

**CONSTRUCTION QUALITY ASSURANCE (CQA) PLAN
DOMINION – CHESAPEAKE ENERGY CENTER
INDUSTRIAL SOLID WASTE LANDFILL – PERMIT #440
CHESAPEAKE, VIRGINIA**

Prepared for:



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1.0 INTRODUCTION

This Construction Quality Assurance (CQA) Plan was prepared by Golder Associates Inc. (Golder) to assist Dominion (OWNER) in performing construction of the landfill components at the Chesapeake Energy Center's Industrial Solid Waste Landfill in Chesapeake, Virginia according to the Construction Drawings and Technical Specifications. This plan is intended to meet the requirements of 9VAC20-81-130.Q.

To implement the construction project, a CONTRACTOR, familiar with earthwork and geosynthetics construction, will serve as a general CONTRACTOR (CONTRACTOR) providing construction services and a CQA Consultant will be retained by the OWNER to ensure project conformance of construction activities to established CQA standards. The CQA Plan provides guidance information and procedures that should be undertaken by all parties so the work will be of the quality necessary to meet the project objectives and will be responsive to the requirements of the OWNER.

This CQA Plan is a supplemental document to the Construction Drawings and Technical Specifications for each project. Where a conflict arises, the contract documents will govern.

1.1 PROJECT DESCRIPTION

The activities addressed under this CQA Plan include the following activities:

- Earthworks;
- Subgrade preparation;
- Polyethylene Geomembrane (HDPE) installation;
- Geonet Composite and Geotextile installation; and,
- HDPE Pipe installation.

1.2 DEFINITIONS

Quality Control: A planned system of activities, or the use of such a system, whose purpose is to provide a level of quality that meets the needs of users. The objective of quality control is to provide a quality product that is safe, adequate, dependable, and economical. The overall system involves integrating the quality factors of several related steps including: the proper specification of what is wanted, production to meet the full intent of the specification, inspection to determine whether the resulting material, product, service, etc. is in accordance with the Specifications, and review of usage to determine necessary revisions of Specifications. In practice, Quality Control refers to those procedures, criteria, and tests employed and paid for by the CONTRACTOR(s) to confirm that the work satisfies the CONTRACTOR's standards and is in compliance with the Construction Drawings and Technical Specifications. This CQA plan does not address quality control procedures, criteria, and/or tests employed by the CONTRACTOR.

Quality Assurance: A planned system of activities whose purpose is to provide assurance that the overall quality control program is in fact being effectively implemented. The system involves a continuing evaluation of the adequacy and effectiveness of the overall quality control program with the ability to have corrective measures initiated where necessary. For a specific material, product, service, etc., this involves verifications, audits, and the evaluation of the quality factors that affect the specification, production, inspection, and use of the product, service, system, or environment. In practice, Quality Assurance refers to those procedures, criteria, and tests required and paid for by the OWNER to confirm that the work performed by the CONTRACTOR(s) is in compliance with the approved Construction Drawings and Technical Specifications and any additional requirements of this plan.

Lot: A quantity of resin (usually the capacity of one rail car) used in the manufacture of geosynthetics material. The finished geosynthetics product (e.g., polyethylene geomembrane roll or geocomposite roll) will be identified by a unique number traceable to the resin lot used.

Geosynthetics: The collective name for polymeric materials used in civil construction. Includes materials such as geomembrane, geotextile, geocomposite, and other like products.

Panel: A unit area of geosynthetic material that will be deployed and used as part of this project. A panel is identified as a roll or portion of a roll that is larger than 100 square feet.

Subgrade Surface: The soil layer surface which immediately underlies the geosynthetic material(s).

1.3 PARTIES

OWNER: The OWNER is the individual, corporation, entity, public body, or authority with whom the CONTRACTOR has entered into the Agreement and for whom the Work is performed. For this project, the OWNER is Dominion.

ENGINEER: The ENGINEER is the official representative of the OWNER. The ENGINEER is responsible for the preparation of the Construction Drawings, Technical Specifications, and the CQA Plan. The ENGINEER is also responsible for the interpretation of those documents and for resolution of technical matters that arise during construction.

CONTRACTOR: The CONTRACTOR has the primary responsibility for ensuring that the landfill is constructed in accordance with the Construction Drawings and Technical Specifications developed by the ENGINEER and approved by the permitting agency. Other responsibilities include the performance of all construction activities at the site including site facilities, administration, material purchasing, safety, supervision, construction quality control, installation, and subcontracting. The CONTRACTOR is responsible for the protection of completed work until it is accepted by the OWNER. The CONTRACTOR

is also responsible for informing the OWNER and CQA Consultant of the scheduling and occurrence of all construction activities. The CONTRACTOR shall be fully responsible for scheduling and coordinating the work of Subcontractors and for ensuring that the Subcontractor adheres to the requirements of this CQA Plan.

CQA Consultant: The CQA Consultant is an entity, independent from the OWNER, CONTRACTOR(s), Manufacturer, and Installer, that is responsible for observing, testing and documenting activities related to the quality assurance at the site. The CQA Consultant shall be knowledgeable of soil properties, geosynthetics properties, and the practices typical of the Work. This party will perform field and laboratory testing of soils and other earth materials for evaluation and verification purposes. This party will also observe installation of the geosynthetic liner and coordinate sampling and testing of the geosynthetics with the Geosynthetic CQA Laboratory. The CQA Consultant will be responsible for reviewing the required CONTRACTOR submittals for conformance to the Technical Specifications, Construction Drawings, and this CQA Plan. The CQA Consultant is also responsible for issuing a certification report, sealed by a Professional Engineer licensed in the Commonwealth of Virginia. The OWNER may assign the duties of the ENGINEER to the CQA Consultant provided the CQA Consultant is qualified.

Geosynthetic Manufacturer (Manufacturer): The party responsible for manufacturing the geosynthetic rolls.

Geosynthetic CQA Laboratory (Testing Laboratory): Party, independent from the OWNER or CONTRACTOR, Manufacturer and Installer, responsible for completing laboratory tests on samples of geosynthetics obtained at the site or during manufacturing.

Geosynthetic Installer: The Geosynthetic Installer is responsible for field handling, sorting, placing, seaming, loading (against wind), and other aspects of the geosynthetics installation, including geomembranes, geotextiles, geonets, and geonet composites. The Installer is responsible for the protection of the materials once they arrive on site until the work is accepted by the OWNER.

Geotechnical CQA Laboratory: Party, independent from the OWNER or CONTRACTOR, responsible for completing laboratory tests on soil samples obtained at the site or source.

Subcontractor: The Subcontractor is an entity or individual who has a direct contract with the CONTRACTOR for the performance of a part of the Work. The Subcontractor shall communicate with the OWNER or ENGINEER through the CONTRACTOR. The Subcontractor shall adhere to the requirements of the Technical Specifications and this CQA Plan as it relates to the Subcontractor's part of the Work.

2.0 CQA PERSONNEL

The OWNER will retain a CQA Consultant to assure that proper construction techniques and procedures are used and to verify that the materials used meet the Technical Specifications. The CQA Consultant must employ engineer(s) licensed to practice in the Commonwealth of Virginia and personnel experienced in the field of solid waste management and landfill construction. At the completion of the work, the program requires certification reports indicating that the facility has been constructed in accordance with the Technical Specifications and approved permit. It is the responsibility of the CQA Consultant to prepare these reports.

3.0 CQA LABORATORIES

3.1 GEOTECHNICAL CQA LABORATORY

3.1.1 Experience and Qualifications

The Geotechnical CQA Laboratory must have experience in testing soils and aggregates, and be familiar with ASTM International (ASTM) test standards and other applicable test standards as required in the Technical Specifications. The geotechnical laboratory must have proven their abilities on previous work with the ENGINEER or shall provide the ENGINEER with their Qualifications and Experience (Q&E) package demonstrating their experience as it relates to the Technical Specifications. The Q&E package shall include a project list showing the name, address, and telephone number of the appropriate party to contact for reference. The Geotechnical CQA Laboratory must be capable of providing preliminary permeability test results within 48 hours and final permeability test results within 72 hours of receipt of sample. The laboratory must be capable of providing all other test results within five days of receipt of samples.

The Geotechnical CQA Laboratory shall provide a contract administrator/project manager for the project as the responsible person to contact. This person shall oversee the analytical procedures and testing as well as review and reporting of the results.

3.1.2 Responsibilities

The Geotechnical CQA Laboratory is responsible for performing all geotechnical laboratory tests and formally submitting results to the ENGINEER as required in the Technical Specification. These tests shall include, but are not limited to, those indicated in the Technical Specifications.

3.2 GEOSYNTHETIC CQA LABORATORY

3.2.1 Experience and Qualifications

The Geosynthetic CQA Laboratory must have experience in testing geosynthetics, and must conform to ASTM, National Sanitation Foundation (NSF), Geosynthetic Research Institute (GRI), and other applicable test standards, as required in the Technical Specifications. The geosynthetic laboratory must have proven their abilities on previous work with the ENGINEER or shall provide the ENGINEER with their Qualifications and Experience (Q&E) package demonstrating their experience as it relates to the Technical Specifications. The Q&E package shall include a project list showing the name, address, and telephone number of the appropriate party to contact for reference. The Geosynthetic CQA Laboratory must be capable of providing test results within 48 hours from receipt of samples.

The Geosynthetic CQA Laboratory shall provide a contract administrator/project manager for the project as the responsible person to contact. This person shall oversee the analytical procedures and testing as well as review and reporting of the results.

3.2.2 Responsibilities

The Geosynthetic CQA Laboratory is responsible for performing all geosynthetic laboratory tests and formally submitting results to the ENGINEER as required in the Technical Specifications. These tests shall include, but are not limited to, those indicated in the Technical Specifications.

4.0 CQA TESTING AND INSPECTION CRITERIA

This section of the CQA Plan describes the inspection activities (observations and tests) that will be performed during construction to ensure that the facility is constructed to meet or exceed all design criteria, plans, and specifications. The scope of this section addresses the construction, including material installation and the manufacture/fabrication of the following specific components:

- Earthworks;
- Subgrade preparation;
- Polyethylene Geomembrane (HDPE) installation;
- Geonet Composite and Geotextile installation; and,
- HDPE Pipe installation.

4.1 GENERAL PRECONSTRUCTION ACTIVITIES

Prior to the start of construction, a preconstruction meeting shall be held among the OWNER, the ENGINEER, CQA Consultant, Geosynthetics Installer (Installer) and the CONTRACTOR responsible for completing the work. The topics covered at this meeting shall include, but not be limited to:

- CQA documents and supporting information;
- The site-specific CQA plan, its role relative to accomplishing the intent of the design, as well as review of the Construction Drawings and Technical Specifications;
- Responsibilities of each party;
- Lines of authority and communication for each organization;
- Procedures or protocol for construction, change orders, deficiencies, repairs, and retesting;
- Methods of documenting and reporting inspection data;
- Work area security and safety protocol;
- Location and protection of construction materials, and the prevention of damage of the materials from inclement weather or other adverse events;
- Conducting a site walk to review site conditions as well as material staging and storage locations;
- The construction plan, schedule, and procedures; and
- Installation, testing, and acceptance criteria and procedures.

4.2 EARTHWORKS

Structural fill shall be prepared and compacted in accordance with the Technical Specifications and to the grades and lines indicated on the Construction Drawings. Structural fill will also be used for liner subgrade, pipe backfill, and final cover construction. The surface shall be free of vegetation, construction debris, sticks or roots, sharp rocks, void spaces, ice, abrupt elevation changes, standing water,

desiccation cracks, or other puncture hazards. Structural fill shall meet the requirements of Section 02200 of the Technical Specifications.

4.2.1 Material Evaluation

Preconstruction material evaluations shall be performed on samples from proposed sources to ascertain their acceptability as construction materials. Construction testing shall be performed during the course of the Work to verify material compliance with the Technical Specifications.

The criteria determining the acceptability of materials for construction shall be as defined in the Technical Specifications, Virginia Department of Transportation (VDOT) Specifications, and/or as detailed in this CQA Plan. All evaluation tests are to be performed by the Geotechnical CQA Laboratory approved for use by the CQA Consultant. Test reports will state compliance with or deviation from applicable ASTM standards as outlined in the following sections.

4.2.1.1 Preconstruction Material Evaluation

Structural fill shall be sampled and tested prior to use for the project in accordance with Table 1 of Section 02200 to ascertain its conformance to the Technical specifications. Where structural fill soil types vary substantially and are not segregated, representative blends of the soils anticipated for construction use should also be sampled and tested. The material tested shall comply with a maximum particle size of less than 2 inches, except when materials are used for liner subgrade or landfill final protective cover where the maximum particle size shall be 1/2 inch.

As a general rule, a minimum of two series of preconstruction tests should be performed for every source of soil proposed for use as structural fill. Additional preconstruction samples should be taken and tested when the material changes or initial preconstruction test results appear inappropriate or questionable. When the same borrow source is utilized for more than one construction area, results from the previous tests may be used to supplement the preconstruction data.

4.2.2 Construction Observation

Observation of excavation and structural fill placement shall be coordinated with construction testing. Acceptance criteria for construction work shall be as identified in the Technical Specifications. At a minimum, the CQA Consultant shall monitor and record the following during the construction:

- Consistency of the materials during processing and placement; and,
- Deleterious material that may hinder proper soil compaction.

Structural fill grades shall be surveyed by the designated surveyor in accordance with the Technical Specifications.

4.2.3 Construction Testing

CQA testing during construction shall be conducted in accordance with Table 3 of Section 02200 of the Technical Specifications. All field and laboratory tests shall be conducted on samples taken during the course of the construction work. Testing and sampling procedures shall be observed and documented by the CQA Consultant.

Construction Observation: The CQA Consultant will be on-site at all times construction is ongoing, observing and documenting all relevant activities. The ENGINEER will visit the site periodically as construction progress warrants. Such visits will be frequent enough to allow the ENGINEER to be fully knowledgeable of the construction methods and performance. The ENGINEER may then determine if CQA observation and testing activities are adequate to meet the terms and intent of this CQA Plan.

Visual observation shall include, but not be limited to, the following:

- Consistency of materials and
- Areas where damage due to excess moisture, insufficient moisture, or freezing may have occurred.

Construction Testing: During construction, structural fill shall be sampled and tested in accordance with the frequencies and test methods presented in Table 3 of Section 02200.

Structural Fill Field Compaction Verification: Structural fill compaction and moisture content verification shall be determined using the nuclear density test method (ASTM D6938) at a minimum frequency of one per 10,000 square feet per lift and one per lift per 100 L.F. of pipe trench. Structural fill shall be placed in maximum 9-inch compacted layers and shall be compacted to the minimum densities as shown in Table 2 of Section 02200 of the Technical Specifications.

4.2.4 Defects and Repairs

4.2.4.1 Identification

If a defect is identified in the structural fill, the CQA Consultant shall determine the extent and the nature of the defect. If the defect is indicated by an unsatisfactory test result, the CQA Consultant shall determine the extent of the deficient area by additional tests, observations, a review of records, or other means that the CQA Consultant deems appropriate.

4.2.4.2 Notification

After determining the extent and nature of the defect, the CQA Consultant shall promptly notify the CONTRACTOR and the ENGINEER.

4.2.4.3 Repairs and Retesting

The CONTRACTOR shall correct all deficiencies in accordance with the Technical Specifications. The CQA Consultant shall schedule appropriate retests when the work deficiencies have been corrected. All retests by the CQA Consultant must verify that the deficiencies have been corrected before additional work may be performed by the CONTRACTOR in the area of the deficiency. The CQA Consultant shall observe any repair and report any noncompliance with the above requirements in writing to the ENGINEER.

4.3 HDPE POLYETHYLENE GEOMEMBRANE

Stringent QA and careful documentation are required in the production and installation of all of the High Density Polyethylene (HDPE) geomembrane materials. The work addressed under this section shall facilitate proper construction of all geomembrane components of the landfill final cover system. Work shall be constructed to the lines, grades, and dimensions indicated on the Construction Drawings, in accordance with the Technical Specifications or as required by the OWNER or ENGINEER.

The CQA Consultant shall issue a written daily report of activities. These reports shall include, at a minimum, observations, test results, problems encountered, and resolutions. Construction reports summarizing significant events and addressing problems encountered and their resolutions shall be issued to the ENGINEER. The format of these reports and frequency shall be established at the preconstruction meeting.

4.3.1 Manufacture of Geomembrane

The polyethylene resin used shall be virgin material with no more than 2% rework. If rework is used, it must be a similar formulation of the parent material. No post-consumer resin of any type shall be added to the formulation. Geomembrane shall meet the material requirements in Section 02597 of the Technical Specifications.

Prior to the installation, the Manufacturer will provide the CQA Consultant with the following:

- A properties sheet including all specified properties measured using test methods indicated in the Technical Specifications or equivalent methods approved by the ENGINEER and CQA Consultant;
- A list of quantities and descriptions of materials other than the base polymer that comprise the geomembrane;
- The sampling procedure and results of testing; and
- A certification that property values given on the properties sheet are minimum or maximum values and guaranteed by the Manufacturer.

The CQA Consultant will verify that:

- The property values certified by the Manufacturer meet all of the Technical Specifications; and
- The measurements of properties by the Manufacturer are properly documented, the test methods used are acceptable, and the geomembrane meets the Manufacturer specifications and the Technical Specifications.

4.3.2 Conformance Testing

The manufacturer and the CQA Consultant will perform MQC and QA verification testing in accordance with Section 02597 of the Technical Specifications. Samples of the geomembrane material shall be taken from the leading edge of the roll and shall be three feet wide by the length of the roll. QA Samples shall be taken at the factory prior to shipment or upon delivery at the site.

4.3.3 Transportation and Delivery

All on-site storage and handling is the responsibility of the CONTRACTOR or Installer. The CONTRACTOR or Installer is responsible for the submittal of shipping manifests and all other relevant documents to the CQA Consultant.

Upon delivery at the site, the CQA Consultant shall inventory all rolls and conduct a surface observation of each roll or factory panel for defects or damage. The inspection will be performed without unrolling rolls or unfolding factory panels unless defects or damages are found or suspected. The CQA Consultant will indicate those rolls with severe flaws that should be removed from the site.

The Installer will be responsible for the storage of the geomembrane on-site upon arriving at the site. The OWNER will provide storage space in a location (or several locations) such that on-site transportation and handling are minimized. Storage space should be protected from theft, vandalism, passage of vehicles, etc.

The CQA Consultant will verify that storage space selected is in a well-drained area and that cribbing techniques have been used as needed to ensure that the materials will not be sitting in ponded water in the event of adverse weather.

4.3.4 Construction

The Installer shall submit proposed panel layouts to the CQA Consultant at least two weeks prior to mobilization of installation crews. In general, seams should be oriented parallel to the line of maximum slope, i.e., oriented with, not across, the slope. In corners and other geometrically complex locations, the number of seams should be minimized. No butt seam or tee seam will be less than five feet from the toe of slopes or areas of potential stress concentrations unless otherwise authorized by the CQA Consultant.

Once the panel layout is approved, the Installer may not substantially change the layout without permission of the CQA Consultant, ENGINEER, or OWNER. The Installer shall submit a drawing of proposed seam completion details for intersections of three or more panels to the ENGINEER and the CQA Consultant prior to shipment of the geomembrane.

Subgrade surfaces to receive geomembrane shall meet the requirements of Section 4.2 and the Technical Specifications. The Installer shall provide written certification that the subgrade surface on which the geomembrane will be installed is acceptable. During placement, the CQA Consultant will verify that:

- Any equipment used does not damage the geomembrane by handling, trafficking, excessive heat, leakage of hydrocarbons, or other means;
- The prepared surface underlying the geomembrane has not deteriorated since previous acceptance and is still acceptable immediately prior to geomembrane placement;
- Any geosynthetic elements immediately underlying the geomembrane are of acceptable cleanliness and free of debris;
- All personnel working on the geomembrane do not smoke, wear damaging shoes, or engage in other activities that could damage the geomembrane;
- The method used to unroll the panels does not cause scratches or crimps in the geomembrane and does not damage the supporting soil;
- The method used to place the panels minimizes wrinkles (especially differential wrinkles between adjacent panels);
- Adequate temporary loading and/or anchoring (e.g., sand bags, tires), not likely to damage the geomembrane, has been placed to prevent uplift by wind (in case of high winds, the loading should be continuous along the edges of panels to minimize the risk of wind flow under the panels); and
- Direct contact of equipment with the geomembrane is minimized; i.e., the geomembrane is protected by geotextiles, extra geomembrane, or other suitable materials, in areas where excessive traffic may be expected. Portable generators may not be placed directly on the geomembrane, but shall be placed on a rub sheet.

The CQA Consultant will notify the Installer and Contractor if the above conditions are not fulfilled.

After placement and prior to seaming, the CQA Consultant will visually examine each panel for damage. The CQA Consultant will advise the Geomembrane Installer which panels, or portions of panels, should be rejected, repaired, or accepted. Damaged panels or portions of damaged panels that have been rejected will be marked, and their removal from the work area shall be recorded by the CQA Consultant.

Prior to seaming, the CQA Consultant shall verify that the seam area is clean and free of moisture, dust, dirt, debris of any kind, and foreign material. The CQA Consultant shall verify that the bonding surfaces are thoroughly cleaned by mechanical abrasion prior to extrusion welds. QC testing of the seams shall be conducted by the Installer under the observation of the CQA Consultant. The Installer shall supply qualified personnel and testing equipment. The CQA Consultant or Geosynthetic CQA Laboratory may perform additional testing to verify that the seams meet the requirements of the Technical Specifications.

During geosynthetics construction, the CQA consultant shall maintain records on the following items:

- Geosynthetic roll inventory (geomembrane, geocomposite, geotextile, etc.)
- Laboratory testing of geosynthetic materials (conformance and seam strength)
- Geosynthetic panel installation logs, including subgrade acceptance
- Seam testing logs, both destructive and nondestructive
- Geomembrane repair logs
- General construction activity logs for daily reports

4.3.4.1 Trial Seams

Trial seams shall be made each day prior to commencing field seaming. The seams shall be made on fragments of geomembrane under the same surface and environmental conditions as the production seams to verify that seaming conditions are adequate. The trial seams shall be made at the beginning of each seaming period; at changes of equipment, equipment settings, operator, weather, or sheet temperature; at the CQA Consultant’s discretion; at least once every four to six hours during continuous operation of each welding machine; or at change in geomembrane material type (i.e., smooth-to-smooth seam versus smooth-to-textured seam).

The trial seam sample shall be at least five feet long by one foot wide with the seam centered lengthwise. For dual-track fusion welds, six one-inch wide by six-inch long test strips shall be cut from the trial seam. Quantitatively test three specimens for inside and outside peel adhesion (peel) and three specimens for bonded seam strength (shear). For extrusion welds, six one-inch wide by six-inch long test strips shall be cut from the trial seam. Quantitatively test three specimens for peel and three specimens for bonded seam strength (shear). A trial seam sample shall pass when the values shown below are achieved in both peel and shear testing.

MINIMUM POLYETHYLENE SEAM PROPERTIES (per GRI GM-19)

PROPERTY	METHOD	40 MIL HDPE	60 MIL HDPE
Shear Strength	ASTM D6392	80 ppi	120 ppi
Peel Adhesion:			
Fusion	ASTM D6392	60 ppi	91 ppi
Extrusion	ASTM D6392	52 ppi	78 ppi

The strength of four out of five specimens shall meet or exceed the value shown in this table. The fifth must meet or exceed 80% of the given value in order to be considered a passing test.

Unacceptable break codes are:

- Fusion: AD and AD-Brk>25%
- Extrusion: AD1, AD2, AD-WLD (unless strength is achieved)

Trial seams shall be repeated, in their entirety, when any of the trial seam samples fail in either peel or shear. If additional trial seams fail, 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 trial seams are achieved. No welding equipment or welder shall be allowed to begin production welds until equipment and welders have a successfully completed trial seam. Seaming shall not proceed when ambient air temperature or adverse weather conditions jeopardize the integrity of the liner installation. Installer shall demonstrate that acceptable seaming can be achieved by completing passing trial seams.

The remainder of the successful trial seam shall be assigned a number and marked accordingly by the CQA Consultant, who shall also log the date, hour, ambient temperature, number of seaming apparatus, name of seamer, and pass or fail description. The sample itself shall be archived until project completion.

4.3.4.2 Non-Destructive Testing

Production seams shall be continuously tested by the Installer using non-destructive techniques. The Installer shall perform all air pressure (fusion-welded seams) and vacuum testing (extrusion-welded seams) under the observation of the CQA Consultant as follows:

- Extrusion Weld Testing – Non-destructive testing of the extrusion weld shall be conducted with a vacuum box assembly consisting of a rigid housing, a transparent viewing window, a soft gasket attached to the bottom, a valve assembly, and a vacuum gauge. The assembly shall be capable of maintaining at least a three-psi vacuum. A passing extrusion seam shall exhibit at least a three-psi vacuum for a minimum of 10 seconds. The presence of soap bubbles in rapid succession is indicative of a leak. The viewing window should be regularly cleaned to ensure a clear view of the seam section being tested. All areas where soap bubbles appear shall be marked, repaired, and retested.
- Fusion Weld Testing – Non-destructive testing of the fusion weld shall be conducted with an air pump or tank capable of generating and sustaining pressure over 30 psig; a sharp, hollow needle, or other approved pressure-feed device equipped with a pressure gauge; a utility knife with hook blade; a hot air gun or other device, and clamps to seal the ends of the air channel.
 - Seal both ends of the seam to be tested
 - Pressurize the seam to 30 psi, close valve and allow pressure to stabilize for approximately 2 minutes
 - Observe air pressure 5 min after initial 2-min stabilization period ends. If pressure loss exceeds 2 psi or pressure does not stabilize, locate faulty area and repair.
 - Cut opposite end of tested seam area once testing is completed to verify continuity of air channel. If air does not escape, locate blockage and retest unpressurized area. Repair cut end of air channel.
 - A test is considered passing if the pressure loss is less than 2 psi.

4.3.4.3 Destructive Testing

Extrusion- and fusion-welded field seams shall be destructively tested at a minimum frequency of one test per 500 linear feet of seam length per welding machine. Destructive test samples shall be located by the CQA Consultant as seaming progresses and shall be removed by the Installer to obtain laboratory test results before the geomembrane is covered. Samples shall be 12-inches wide by a minimal length (typically 42 inches) with the seam centered lengthwise (a minimum of six inches on either side of the seam). The sample shall be cut into three parts for distribution to the Installer for field testing (12-inches), to the Geosynthetic CQA Laboratory for testing (18 inches), and to the OWNER for archive (remainder).

All passing seams shall meet the requirements in the table below:

MINIMUM POLYETHYLENE SEAM PROPERTIES (per GRI GM-19)

PROPERTY	METHOD	40 MIL HDPE	60 MIL HDPE
Shear Strength	ASTM D6392	80 ppi	120 ppi
Peel Adhesion:			
Fusion	ASTM D6392	60 ppi	91 ppi
Extrusion	ASTM D6392	52 ppi	78 ppi

The strength of four out of five specimens shall meet or exceed the value shown in this table. The fifth must meet or exceed 80% of the given value in order to be considered a passing test.

Unacceptable break codes are:

- Fusion: AD and AD-Brk>25%
- Extrusion: AD1, AD2, AD-WLD (unless strength is achieved)

Samples that do not pass the shear and peel tests shall be resampled from locations at least 10 feet on each side of the original location. These two retest samples must pass both shear and peel testing. If these two samples do not pass, then additional sampling shall continue as described in the Technical Specifications until the questionable seam area is defined.

4.3.4.4 Repairs

Any portion of unsatisfactory geomembrane or seam area failing a destructive or non-destructive test shall be repaired. Damaged geomembrane shall be removed and replaced with acceptable geomembrane materials if the damage cannot be satisfactorily repaired. The Installer shall be responsible for repair of damaged or defective areas. Agreement upon the appropriate repair method shall be decided between the OWNER, ENGINEER or CQA Consultant, and the Installer. Procedures available include the following:

- Patching - Used to repair large holes, tears, undispersed raw materials, and contamination by foreign matter.
- Spot Welding - Used to repair pinholes, other localized flaws (minor), or where geomembrane thickness has been reduced.
- Capping - Used to repair large lengths of failed seams by covering with new material.
- Replacement - Removing the unacceptable seam and replace with new material.

In addition, surfaces of the geomembrane that are to be repaired by extrusion welds shall be lightly abraded with a disc grinder or equivalent to ensure cleanliness. All geomembrane surfaces shall be clean and dry at the time of repair. Patches or caps shall be extended at least six inches beyond the edge of the defect. All corners of patch material shall be rounded. The CQA Consultant shall number and log each patch repair, and the Installer shall non-destructively test each repair using methods specified in this plan.

4.3.4.5 Final Inspection

A final inspection shall be completed by the Installer, ENGINEER, CQA Consultant, and OWNER prior to placement of additional layers of geosynthetic materials or the Installer demobilizing from the site. All identified problem areas shall be repaired by the Installer and accepted by the CQA Consultant.

4.3.4.6 Survey

As geomembrane installation progresses, identification of all panels, seams, locations of destructive test locations, and anchor trenches shall be made by survey. Survey reporting requirements for geomembrane installation are outlined in Section 5.2.

4.4 GEOTEXTILES

4.4.1 Manufacture of Geotextile

The geotextile Manufacturer shall provide the ENGINEER and the CQA Consultant with a list of guaranteed properties for the type of geotextile to be supplied. The geotextile Manufacturer shall provide the ENGINEER and the CQA Consultant with a Manufacturer's installation guide.

4.4.1.1 Woven Geotextile

- (a) Woven geotextiles used in the perimeter roadways shall be manufactured by Mirafi, Amoco, Nicolon or other approved manufacturers. Woven geotextiles used as roadway stabilization fabric shall meet the requirements of AASHTO M288 Survivability Class 2 or better.
- (b) Woven geotextiles shall be placed at the roadway subgrade elevations as indicated on the Contract Drawings. Woven geotextile shall meet the minimum properties as specified in Section 02595 of the Technical Specifications.
- (c) To keep the number of seams to a minimum, the geotextile shall be provided in rolls not less than 12 feet wide.

4.4.1.2 Nonwoven Geotextile

- (a) The CQA Consultant shall examine all of Manufacturer's certifications to ensure that the property values listed on the certifications meet or exceed those specified.
- (b) The geotextile used for wrapping the leachate collection stone shall be a nonwoven geotextile conforming to AASHTO M288 Survivability Class 2.

4.4.2 Transportation and Delivery

All on-site storage and handling is the responsibility of the CONTRACTOR or Installer as defined in the Technical Specifications. The CONTRACTOR or Installer is responsible for the submittal of shipping manifests and other relevant documents to the CQA Consultant.

Upon delivery to the site, the CQA Consultant shall inventory the rolls and conduct a surface observation of each roll or factory panel for defects or damage. The inspection will be performed without unrolling rolls or unfolding factory panels unless defects or damages are found or suspected. The CQA Consultant will indicate those rolls with severe flaws that should be removed from the site.

The OWNER will provide storage space in a location (or several locations) that will minimize on-site transportation and handling. The storage space should be protected from theft, vandalism, passage of vehicles, etc. The CQA Consultant will verify that the storage space selected is in a well-drained area

and that cribbing techniques have been used as needed, ensuring that the materials will not be sitting in moisture or mud in the event of adverse weather.

4.4.3 Construction

During deployment, the CQA Consultant shall inspect the geotextile for damage due to equipment, to dragging across the geomembrane, or other potentially damaging activities. The Installer shall handle all geotextiles in such a manner as to ensure they are not damaged and that the following shall be complied with:

- On slopes, the geotextile shall be secured in the anchor trench and rolled down the slope in such a manner as to continually keep the geotextile sheet in tension. If necessary, the geotextile shall be positioned by hand after being unrolled to minimize wrinkles; however, the geotextile shall not be dragged across the geomembrane. Geotextile shall not be placed in the horizontal direction (i.e., across the slope).
- In the presence of excessive wind, geotextile shall be weighted with sandbags or the equivalent. Such sandbags shall be installed during placement and shall remain until replaced with cover material.

Adjacent geotextile shall be joined according to the Manufacturer's recommendations, the Manufacturer's Installation Guide, Construction Drawings, and the Technical Specifications. At a minimum, the following requirements shall be met:

- Adjacent rolls shall be overlapped a minimum of six inches.
- Overlaps shall be secured by continuous sewing, heat bonding, or other means approved by the ENGINEER.
- Where seams do not need to be sewn, a minimum 18-inch overlap shall be maintained.

Holes or tears in the geotextile shall be repaired by placing a patch of geotextile extending a minimum of two feet beyond the edges of the hole or tear and shall be heat bonded. If the hole or tear width across the roll is more than 50 percent the width of the roll, the damaged area shall be cut out and the two portions of the geotextile shall be sewn together.

4.5 GEONET COMPOSITE (GEOCOMPOSITE)

4.5.1 Manufacture of Geonet Composite

The geonet composite manufacturer shall provide the ENGINEER and the CQA Consultant with a list of guaranteed properties for the type of geonet composite to be supplied. The geonet composite manufacturer shall provide the ENGINEER and the CQA Consultant with a Manufacturer's installation guide.

The Manufacturer's quality control (QC) testing shall comply with Tables 02590-1 and 02590-2 of Section 02590 of the Technical Specifications and results of the manufacturer's testing shall be submitted to the CQA Consultant prior to shipment of material to the site. The CQA Consultant shall examine all manufacturer certifications to ensure that the property values listed on the certifications meet or exceed those specified.

4.5.2 CQA Conformance Testing

The CQA Consultant or a designated independent geosynthetics laboratory will perform additional quality assurance (QA) testing in accordance with Table 02590-3 to verify that the geonet composite meets the requirements of Section 02590 of the Technical Specifications. Samples of the geonet composite shall be taken from the leading edge of the roll and shall be three feet wide by the length of the roll. Samples shall be taken at the factory prior to shipment or upon delivery at the site.

4.5.3 Transportation and Delivery

All storage and handling on-site is the responsibility of the CONTRACTOR or Installer. The CONTRACTOR or Installer is responsible for the submittal of shipping manifests and all other relevant documents to the CQA Consultant.

Upon delivery to the site, the CQA Consultant shall inventory all rolls and conduct a surface observation of each roll or factory panel for defects or damage. The inspection will be performed without unrolling rolls or unfolding factory panels unless defects or damages are found or suspected. The CQA Consultant will indicate those rolls with severe flaws that should be removed from the site.

The OWNER will provide storage space in a location (or several locations) such that on-site transportation and handling are minimized. Storage space should be protected from theft, vandalism, passage of vehicles, etc.

The CQA Consultant will verify that storage space selected is in a well-drained area and that cribbing techniques have been used as needed to ensure that the materials will not be sitting in ponded water or mud.

4.5.4 Construction

During deployment, the CQA Consultant shall inspect the geonet composite for damage due to equipment, deployment across the geomembrane, or other potentially damaging activities. The Installer shall handle all geonet composite in such a manner as to ensure it is not damaged and the following shall be complied with:

- On slopes, the geonet composites shall be secured in the anchor trench and the rolled down the slope in such a manner as to continually keep the geonet composite sheet in tension. If necessary, the geonet composites shall be positioned by hand after being unrolled to minimize wrinkles. Geonet composite shall not be placed in the horizontal direction (i.e., across the slope).
- In the presence of excessive wind, geonet composite shall be weighted with sandbags or the equivalent. Such sandbags shall be installed during placement and shall remain until replaced with cover material.

Adjacent geonet composites shall be joined according to the Manufacturer's recommendations, the Manufacturer's Installation Guide, construction drawings and Specifications. As a minimum, the following requirements shall be met:

- Adjacent rolls shall overlap the geonet component by at least six inches;
- Butt-seams shall overlap one to two feet;
- These overlaps shall be secured by tying;
- Tying can be achieved by plastic fasteners or polymer braid. Tying devices shall be white or yellow for easy inspection. Metallic devices are not allowed;
- Fasteners shall be spaced a maximum of five feet along downslope roll overlaps, a maximum of two feet along cross-slope roll overlaps, and a maximum of six inches in an anchor trench.
- The edges of the top geotextile component shall be continuously sewn or continuously heat bonded.

Holes or tears in the geonet composite shall be repaired by placing a patch of geonet composite extending a minimum of two feet beyond the edges of the hole or tear. The patch shall be fastened to the original roll with approved fasteners spaced every six inches around the patch. If the hole or tear width across the roll is more than 50 percent the width of the roll, the damaged area shall be cut out and the two portions of the geonet shall be overlapped one to two feet and tied together every six inches.

4.7 LEACHATE COLLECTION MATERIAL

The leachate collection material shall consist of clean, subangular, loose non-carbonate gravel used to provide drainage for leachate. The Leachate Collection material shall be placed according to the Technical Specifications and Construction Drawings. The leachate collection material shall be free of rubble, wood, stumps, brush, metal, cinders, trash, demolition debris, garbage, topsoil, organic soil, loam, sludge, and other deleterious materials.

4.7.1 Material Evaluation

Preconstruction material evaluations shall be performed on samples from potential sources to ascertain their acceptability as construction materials. Testing shall be performed to verify material compliance with the Technical Specifications.

Criteria to be used for determination of acceptable materials for construction shall be as defined in the Technical Specifications, Virginia Department of Transportation (VDOT) Specifications, and as detailed in this CQA Plan. All evaluation tests are to be performed in the Geotechnical CQA Laboratory approved for use by the CQA Consultant. Test reports will state compliance with or deviation from applicable ASTM standards.

4.7.2 Construction Observation

Observation of the drainage material placement shall be coordinated with construction testing. Acceptance criteria for construction work shall be as identified in the Technical Specifications. At a minimum, the CQA Consultant shall observe and record the following during the placement of the drainage/protection layer:

- Consistency of the materials during processing and placement; and,
- Deleterious material.

4.8 HDPE PIPING

The work addressed under this section shall facilitate proper construction of all HDPE piping for the collection and removal of leachate from the landfill. All work shall be constructed to the lines, grades, and dimensions indicated on the Construction Drawings, in accordance with the Technical Specifications, or as required by the OWNER or ENGINEER.

4.8.1 Manufacture of HDPE Pipe

The CONTRACTOR shall submit manufacturer's data sheets, certification of compliance with specifications for all pipes, fittings and appurtenances. Prior to the installation, the CONTRACTOR shall provide the CQA Consultant with the following:

- A properties sheet including all specified properties measured using test methods indicated in the Technical Specifications or equivalent methods approved by the ENGINEER and CQA Consultant; and,
- A certification that property values given in the properties sheet are minimum or maximum values and are guaranteed by the Manufacturer.

The CQA Consultant will verify that:

- The property values certified by the Manufacturer meet all of the Technical Specifications; and,
- The measurements of properties by the Manufacturer are properly documented, the test methods used are acceptable, and the HDPE pipe meets the Manufacturer's specifications and the Technical Specifications.

4.8.2 Transportation and Delivery

All storage and handling on-site is the responsibility of the CONTRACTOR. The CONTRACTOR is responsible for the submittal of all other relevant documents to the CQA Consultant.

Upon delivery at the site, the CQA Consultant shall conduct a surface observation of the pipe as is feasible for defects or damage. The inspection will be performed without unstacking pipe unless defects or damage are found or suspected. The CQA Consultant will indicate those pipes with severe flaws that should be removed from the site.

Once on site, the CONTRACTOR will be responsible for the storage of the pipe. The OWNER will provide storage space in a location (or several locations) such that transportation and handling are minimized. The storage space should be protected from theft, vandalism, passage of vehicles, etc.

4.8.3 Construction

4.8.3.1 Pipe Placement

Piping shall be field fit and not cut based on measurements made from the Construction Drawings. Pipe shall be carried manually by using mechanical equipment with flat forks or fabric slings. Pipe shall not be dragged on the ground. The CONTRACTOR shall join pipes using the Manufacturer-recommended fusion methods. The pipe bedding and backfill shall be prepared and the pipe placed and buried as required in the Technical Specifications. During placement, The CQA Consultant will verify that:

- Equipment used does not damage the HDPE pipe by handling, excessive heat, or other means;
- The prepared surface and trench underlying the HDPE pipe has not deteriorated since previous preparation and is still acceptable immediately prior to pipe placement;
- Personnel do not engage in activities that could damage the pipe;
- Methods used to place the pipe do not damage the pipe or supporting soil;
- The pipe is backfilled in a method to completely support the pipe with bedding; and
- Methods used to backfill the pipe do not displace the pipe.

4.8.3.2 Non-destructive Testing

Non-perforated HDPE pipe shall be tested by the CONTRACTOR using non-destructive techniques prior to backfilling the pipe. The Contractor shall perform hydrostatic testing under the observation of the CQA

Consultant according to Section 02651 of the Technical Specifications. Test the electrical integrity of the installed tracer wire prior to backfilling the pipe.

4.8.3.3 Repairs

Any portion of piping failing the pressure test shall be repaired. Damaged pipe shall be removed and replaced when pipe damage cannot be satisfactorily repaired. If the air pressure test fails, the failing section shall be located, removed, and rejoined.

4.8.3.4 Final Inspection

A final inspection shall be completed by the CONTRACTOR and CQA Consultant prior to backfilling the pipe. All identified problem areas shall be repaired by the CONTRACTOR and accepted by the CQA Consultant prior to backfilling.

5.0 RECORDS AND REPORTING

This section of the CQA Plan describes the recordkeeping requirements of the CQA consultant during construction activities and the reporting requirements to document the completion of construction. Following construction, a certification report signed by a Virginia Professional Engineer must be submitted to the DEQ. In the case of closure, a certification signed by a Virginia Professional Engineer verifying closure has been completed will be required.

5.1 RECORDKEEPING DURING CONSTRUCTION

During construction, the CQA consultant shall maintain records on the following items:

- Laboratory testing of soil materials
- Field Soil testing logs (compaction testing)
- Geosynthetic roll inventory (geomembrane, geocomposite, geotextile, etc.)
- Laboratory testing of geosynthetic materials (conformance and seam strength)
- Geosynthetic panel installation logs, including subgrade acceptance
- Seam testing logs, both destructive and nondestructive
- Geomembrane repair logs
- Laboratory testing of drainage material
- General construction activity logs for daily reports

5.2 SURVEYING

As part of the certification report submitted to the DEQ, as-built drawings sealed by a Virginia Licensed Land Surveyor will be included. These drawings must be to scale, have a contour interval of 2 feet or less, and be on a 24"x36" sheet size.

As a minimum, drawings for a Closure Construction Certification Report will include:

1. Existing Conditions
2. Top of Base Grade
3. Geomembrane panel layout and destructive sample locations
4. Geomembrane panel layout including panel numbers, roll numbers and repair locations
5. Top of Final Cover, including thickness verification of layer

5.3 REPORTING

At the completion of construction a report must be submitted to the DEQ documenting the construction activities. The certification report must contain the following sections:

- PE certification as required by the VSWMR
- A site location map and a cross section of constructed layers
- Narrative describing the construction activity, testing performed, and conformance with the permit requirements
- Structural Fill Data, including:
 - Laboratory testing of fill materials
 - Records of field density testing, with location maps of field tests
- Geosynthetic Installation Data, including (as applicable):
 - Material inventory
 - MQC and CQC testing results
 - Subgrade acceptance forms
 - Panel deployment logs
 - Seaming logs
 - Seam defect and repair logs
 - Non-destructive testing logs
 - Destructive testing logs
- Drainage Layer Data (if applicable), including laboratory test results
- Final Cover Soil Data (if applicable), including:
 - Laboratory testing of soil materials
 - Records of field density testing, with location maps of field tests
- Resumes of key personnel
- As-Built drawings as described in Section 5.2