grading requirements of the Technical Specifications.

2. Perform moisture-density relationship testing to determine the maximum dry density and optimum moisture content of subgrade fill materials.

3. Document subgrade is proof rolled/compacted as prescribed in the Technical Specifications and in this CQA Plan.

4. Observe and document that angular or sharp rocks, and other deleterious materials that could damage the geosynthetics are removed from the prepared subgrade surface. Observe and document that the subgrade is free of irregularities and is rolled smooth prior to geosynthetics placement.

5. Coordinate with the Contractor and Surveyor to perform subgrade verification survey upon completion of the subgrade preparation. Document corrective action measures for over- or under-builds as determined by the verification surveys have been corrected and the area has been re-surveyed. Verification surveys will also be used to determine the limits of the subgrade preparation. Submit copy of verification surveys to the CQA Engineer and Owner prior to placing or installing any overlying materials.

6. The Contractor and Geosynthetic Installer shall inspect the HDPE subgrade surface and certify that it is in conformance with the Technical Specifications and approved plans prior to placing or installing any overlying materials. The CQA Engineer or CQA Technician shall observe, document, and agree that the HDPE subgrade surface is in conformance with the Technical Specification and approved plans.

The following table establishes the minimum test frequencies for earthwork CQA. Additional testing must be conducted whenever work or materials are suspect, marginal, or of poor quality. Additional testing may also be performed to provide additional data for engineering evaluation. Any re-tests performed because of a failing test do not contribute to the total number of tests performed in satisfying the minimum test frequency.

Table 1.1 Geosynthetic Subgrade/Fill/CCR Stacking Testing Frequency

Properties	ASTM Test Method	Fill[2]	Trench Fill	CCR Stacking
Moisture-Density [1]	D698 or D1557	1 Per 5,000 CY or Material Type (minimum of 2)	1 Per Material Type	1 Per 100,000 CY or Material Type (minimum of 2)
Grain Size Analysis	D6913 or D7928	1 Per 5,000 CY or Material Type (minimum of 2)	1 Per Material Type	
Atterberg Limits (if applicable)	D4318	1 Per 5,000 CY or Material Type (minimum of 2)	1 Per Material Type	
Nuclear Density - Water Content	D6938	1 Per 1,500 CY (1 Per 10,000 sf/6-inch lift)	1 Per Lift Per 200 Linear Feet	1 Per 40,000 SF per lift
Visual Classification	D2488	As Appropriate	As Appropriate	
Moisture Content [3]	D2216	1 per 10 Nuclear Densometer Tests	1 per 10 Nuclear Densometer Tests	1 per 10 Nuclear Densometer Tests

Properties	ASTM Test Method	Fill[(2)]	Trench Fill	CCR Stacking
Sand Cone Density or Drive Tube Sample	D1556 or D2937	1 per 25 Nuclear Densometer Tests	1 per 25 Nuclear Densometer Tests	1 per 25 Nuclear Densometer Tests

NOTES: CY – cubic yard

1. Perform a Check Point (One-Point selected at near optimum and compared to the ASTM D698 or D1557 curve) at least once for every 10,000 cubic yards of material placed.
2. Tests shall be performed on an even grid to provide adequate testing coverage. For large fills in small areas, the testing frequency shall be increased as necessary to ensure testing for each lift of fill placed.
3. For self-cementing fly ash consider lowering the drying temperature to 140°F (60°C) to avoid driving off the water of hydration or performing comparison testing with a typical 230°F (110°C).

1.5.1 Compacted CCR Subgrade

1. Observe and document CCR subgrade material is uniformly spread and that nominal loose lift thicknesses do not exceed 12 inches and is properly moisture conditioned, as necessary.

2. Observe and document the CCR is compacted to meet the Technical Specifications and CQAP.

3. Contractor shall ensure all required field density and moisture content tests, or proof-rolling are complete before the subgrade is accepted.

4. Observe and document that the exposed surface of the CCR subgrade is rolled with a smooth drum roller or equivalent at the end of each workday or when required to protect the material from adverse weather conditions.

5. Observe and document that the prepared compacted surface is free of all rock, rock fragments, or other deleterious materials greater than 1/4-inch and protruding from the prepared surface.

6. Observe and document that the prepared CCR subgrade is maintained to prevent desiccation cracking by the Contractor until the subgrade is accepted by the Installer. If excessive desiccation cracking occurs, the Contractor will be responsible for scarification, moisture conditioning, re-compaction and re-certification of the layer. The CQA Technician will document that all desiccation cracks are repaired as required by the specifications.

7. Observe and document the CCR surface on which the geomembrane is to be placed is maintained in a firm, clean, and smooth condition before and during the liner installation.

1.6 Protective Soil Cover

The protective soil cover should be placed in a single lift that is placed at the bottom of the slope and pushed upslope, using a low-ground pressure dozer with a maximum ground contract pressure of 5 psi. Protective soil cover should be placed in a manner that does not damage the geosynthetics and minimizes tensile forces in the geosynthetics. At no time is it acceptable to place the protective soil cover by pushing down slope.

The actual thickness of the protective soil cover shall be monitored and verified after it is placed and compacted with the tracks of the construction equipment. Thickness will be verified by survey or direct measurement. The thickness of the soil layer shall not be less than 18 inches. Thickness measurements shall be taken on an approximate 100-foot grid. The protective soil cover grades shall be documented

by the Surveyor. Care shall be taken around pipe inlets, outlets, and other protrusions to prevent physical damage by the construction equipment.

The CQA Technician shall report any nonconformance to the CQA Engineer, Project Manager and Contractor immediately. The material used for the protective soil cover shall be tested to document the material properties in accordance with Table 6.2.

Table 1.2 Protective Soil Cover Testing

Properties	ASTM Test Method	Frequency
Grain Size Analysis	D6913 or D7928	1 per 10,000 cubic yards or one per material type
Visual Classification	D2488	As appropriate
Atterberg Limits (if applicable)	D4318	1 per 10,000 cubic yards or one per material type
Hydraulic Conductivity (1)	D2434 or D5084	1 per 10,000 cubic yards or one per material type

NOTES:

1. Testing of hydraulic conductivity of protective cover soils may be required on a site-specific basis

The CQA Technician shall observe and document the protective soils to ensure they are uniform and conform to the requirements of the CQA Plan, Technical Specifications, Construction Drawings, and the Permit drawings. For fill materials obtained from borrow areas, conformance tests shall be performed by the CQC Engineer or CQC Technician in accordance with the CQA Plan prior to the materials being used.

CQA Technician shall observe soils for deleterious materials (e.g., roots, stumps, rocks, and large objects). The protective soil cover material shall be free of angular stones, particles greater than 1-inch in diameter, or other foreign matter that could damage the geocomposite and the HDPE geomembrane liner.

Priority pollutant testing shall be performed by Contractor on each imported material source. The Contractor shall notify the Owner at least 3 weeks prior to hauling activities so the Owner may observe the collection of soil samples for chemical analyses. No off-site borrow materials may be brought onto the site until the analytical results have been reviewed by the Owner and the borrow source approved.

The CQA Technician shall confirm that the protective soil cover is placed and compacted with a minimum of four complete passes with the tracks of low contact pressure, wide-tracked construction equipment.

1.7 Topsoil

The topsoil shall be on-site or off-site material capable of supporting vegetative growth placed in a minimum 6-inch lift over the protective soil layer. The material used for the topsoil layer shall be tested to document the material properties in accordance with Table 6.2. If an off-site topsoil source is used the Contractor shall provide priority pollutant testing for qualification of all off-site material sources prior to any material being delivered to the project site. The topsoil shall be placed, graded, and lightly compacted with the tracks of the construction equipment to a uniform 6-inch lift thickness. Thickness will be verified using survey or direct measurements on an approximate 100-foot grid.

Vegetation shall be established in accordance with the Closure Plan. If the use of fertilizers is warranted, the Contractor shall follow the Fertilizer Requirements in the Closure Plan. The topsoil shall be fertilized, seeded, and covered with a temporary erosion matting in accordance with the requirements of this CQA Plan. The Contractor shall be responsible for erosion damage, repair, and maintenance of

the seeded areas until a satisfactory growth of grass shall be established. Testing of the topsoil layer will not be required. After placement of the topsoil layer, a final topographic survey shall be prepared which indicates the finished surface elevations.

1.8 Non-Conforming Work

If a defect or deficiency is observed and documented, the CQA Technician shall promptly notify the Contractor, CQA Engineer, and Project Manager. The Contractor is responsible for correcting the defect or deficiency. If necessary, a meeting or conference call may be held as needed to assess the problem, review alternative solutions, and implement an action plan.

The Contractor shall correct all deficiencies to meet the project specifications. If project specification criteria cannot be met, or unusual weather conditions hinder work, the Contractor and CQA Engineer shall develop and present to the Project Manager suggested solutions for approval.

The Contractor and CQA Technician shall schedule appropriate re-tests when the work defect has been corrected. All re-tests by the CQC Engineer or CQC Technician must verify that the defect has been corrected before additional work is performed by the Contractor around the deficiency.

1.9 Construction Quality Assurance for Geosynthetics

This section describes CQA procedures for the installation of geosynthetics including:

1. Geomembrane
2. Geocomposite drainage layer

1.9.1 Geomembrane

The geomembrane will be a minimum 60-mil textured High Density Polyethylene (HDPE), meeting the minimum physical properties in the latest version of GRI-GM13-Test Methods, Test Properties and Testing Frequency for Smooth and Textured Geomembranes as outlined in Table 6.3. The 60-mil textured geomembrane shall be supplied and installed by geosynthetics manufacturers approved by Owner.

Table 1.3 Required Sheet Testing of Polyethylene Geomembrane

PROPERTIES	ASTM METHOD	VALUE 60-mil textured	FREQUENCY (minimum)
Thickness (min. ave.)	D5994	Nom. (-5%)	Per roll
♦ Lowest individual for 8 out of 10 values		-10%	
♦ Lowest individual for any of the 10 values		-15%	
Asperity Height (min. ave.)	D7466	16 mil	every second roll (1)
Density (min. ave.)	D1505/ D792	0.940 g/cc	200,000 lb
Tensile Properties (min. ave.) (2)	D6693		20,000 lb
♦ Yield strength	Type IV	126 lb/in.	
♦ Break strength		90 lb/in.	
♦ Yield elongation		12%	
♦ Break elongation		100%	
Tear Resistance (min. ave.)	D1004	42 lb	45,000 lb

PROPERTIES	ASTM METHOD	VALUE 60-mil textured	FREQUENCY (minimum)
Puncture Resistance (min. ave.)	D4833	90 lb	45,000 lb
Stress Crack Resistance [3]	D5397 (App.)	500 hr.	Per GRI-GM 10
Carbon Black Content (range)	D4218 [4]	2.0-3.0%	20,000 lb
Carbon Black Dispersion	D5596	Note [5]	45,000 lb
Oxidative Induction Time (OIT) (min. ave.) [6]			200,000 lb
(a) Standard OIT	D8117	100 min.	
---or---			
(b) High Pressure OIT	D5885	400 min.	
Oven Aging at 85°C [6], [7]	D5721		Per each formula
(a) Standard OIT (min. ave.) retained after 90 day	D8117	55%	
---or--			
(b) High Pressure OIT (HP OIT) (min. ave.) retained after 90 days	D5885	80%	
UV Resistance [8]	D7238		Per each formula
(a) Standard OIT (min. ave.)	D8117	N.R. [9]	
---or---			
(b) High Pressure OIT (min. ave.) retained after 1,600 hrs [10]	D5885	50%	

NOTES:

1. Alternate the measurement side for double sided textured sheet.
2. Machine direction (MD) and cross machine direction (XMD) average values should be based on 5 test specimens each direction.
   Yield elongation is calculated using a gage length of 1.3 inches.
   Break elongation is calculated using a gage length of 2.0 inches.
3. SP-NCTL per ASTM D5397 Appendix, is not appropriate for testing geomembranes with textured or irregular rough surfaces. Test should be conducted on smooth edges of textured rolls or on smooth sheets made from the same formulation as being used for the textured sheet materials.
   The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQC testing.
4. Other methods such as D 1603 (tube furnace) or D 6370 (TGA) are acceptable if an appropriate correlation to D 4218 (muffle furnace) can be established.
5. Carbon black dispersion (only near spherical agglomerates) for 10 different views: 9 in Categories 1 or 2 and 1 in Category 3.
6. The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.
7. It is also recommended to evaluate samples at 30 and 60 days to compare with the 90-day response.
8. The condition of the test should be 20 hours. UV cycle at 75°C followed by 4 hr. condensation at 60°C.
9. Not recommended since the high temperature of the std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.
10. UV resistance is based on percent retained regardless of the original HP-OIT value.
11. Unit abbreviations: % - percent, g/cc – grams per cubic centimeter, lb – pounds, lb/in – pounds per inch, min – minutes, min ave. – minimum average

The geomembrane material shall be textured and have sufficient interface shear resistance (friction angle plus adhesion) with contiguous liner components as required in the design. The interface shear strength will be determined by direct shear testing of the proposed geosynthetic materials and soils, conducted at normal loads specified by the Design Engineer, for each interface. Interface friction testing shall be completed for each phase of construction, to confirm the proposed geosynthetic can meet the design requirements.

1.9.2 Geomembrane Conformance Sampling

Conformance sampling of the geomembrane rolls will be performed in accordance with ASTM D 4354 – Standard Practice for Sampling of Geosynthetics and Rolled Erosion Control Products for Testing. The samples may be collected prior to shipment from the manufacturer's facility or once the rolls are delivered to the project site. Samples will be forwarded to a certified geosynthetics laboratory for conformance testing. Conformance testing requirements are shown in Table 6.4.

Table 1.4 Polyethylene Geomembrane Conformance Sampling and Testing

PROPERTY	ASTM METHOD	FREQUENCY	VALUE
Thickness	D5994	Five places per roll	57 mil (minimum average) 51 mil (single reading)
Asperity Height	D7466	Every second roll	16 mil
Tensile Properties	D6693	1 test / 100,000 ft^2 / resin batch	♦ Yield Strength - 126 lb/in
			♦ Break Strength - 90 lb/in
			♦ Yield Elongation - 12%
			♦ Break Elongation - 100%
Density	D1505	1 test / 100,000 ft^2 / resin batch	0.940 g/cc (min.)
Tear Resistance	D1004	1 test / 100,000 ft^2 / resin batch	42 lbs
Stress Crack Resistance	D5397 (Appendix)	1 test per resin batch	500 hours
Melt Flow Index	D1238	1 test / 100,000 ft^2 / resin batch	1.0 g/10 minutes
Puncture Resistance	D4833	1 test / 100,000 ft^2 / resin batch	90 lbs
Carbon Black Content	D4218	1 test / 100,000 ft^2 / resin batch	2.0-3.0%
Carbon Black Dispersion	D5596	1 test / 100,000 ft^2 / resin batch	Note (2)

NOTES:

1. Stress crack resistance and melt flow index test results by the manufacturer are acceptable provided the testing is completed at the same or greater frequency as shown.
2. Carbon black dispersion (only near spherical agglomerates) for 10 different views: 9 in Categories 1 or 2 and 1 in Category 3.
3. Unit abbreviations:
   % - percent, ft^2 – square feet, g – grams, lbs – pounds, g/cc – grams per cubic centimeter lb/in – pounds per inch

1.9.3 Geomembrane Panel Deployment

Quality assurance monitoring for geomembrane panel deployment:

1. Obtaining a written acceptance of the subgrade by the geomembrane Installer.

2. Documenting weather conditions (e.g., temperature, wind). The geomembrane Installer is responsible for geomembrane placement and determining if weather conditions are acceptable for geomembrane placement.

3. Monitoring and documenting geomembrane placement.

4. Identifying and noting panel damage, defects, tears, or other deformities.

5. Observing panel placement for proper overlap.

6. Measuring as delivered panel lengths.

7. Recording the locations of installed panels and checking that the panels have been installed in accordance with the design plan.

8. Assigning each panel, a unique panel number and identifying that panel with the manufacturer's roll number.

9. Recording panel numbers and locations on a panel layout diagram.

1.9.4 Geomembrane Field Seam Construction and Testing

Quality assurance monitoring and testing to be conducted for geomembrane seam construction and testing is as follows:

Test seams shall be made each day prior to commencing field seaming. These seams shall be made on fragment pieces of geomembrane liner to observe that seaming conditions are adequate. Such test seams shall be made at the beginning of each seaming period; at changes of equipment, personnel, equipment settings, weather, power supply interruption, or sheet temperature; at the CQA Engineer's discretion; and at least once every 4 hours during continuous operation of each welding machine. Also, each seamer shall make at least one test seam each day. Requirements for test seams are as follows:

1. The test seam sample shall be at least 5-feet long by 1-foot wide with the seam centered lengthwise. Six adjoining specimens, 1-inch wide each, shall be die-cut from the test seam sample. These specimens shall be tested in the field with a tensiometer for both shear (three specimens) and peel (three specimens) for single-track fusion welds or extrusion welds. For dual-track fusion welds, the Contractor shall test each track as if it were a single-track weld. Test seams shall be tested by the Contractor under observation of the CQA Technician, or designated representative of the Owner. The specimens should not fail in the weld. No strain measurements need to be obtained in the field. A passing fusion or extrusion welded test seam shall be achieved when the criteria described in Table 6.5 are satisfied. If a test seam fails, the entire operation shall be repeated. If the additional test seam fails, the seaming apparatus or seamer shall not be accepted and shall not be used for seaming until the deficiencies are corrected and two consecutive successful full test seams are achieved. Test seam failure is defined as failure of any one of the specimens tested in shear or peel. For double-weld seams, both weld tracks shall meet the test seam criteria.

2. The CQA Technician shall log the date, hour, ambient temperature, number of seaming unit, name of seamer, and pass or fail description.

1.9.5 Non-Destructive Testing

The entire length of all production seams shall be non-destructively tested by the Installer. The Installer shall perform all pressure and vacuum testing under the observation of the CQA Technician. Requirements for non-destructive testing are as follows:

Single-Weld Seams (Extrusion Welds)

1. The Installer shall maintain and use equipment and personnel at the site to perform continuous vacuum box testing on all single weld production seams. The system shall be capable of applying a vacuum of at least 5 psi. The vacuum shall be held for a minimum of 10 seconds for each section of seam.

2. If air bubbles are present, the area shall be marked clearly for repair.

3. If the vacuum test indicates leakage, the area shall be patched, or the entire seam shall be capped.

Double-Weld Seams (Split Wedge)

1. The Installer shall maintain and use equipment and personnel to perform air pressure testing of all double weld seams. The system shall apply a pressure of at least 30-psi for not less than 5 minutes.

2. Pressure loss tests shall be conducted in accordance with the procedures outlined in "Pressurized Air Channel Test for Dual Seamed Geomembranes," GRI Test Method GM-6. As outlined by the test method, the seam or portion thereof being tested shall be pressurized to 30 psi and, following a 2-minute pressurized stabilization period, pressure losses over a measurement period of 5 minutes shall not exceed 4 psi for a 40-mil sheet and 3 psi for 60-mil.

3. The Installer shall demonstrate the required pressure over the entire length of the seam.

4. If pressure drops below the allowance, the test shall be considered a failure and the following procedures shall be implemented:

   Check to determine if there is excessive seepage around the inflation needle.

   Check both ends of the seam to ensure the flow channel is completely sealed.

   Walk the length of the seam; look and listen for air leaks.

   If either of these procedures fails to identify the leak, trim the seam overlap, and vacuum test the seam to locate the leak.

   Once the leak is identified, make the necessary repairs and retest the seam.

1.9.6 Destructive Testing

Destructive testing shall be performed on at least one field-seamed sample per day per seaming crew or machine. The sampling frequency shall be at least one sample every 500-linear-foot of production seam (applies to both fusion and extrusion welds). If the weather conditions are such that the ambient air temperature is less than 41-degrees Fahrenheit, then the minimum frequency may be increased by the owner, CQA Technician or Engineer. The locations shall be selected by the CQA Technician or Engineer. Sufficient samples shall be obtained by the Contractor to provide one sample to the archive (owner), one sample to the CQA Technician or Engineer for laboratory testing, and one sample to be retained by the Installer for field testing. The Installer shall mark each sample with the name of the person welding, date, time, ambient air temperature, temperature of heating element, speed of seaming, and

identification number of seaming unit. The test seam sample shall be a minimum of 3-feet long by 1-foot wide with the seam centered lengthwise. Testing requirements are as indicated in Table 6.5.

1. The Installer shall test samples in the field under the observation of the CQA Technician or Engineer. All tests shall be performed using a calibrated, motor-driven, strain controlled tensiometer approved by the Engineer.

   Peel shall be measured for one sample (that is, five specimens). Peel tests shall be evaluated for the criteria described in Table 6.5. For double track welders, peel tests (5 specimens) shall be evaluated for each track.

   Shear shall be measured for one sample (that is, five specimens). Tests shall be evaluated for the criteria described in Table 6.5.

2. The CQA Technician shall observe all production seam field test procedures and may perform laboratory testing for both peel and shear and evaluate test results in accordance with Table 6.5.

3. The CQA Technician shall be responsible for the archive specimen and shall assign a number to the archive sample and mark the sample with the number and shall also log the date, seam number, approximate location in the seam, and field test pass or fail description, if applicable.

Table 1.5 Polyethylene Geomembrane Seam Properties

PROPERTY	ASTM METHOD	VALUE
Bonded Seam Strength	D4437	120 ppi minimum
Peel Adhesion: Fusion Extrusion	 D4437 D4437	 91 ppi minimum 78 ppi minimum
Modifications to ASTM D 4437: For shear tests, sheet shall yield before failure of seam. For peel adhesion, seam separation shall not extend more than 50% of seam width into seam. For either test, testing shall be discontinued when sample has visually yielded. For bonded seam strength tests five of five samples shall pass and for peel adhesion four of five samples shall pass for seam to qualify and all shall have a strength value.		

NOTE: ppi - pounds per inch width of seam

1.9.7 Seam Repair

Damaged and sample coupon areas of geomembrane shall be repaired by the Installer by construction of a cap strip. No repairs shall be made to seams by application of an extrusion bead to a seam edge previously welded by fusion or extrusion methods. Repaired areas shall be tested for seam integrity. Damaged materials are the property of the Installer and shall be removed from the site. The following quality assurance monitoring and testing will be implemented to monitor defect repairs:

1.9.8 Destructive Test Failure Procedures

When a sample fails destructive testing, the Contractor has the following options:

1. Repair seam between any two passing destructive test locations.

2. Trace welding path to intermediate point (10-feet minimum from point of failed test in each direction) and take small sample with 1-inch-wide die for an additional field test at each location. If these additional samples pass the test, then take full size destructive sample for peel and shear testing in accordance with this section. If these samples pass the tests, repair seam between these locations. If either sample fails, repeat process to establish zone in which seam should be repaired.

Acceptable repaired seams shall be bound by locations from which samples passing destructive tests have been taken. In cases exceeding 150-feet of repaired seam, the CQA Engineer may have Installer destructive test repair seam. When sample fails, CQA Technician or CQA Engineer may require additional testing of seams that were welded by same welder and/or welding apparatus during same time shift.

1.9.9 Repair Verification

The CQA Technician shall observe, number, and log each repair. The CQA Technician shall observe non-destructive testing of each repair. Repairs more than 150-feet long may require destructive test sampling. Failed destructive or non-destructive tests indicate that repair shall be redone and retested until passing tests are achieved.

1.10 Geocomposite Drainage Layer

Geocomposite drainage layer shall be a HDPE geonet sandwiched and heat bonded to two nonwoven geotextiles. The geocomposite drainage layer shall be tested and certified by the manufacturer to meet the physical properties outlined in Table 6.6.

Table 1.6 Required Quality Assurance/Quality Control Testing for Geocomposite Drainage Layer

PROPERTY	ASTM METHOD	FREQUENCY	VALUE
Transmissivity	D4716	1 per 100,000 sf minimum of 2	$1.5x10^{-3}$ m^2/s min. (gradient=1.0; pressure=10,000 psf)
Resin Density	D1505	1 per 200,000 sf minimum of 2	≥ 0.94 g/cc
Ply Adhesion	D7005	1 per 100,000 sf minimum of 2	>1.0 ppi min. and average > 2.0 ppi
Thickness	D5199	1 per 100,000 sf minimum of 2	300 mils, min.

NOTES:
1. Unit abbreviations:
cc - cubic centimeter g – gram m – meter m^2/sec – square meters per second min – minimum
ppi - pounds per inch psf - pounds per square foot s – second sf - square foot

The CQA Technician shall observe and monitor the installation of the geocomposite drainage layer to verify the following:

1. Monitoring and observing geocomposite drainage layer placement.

2. Observing geomembrane for damage during geocomposite drainage layer installation. Should the liner be damaged the Geomembrane Installer shall make immediate repairs and properly document the repairs prior to continuing geocomposite installation.

3. Identifying and noting panel damage, defects, tears, or other deformities to geocomposite drainage layer.

4. Observing panel placement for proper overlap.

5. Observing proper tying of geonet and sewing of geotextile for longitudinal seams and tying of geonet for transverse seams.

6. Observing proper repairs to geonet and geotextile.

The CQA Technician shall be present during all placement operations and observe that work is in accordance with the construction plans and specifications and CQA Plan.

1.11 Stormwater Management Features

The CQA Technician shall observe and monitor the installation of stormwater management features to verify the following:

1. Diversion ditches are excavated and graded as shown on the Drawings. The ditches shall have the required stabilization measures in place as noted on the Drawings and Operation Plans.

2. Drainage pipes and culverts match the specified material type and dimensions and are installed to the lines and grades as shown on the Drawings.

3. The areas to receive drainage pipes and culverts are compacted and any soft or unsuitable material removed, the area backfilled, and covered in accordance with this Design and Technical Specifications.

4. Backfill material around drainage pipes and culverts is placed and compacted in accordance with the Technical Specifications.

5. All connections between pipe sections are watertight and assembled in accordance with manufacturer recommendations.

1.12 Sediment and Erosion Control Features

The CQA Technician shall observe and monitor the installation of sediment and erosion control features to verify the following:

1. Minimum sediment and erosion control measures shown on the Design & Operation Plans are in place. All necessary erosion control measures and stormwater management structures are clean and in good repair. Sediment basins are not overfilled and have additional capacity available.

2. Assess the overall effectiveness of the sediment and erosion control features.

3. Additional measures shall be taken as required or as directed by the Owner to minimize erosion of soil and/or ash.

1.13 Site Restoration

The CQA Technician or CQA Engineer shall observe and monitor the status of site restoration. Vegetative cover should be re-established within 2 weeks after any final repairs. Permanent covers which are slow to establish vegetation shall receive additional seeding. Seeding and fertilizing requirements are provided in the Closure Plan, Section 1.6. Deep rooting plants such as weeping love grass and lespedeza shall not be used to reseed areas. Planting dates, fertilizer rates and seeding rates should be documented by the CQA Technician. The erosion control measures shall remain in place until a satisfactory stand of perennial grass in accordance with the vegetation schedule above is growing. A satisfactory stand of grass is defined as a full cover: 100 percent of the soil surface is uniformly covered in permanent vegetation with a density of 70 percent or greater. The CQA Technician should document when a satisfactory stand of grass is developed, and when erosion control measures are removed.

1.14 Documentation Records and Certification

The CQA Plan requires thorough monitoring and documentation of all construction activities. The CQA Engineer will ensure that all QA/QC requirements have been addressed and satisfied. Documentation will consist of daily record keeping, testing and installation reports, non-conformance reports (if necessary), progress reports, photographic records, design and specification revisions, and a construction report.

1.14.1 Daily Record of Construction Progress

The daily field report will summarize ongoing construction activities and will be prepared by the CQA Technicians, reviewed, and approved by the CQA Engineer. At a minimum, the report will include the following:

1. Date, project name, project number, and location.
2. A unique number for cross-referencing and document control.
3. Weather data.
4. A description of ongoing construction and inventory of equipment utilized by the Contractor.
5. A brief description of tests and observations, identified as passing or failing, or, in the event of failure, all retesting.
6. Areas of non-conformance/corrective actions, if any.
7. Summary of materials received and quality documentation.
8. Follow-up information on previously reported problems, deficiencies, or non-conformance.
9. Construction photographs included in the daily field reports or separate photograph log documenting construction progress.

1.14.2 Design and Specification Changes

Design and specification changes may be required during construction. Design and specification changes will only be made with written agreement of the Design Engineer, Owner and Contractor.

1.15 Construction Certification Report

At the completion of the project, the CQA Engineer and/or the Design Engineer will submit a final construction documentation report. This report will document that the work has been performed in compliance with the construction drawings and specifications.

At a minimum, the report will contain:

1. A written narrative and summary of the construction project from beginning to end that discusses the CQA requirements for each major portion of construction and all construction activities.

2. A summary of all field and laboratory test frequencies and results.

3. Sampling and testing location drawings.

4. A description of significant construction problems and the resolution of these problems.

5. A list of changes from the construction drawings and specifications and the justifications for these changes.

6. Documentation that the materials of construction, means and methods, and result comply with the Technical Specifications and CQA Plan.

7. As-built record drawings.

8. A Certification Statement.

The as-built record drawings and grade tables will accurately locate and document the constructed work items, including the location of piping, anchor trenches, soil layer thicknesses, etc. All surveying and base maps required for the development of the as-built record drawings will be prepared and stamped by the Registered Land Surveyor. The CQA Engineer will review the as-built drawings for completeness.

The CQA Engineer will certify that the subgrade and final cover systems, access roads, ditches, sediment basin and other associated ancillary facilities for the landfill closure are constructed according to the approved Construction Drawings, Technical Specifications, and this CQA Plan.