CONSTRUCTION QUALITY ASSURANCE PLAN GUIDELINES

Bremo Power Station – SW Permit #618

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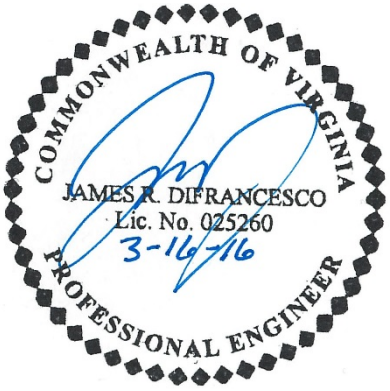

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1.0 INTRODUCTION

This Construction Quality Assurance Plan Guideline (the CQA Plan) was prepared by Golder Associates Inc. (Golder) to assist Dominion Power, Inc. (OWNER) in performing construction for the North, East, and West pond closure at the Bremo Power Station, Fluvanna County, Virginia according to the Construction Drawings and Technical Specifications pursuant to that certain Construction Services Agreement (the "Contract") between OWNER and Ryan Central Incorporated (the "CONTRACTOR").

The CQA Plan provides guidance information and procedures that should be undertaken by Contractor to perform the Work and complete the Project as required by the Contract.

This CQA Plan is a supplemental document to the Contract, the Construction Drawings and Technical Specifications for the Project. Where a conflict arises, the Contract Documents will govern. All terms not defined herein will have the meaning set forth in the Contract. To the extent there is a conflict between the provisions of this CQA Plan and the remainder of the Contract, OWNER will determine which provisions governs. The QA/QC program adapted by CONTRACTOR pursuant to the Contract will be in general conformance with the provisions of this CQA Plan.

1.1 Project Description

The activities addressed under this CQA Plan includes all Work set forth in the Contract and includes the following activities:

1. Earthworks, including soils and Coal Combustion Residuals (CCR);
2. High Density Polyethylene (HDPE) Geomembrane;
3. Geonet Composite; and,
4. Protective Cover Layer and Vegetative Support Layer soils.

1.2 Definitions

1.2.1 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 quality 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 plan does not address quality control procedures, criteria, and/or tests employed by the CONTRACTOR.

1.2.2 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.

1.2.3 Lot

A quantity of resin (usually the capacity of one rail car) used in the manufacture of polyethylene geomembrane rolls. The finished roll will be identified by a roll number traceable to the resin lot used.

1.2.4 Panel

The unit area of geomembrane that will be seamed in the field. A panel is identified as a roll or portion of a roll that is larger than 100 square feet.

1.2.5 Subgrade Surface

The surface which immediately underlies the geosynthetic material(s).

1.3 Parties

1.3.1 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 Power, Inc.

1.3.2 Engineer

The ENGINEER is an official representative of the OWNER. The ENGINEER is responsible for the preparation of the Construction Drawings and Technical Specifications of the project and for preparation of the CQA Plan. The ENGINEER is also responsible for the interpretation of those documents and for

resolution of technical matters that arise during construction. For this project, the ENGINEER is Golder Associates Inc., Richmond, Virginia.

1.3.3 Contractor

The CONTRACTOR has the primary responsibility for ensuring that the project 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.

1.3.4 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. This party will perform laboratory testing of soils and other earth materials for material evaluation and verification purposes. This party will also observe installation of the geosynthetic cap and coordinate sampling and testing of the geosynthetics with the Geosynthetic CQA Laboratory. The CQA Consultant is also responsible for issuing a certification report, sealed by a registered Professional Engineer, licensed in Virginia.

1.3.5 Land Surveyor

The Land Surveyor shall be a licensed surveyor in the Commonwealth of Virginia. The surveyor is responsible for performing topographic surveys, producing as-built drawings, and for performing all other designated tasks described in the Technical Specifications.

1.3.6 Geomembrane Manufacturer

The party responsible for manufacturing the geomembrane rolls.

1.3.7 Geosynthetic CQA 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.

1.3.8 Geotechnical CQA Laboratory

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

1.3.9 Geomembrane Installer

The Geomembrane 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 also responsible for transportation of these materials to the site. In addition, the Installer is responsible for the protection of the materials once they arrive on site, until the work is accepted by the OWNER.

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 engineers licensed to practice in the State of Virginia and experienced in the field of CCR 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 certifying engineer 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 structural fills 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 and 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. 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 may 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. 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 may 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. The scope of this section addresses the construction, including material installation and the manufacture/fabrication of the following specific components:

1. Earthworks, including soils and Coal Combustion Residuals (CCR);
2. High Density Polyethylene (HDPE) Geomembrane;
3. Geonet Composite; and,
4. Protective Cover Layer and Vegetative Support Layer soils.

This section addresses the inspection activities that are necessary to ensure that the facility is constructed to meet or exceed all design criteria, plans, and specifications.

4.1 General Preconstruction Activities

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

1. Providing each party with all relevant CQA documents and supporting information;
2. Familiarizing each organization with 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;
3. Reviewing the responsibilities of each party;
4. Reviewing lines of authority and communication for each organization;
5. Discussing the established procedures or protocol for construction, change orders, deficiencies, repairs, and retesting;
6. Reviewing methods of documenting and reporting inspection data;
7. Reviewing work area security and safety protocol;
8. Discussing procedures for the location and protection of construction materials, and for the prevention of damage of the materials from inclement weather or other adverse events;

9. Conducting a site walk to review site conditions as well as material staging and storage locations;

10. Discussing the proposed construction plan, schedule, and procedures; and

11. Clarifying installation, testing, and acceptance criteria and procedures.

4.2 Earthworks

Any earthen surface upon which the geomembrane liner of the cap is to be installed shall be prepared and compacted in accordance with the Technical Specifications. The surface shall be smooth, firm, unyielding, and free of vegetation, construction debris, sticks or roots, sharp rocks, void spaces, ice, abrupt elevation changes, standing water, desiccation cracks, or other puncture hazards.

4.2.1 Preconstruction Testing

The CONTRACTOR shall provide the OWNER or ENGINEER samples from each borrow source to be used as structural fill. From each borrow source, representative composite sample(s) shall be tested for the following:

1. Soil Classification (ASTM D2487, which includes Grain Size Analysis - ASTM D422 (or D6913) and Atterberg Limits - ASTM D4318); two per source or material type.

2. Compaction Testing (Proctor) (ASTM D698); two per source or material type.

4.2.2 Soil Stripping and Stockpiling

Stripping of existing cover soil materials shall take place under observation of the CQA Consultant to identify areas where CCR has been disturbed and mixed with the overburden soils. When CCR is discovered, the material shall be segregated and placed in a CCR-mixed soil stockpile area. CCR-mixed soils may be used as structural fill in areas that will be covered with a geomembrane liner; however, CCR-mixed soils shall not be used as final protective cover or vegetative support layer materials.

Any CCR material discovered after October 17th 2015 will not be considered acceptable fill material, and must be disposed of in a landfill. No CCR material may be deposited in any pond after this date.

4.2.3 Soil and CCR Excavation and Fill

Excavation and fill placement of the existing CCR shall take place under observation of the CQA Consultant. Fill shall be placed in lifts of no greater than nine inches compacted thickness to the lines and grades shown on the Contract Drawings. The CQA Consultant shall collect samples for laboratory testing and provide in-situ moisture and density testing in compliance with the Technical Specifications.

4.2.3.1 Test Schedule for Placement of Structural Fill

1. At least one USCS classification shall be performed per 5,000 cubic yards of structural fill placed. The USCS classification shall conform to ASTM D2487 (which includes Grain Size Analysis - ASTM D422 (or D6913) and Atterberg Limits (D4318)).

2. At least one moisture content test shall be performed per 10,000 cubic yards of structural fill placed. The moisture content tests shall conform to ASTM D2216.

3. At least one moisture-density relationship (Proctor) test for 10,000 cubic yards of structural fill. The moisture density curve test shall conform to ASTM D698.

4. Additional tests may be required when soil gradation tests indicate that there has been a change in the material being supplied.

5. Testing of the structural fill will include in-place density and moisture content tests in accordance with ASTM D6938. Frequency: one test per 10,000 square feet per lift.

6. The horizontal and vertical location of all test locations will be recorded by the CQA Consultant. A drawing will be prepared showing all test locations.

Compact fill material to a minimum percentage of the maximum dry density as determined by a standard Proctor (ASTM D698) as shown in the table below:

Material Type / Use	Compaction Requirement	Moisture Content
Structural Fill / Liner Subgrade	90%	-2% to +4%
Structural Fill / Road Subgrade	98%	-2% to +2%
Structural Fill / Trench Backfill & Stockpile	90%	-2% to +4%
CCR / Liner Subgrade	90%	-4% to +4%
Protective Cover Soil	90%	-2% to +4%
Structural Fill / Embankments	95%	-2% to +4%
Structural Fill / Foundations	95%	-2% to +4%
Structural Fill / All other uses	95%	-2% to +4%
Vegetative Soil / Final Cover	Do not compact	n/a

4.2.4 Liner Subgrade Preparation

Immediately before geosynthetic deployment, grade the subgrade to fill in all voids and cracks, and then smooth-roll to provide the best practicable surface for the geosynthetic liner. At the completion of this activity, no wheel ruts, footprints or other irregularities shall exist in the subgrade. All protrusions extending more than one-half inch from the surface shall be removed or crushed.

4.3 HDPE Geomembrane

Stringent quality assurance and careful documentation are required in the production and installation of all geosynthetic materials. The work addressed under this section shall facilitate proper construction of all HDPE geosynthetic components of the liner/cap for 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.

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

4.3.1 Manufacture of Geomembrane

The Manufacturer shall perform MQC testing on the natural resin at the frequencies and for the required physical properties indicated below prior to shipping material to the site.

Manufacturer QC Testing – Natural Resin

PROPERTY	TEST METHOD[1]	HDPE RESIN
Density (g/cm^3)	ASTM D792 (B) or D1505	≥ 0.940 (60-mil) ≥ 0.932 (40-mil)
Melt Flow Index (g/10 min.)	ASTM D1238 (190 °C/2.16 kg)	≤ 1.0
OIT (minutes)	ASTM D3895 (1 atm, 200 °C)	≥ 100

In addition, the Manufacturer shall perform quality conformance testing on the HDPE sheet at the frequencies and for the required physical properties indicated below prior to shipping material to the site.

Manufacturer QC Testing –Double-Sided Textured HDPE Sheet

Testing Properties	Testing Method	40 mil HDPE Value
Thickness (min ave.) • Lowest individual for 8 of 10 values • Lowest individual for any value	ASTM D 5994	38 mil 36 mil 34 mil
Density g/cc	ASTM D1505 or ASTM D792	0.940 mil
Asperity Height (min ave.) (1) (2)	GM-12	16 mil
Tensile Properties (min. ave.) (3) Break strength – lb/in Break elongation - %	ASTM D6693 Type IV	 60 100
Tear Resistance – lb (min. ave.)	ASTM D1004	28
Puncture Resistance – lb (min. ave.)	ASTM D4833	60
Stress Crack Resistance (11)	ASTM D5397	500 hr
Carbon Black Content - %	ASTM D1603 (4)	2.0 to 3.0
Carbon Black Dispersion	ASTM D 5596	Note (5)
Oxidative Induction Time (OIT) (min ave.) (6) Standard OIT High Pressure OIT	 ASTM D3895 ASTM D5885	 100 min 400 min
Oven Aging at 85°C (7) Std. OIT (min. ave.), % retained after 90 days High Pressure OIT (min. ave.), % retained after 90 days	 ASTM D5885 ASTM D5721 ASTM D3895	 55 80
UV Resistance (8) High Pressure OIT (min ave.) % retained after 1600 hrs	ASTM D5885	50

1. Of 10 readings, 8 out of 10 must be ≥14 mils, and lowest individual reading must be ≥ 12 mils
2. Alternate the measurement side for double sided textured sheet.
3. Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction.
   a. Break elongation is calculated using a gauge length of 2.0 in. at 2.0 in/min.
4. Other methods such as D4218 (muffle furnace) or microwave methods are acceptable if an appropriate correlation to D1603 (tube furnace) can be established.
5. Carbon black dispersion (only near spherical agglomerates) for 10 different views:
   a. 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 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.

9. The SP-NCTL test 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 sheet made from the same formulation as being used for the textured sheet materials.

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

1. A properties sheet including, at a minimum, all specified properties, measured using test methods indicated in the Technical Specifications or equivalent methods approved by the ENGINEER and CQA Consultant;

2. A list of quantities and descriptions of materials other than the base polymer that comprise the geomembrane;

3. The sampling procedure and results of testing; and

4. 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:

1. The property values certified by the Manufacturer meet all of the Specifications; and

2. 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 CQA Consultant or a designated independent geosynthetics CQA laboratory will perform quality assurance (QA) testing to verify that the HDPE sheet meets the requirements of the Technical Specifications. These tests and frequencies are also indicated below. Samples of the HDPE geomembrane material 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.

Testing Properties	Testing Method	Conformance QA Testing Frequency
Thickness	ASTM D 5994	1 per 200,000 sf
Density g/cc	ASTM D1505 or ASTM D792	1 per 200,000 sf
Asperity Height (1) (2)	GM-12	1 per 200,000 sf
Tensile Properties (3)	ASTM D6693 Type IV	1 per 200,000 sf
Tear Resistance – lb	ASTM D1004	1 per 200,000 sf
Puncture Resistance – lb	ASTM D4833	1 per 200,000 sf
Carbon Black Content - %	ASTM D1603 (4)	1 per 200,000 sf
Carbon Black Dispersion (5)	ASTM D 5596	1 per 200,000 sf

4.3.3 Transportation and Delivery

All 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 at the site, the CQA Consultant shall inventory all rolls and conduct a surface observation of each roll for defects or damage. The inspection will be performed without unrolling rolls 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 and those rolls with minor flaws. The Installer will be responsible for the storage of the geomembrane on-site upon arriving at the site. The OWNER will provide storage space 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 rainfall.

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 base seam or tee seam will be less than five feet from the toe of slope or areas of potential stress concentrations, unless otherwise authorized by the ENGINEER.

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 at panel corners of three or more sheets to the ENGINEER and the CQA Consultant prior to shipment of the geomembrane.

Subgrade surfaces to receive geomembrane installation shall be relatively smooth and even and free of ruts, voids, protrusions, and deleterious material. 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:

1. Any equipment used does not damage the geomembrane by handling, trafficking, excessive heat, leakage of hydrocarbons or other means;

2. The prepared surface underlying the geomembrane has not deteriorated since previous acceptance, and is still acceptable immediately prior to geomembrane placement;

3. Any geosynthetic elements immediately underlying the geomembrane are of acceptable cleanliness and are free of debris;

3. All personnel working on the geomembrane refrain from smoking, wearing damaging shoes, or other activities that could damage the geomembrane;

5. The method used to unroll the panels does not cause scratches or crimps in the geomembrane and does not damage the supporting soil;

6. The method used to place the panels minimizes wrinkles (especially differential wrinkles between adjacent panels);

7. 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

8. 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.

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 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 for extrusion welds. 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 Laboratory may perform additional testing to verify that the seams meet the requirements of the specifications.

4.3.4.1 HDPE Geomembrane Trial Seams

Trial seams shall be made each day prior to commencing field seaming. The seams shall be made on fragment pieces 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 ENGINEER's or CQA Consultant's discretion; and at least once every four to six hours during continuous operation of each welding machine; or at change in material type (i.e., smooth-to-smooth seam versus smooth-to-textured seam). Each seamer shall make at least two test seams each day.

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 nine one-inch wide by six-inch long test strips shall be cut from the trial seam. Quantitatively test three specimens for inside peel adhesion (peel), three for outside peel, and then 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 results shown in the table below are achieved.

Minimum Polyethylene Seam Properties (per GRI GM-19)

Property	Method	40-mil HDPE
Peel Strength (fusion)	ASTM D6392	60 ppi
Peel Strength (extrusion)	ASTM D6392	52 ppi
Shear Strength (fusion and extrusion)	ASTM D6392	80 ppi

1. The strength of four 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.
2. Unacceptable break codes are:
   a. Fusion: AD and AD-Brk>25%
   b. 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 should be archived until project completion.

4.3.4.2 HDPE Geomembrane Non-Destructive Testing

Production seams shall be tested by the Installer continuously 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:

1. 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 or valve assembly and a vacuum gauge. The assembly shall be capable of maintaining at least a 3 psi vacuum. A passing extrusion seam shall exhibit at least a 3 psi vacuum for at least 15 seconds when using a soapy solution to seal the gasket to the seam. 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 in rapid succession shall be marked, repaired, and retested.

2. 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; hot air gun or other device and clamp to seal the ends of the air channel. After sealing both ends, the fusion seam shall be pressurized to 30 psig and the pressure allowed to stabilize. A passing fusion seam shall have a maximum 4 psig vacuum loss over a five minute time period.

3. Once the seam passes, the opposite end of the seam shall be punctured to release the air, confirming that the entire seam length had been tested. If air is not released once channel has been punctured, a blockage is present. Locate faulty area where the blockage is and retest seam on both sides of blockage. A pressure gauge at both ends of the seam will also be acceptable.

4.3.4.3 HDPE Geomembrane Destructive Testing

Extrusion and fusion welded field seams shall be destructively tested at a minimum frequency of one test per 500 linear feet of seamed 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 minimal length (typically 42 inches) with the seam centered lengthwise (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 Testing Laboratory for conformance testing (18 inches), and to the OWNER for archive (remainder).

Each sample shall be tested five times each for outer peel, inner peel, and shear. A seam sample shall pass when the results shown in the table below are achieved.

Minimum Polyethylene Seam Properties (per GRI GM-19)

Property	Method	40-mil HDPE
Peel Strength (fusion)	ASTM D6392	60 ppi
Peel Strength (extrusion)	ASTM D6392	52 ppi
Shear Strength (fusion and extrusion)	ASTM D6392	80 ppi

1. The strength of four 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.
2. Unacceptable break codes are:
   a. Fusion: AD and AD-Brk>25%
   b. 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 ten 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 samples shall continue to be obtained until the questionable seam area is defined.

4.3.4.4 HDPE Geomembrane 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 damage cannot be satisfactorily repaired. 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:

1. Patching - Used to repair large holes, tears, undispersed raw materials, and contamination by foreign matter.

2. Spot Welding - Used to repair pinholes, other localized flaws (minor) or where geomembrane thickness has been reduced.

3. Capping - Used to repair large lengths of failed seams.

4. 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 disc grinder or equivalent to assure 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 the Installer demobilizing from the site. All identified problem areas shall be repaired by the Installer and accepted by the CQA Consultant prior to the Installer demobilizing from the site.

4.4 EPDM Geomembrane

Stringent quality assurance and careful documentation are required in the production and installation of all geosynthetic materials. The work addressed under this section shall facilitate proper construction of all EPDM geosynthetic components of the liner/cap for the West Treatment Pond. 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.

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

4.4.1 Manufacture of Geomembrane

The Manufacturer shall perform MQC testing on the natural resin at the frequencies and for the required physical properties indicated below prior to shipping material to the site.

Testing Property	Testing Method	Minimum Frequency
Thickness	ASTM-D751	1 per 200,000 SF
Specific Gravity	ASTM-D792	1 per 200,000 SF
Unit Weight	ASTM-D751	1 per 200,000 SF
Break Strength	ASTM D-7004	1 per 200,000 SF
Tear Strength	ASTM D-7004	1 per 200,000 SF
Puncture Resistance	ASTM D-4833	1 per 200,000 SF
Shore A Durometer	ASTM D-2240	1 per 200,000 SF

In addition, the Manufacturer shall perform quality conformance testing on the EPDM sheet at the frequencies and for the required physical properties indicated below prior to shipping material to the site.

Manufacturer QC Testing – Reinforced EPDM

Testing Property	Testing Method	Units	45-mil EPDM Value	60-mil EPDM Value
Thickness	ASTM-D751	in	0.045 +15/-10%	0.060 +15%/-10%
Specific Gravity	ASTM D-792	Gm/cc	1.1	1.1
Unit Weight	ASTM D-751	lb/ft^2	0.32	0.42
Coating over scrim/fabric	ASTM D-751 Type II	in	0.015	0.015
Break Strength	ASTM D-7004	lbf	160	200
Tear Strength	ASTM D-7004	lbf	70	70
Puncture Resistance	ASTM D-4833	lb	75	75
Shore A Durometer	ASTM D-2240		65-10	65-10
Ozone Resistance	ASTM D-1149		No Cracks	No Cracks
Ultimate Elongation[1]	ASTM D-412	%	250	250
Heat Aging • Breaking Strength • Ultimate Elongation[1]	ASTM D-573 ASTM D-7004 ASTM D-7004	lbf	80 200	200 200
Linear Dimensional Change	ASTM D-1204	%	±1	±1
Accelerated Aging: Xenon Arc	ASTM G-155/151		Pass	Pass
Brittleness Point	ASTM D-2137	°F	-49	-49
Water Absorption	ASTM D-471	%	+8, -2	+8, -2
Water Vapor Permeability, max	ASTM E-96	Perm mils	2.0	2.0
Chronic Toxicity Screening	EPA/821-R-02-013/ASTM E-729		Pass/Pass	Pass/Pass

1. Specimens to be prepared from coating rubber compound, vulcanized in a similar method to the reinforced products.

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

1. A properties sheet including, at a minimum, all specified properties, measured using test methods indicated in the Technical Specifications or equivalent methods approved by the ENGINEER and CQA Consultant;

2. A list of quantities and descriptions of materials other than the base polymer that comprise the geomembrane;

3. The sampling procedure and results of testing; and

4. 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:

1. The property values certified by the Manufacturer meet all of the Specifications; and

2. 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.

4.4.2 Conformance Testing

The CQA Consultant or a designated independent geosynthetics CQA laboratory will perform QA testing to verify that the EPDM sheet meets the requirements of the Technical Specifications. These tests and frequencies are also indicated below. Samples of the EPDM geomembrane material 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.

Testing Property	Testing Method	Minimum Frequency
Thickness	ASTM-D751	1 per 200,000 SF
Specific Gravity	ASTM-D792	1 per 200,000 SF
Unit Weight	ASTM-D751	1 per 200,000 SF
Break Strength	ASTM D-7004	1 per 200,000 SF
Tear Strength	ASTM D-7004	1 per 200,000 SF
Puncture Resistance	ASTM D-4833	1 per 200,000 SF
Shore A Durometer	ASTM D-2240	1 per 200,000 SF

4.4.3 Transportation and Delivery

All 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 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 and those rolls with minor flaws. The Installer will be responsible for the storage of the geomembrane on-site upon arriving at the site. The OWNER will provide storage space 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 rainfall.

4.4.4 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 base seam or tee seam will be less than five feet from the toe of slope or areas of potential stress concentrations, unless otherwise authorized by the ENGINEER.

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 at panel corners of three or more sheets to the ENGINEER and the CQA Consultant prior to shipment of the geomembrane.

Subgrade surfaces to receive geomembrane installation shall be relatively smooth and even and free of ruts, voids, protrusions, and deleterious material. 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:

1. Any equipment used does not damage the geomembrane by handling, trafficking, excessive heat, leakage of hydrocarbons, or other means;

2. The prepared surface underlying the geomembrane has not deteriorated since previous acceptance, and is still acceptable immediately prior to geomembrane placement;

3. Any geosynthetic elements immediately underlying the geomembrane are of acceptable cleanliness and are free of debris;

3. All personnel working on the geomembrane refrain from smoking, wearing damaging shoes, or other activities that could damage the geomembrane;

5. The method used to unroll the panels does not cause scratches or crimps in the geomembrane and does not damage the supporting soil;

6. The method used to place the panels minimizes wrinkles (especially differential wrinkles between adjacent panels);

7. 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

8. 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.

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 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 for extrusion welds. 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 Laboratory may perform additional testing to verify that the seams meet the requirements of the specifications.

4.4.4.1 EPDM Trial Seams

EPDM trial seams shall conform to the manufacturer specifications. Typically, a 10-foot seam will be prepared and allowed to cure for 24-hours. The trial seam will then be cut into 1-foot sections and tested using a field tensiometer for shear and peel strength. The trial seam shall meet, at a minimum, the following criteria:

1. Shear strength: 35 lb/in at 200% strain

2. Peel strength: 8 lb/in in cohesive bond mode.

4.4.4.2 EPDM Non-Destructive Testing

All EPDM field seams will be non-destructively tested using the Air Lance Test. The seams will be tested for unbonded areas using a 0.188” air nozzle held 2 inches from the seam with 50 psi air pressure. The air shall be directed between the upper seam edge and the lower panel.

4.4.4.3 EPDM Destructive Testing

All EPDM field-bonded seams will be destructively tested at intervals of 1,500 ft. Three 3-foot sections will be cut at each location (one for field testing, one for lab testing, and one for archiving), and each section will be divided into three 1-foot test strips. The field test strips will be tested using a field tensiometer, the lab test strips will be sent to an independent laboratory for testing, and the archive test strips will be given to Dominion. The destructive test strips shall meet, at a minimum, the following criteria:

1. Shear strength: 35 lb/in at 200% strain
2. Peel strength: 8 lb/in in cohesive bond mode.

4.4.4.4 EPDM Repairs

EPDM repairs will be conducted in accordance with manufacturer recommendations.

4.4.4.5 Final Inspection

A final inspection shall be completed by the Installer, ENGINEER, CQA Consultant, and OWNER prior to the Installer demobilizing from the site. All identified problem areas shall be repaired by the Installer and accepted by the CQA Consultant prior to the Installer demobilizing from the site.

4.5 XR-5 Geomembrane

Stringent quality assurance and careful documentation are required in the production and installation of all geosynthetic materials. The work addressed under this section shall facilitate proper construction of all XR-5 geosynthetic components of the liner/cap for the West Treatment Pond. 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.

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

4.5.1 Manufacture of Geomembrane

The Manufacturer shall perform MQC testing on the geomembrane at the frequencies and for the required physical properties indicated below prior to shipping material to the site.

Testing Properties	Testing Method	Units	Test Value	Frequency
Thickness	ASTM D751	mils	40 (36 min.)	per 36,000 ft^2
Weight	ASTM D751	oz/yd^2	38.0 ± 2.0	per 36,000 ft^2
Tear Strength (trap tear)	ASTM D751	lb	40/55[1]	per 36,000 ft^2
Yield Strength (Break), grab tensile	ASTM D751	lb	550/550[2]	per 36,000 ft^2
Puncture Resistance	ASTM D4833	lb	200 (min.)	per 36,000 ft^2

1. The first number represents the average of all five specimens in both warp and filling directions (10 tests), and the second number represents the average of the five highest peak loads (not including the initial peak loads) for the five test specimens (warp or filling direction).

2. The first number represents the average longitudinal break strength and the second number represents the average transverse break strength.

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

1. A properties sheet including, at a minimum, all specified properties, measured using test methods indicated in the Technical Specifications or equivalent methods approved by the ENGINEER and CQA Consultant;

2. A list of quantities and descriptions of materials other than the base polymer that comprise the geomembrane;

3. The sampling procedure and results of testing; and

4. 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:

1. The property values certified by the Manufacturer meet all of the Specifications; and

2. 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.

4.5.2 Conformance Testing

The CQA Consultant or a designated independent geosynthetics CQA laboratory will perform QA testing to verify that the XR-5 sheet meets the requirements of the Technical Specifications. The CQA testing shall cover all of the test shown in section 4.5.1., and shall be performed at least every 200,000 ft^2. Samples shall be taken at the factory prior to shipment or upon delivery at the site.

4.5.3 Transportation and Delivery

All 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 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 and those rolls with minor flaws. The Installer will be responsible for the storage of the geomembrane on-site upon arriving at the site. The OWNER will provide storage space 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 rainfall.

4.5.4 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 field seams should be minimized. No field seam (except seams parallel to the slope) will be less than five feet from the toe of slope or areas of potential stress concentrations, unless otherwise authorized by the ENGINEER.

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 at panel corners of three or more sheets to the ENGINEER and the CQA Consultant prior to shipment of the geomembrane.

Subgrade surfaces to receive geomembrane installation shall be relatively smooth and even and free of ruts, voids, protrusions, and deleterious material. 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:

1. Any equipment used does not damage the geomembrane by handling, trafficking, excessive heat, leakage of hydrocarbons, or other means;

2. The prepared surface underlying the geomembrane has not deteriorated since previous acceptance, and is still acceptable immediately prior to geomembrane placement;

3. Any geosynthetic elements immediately underlying the geomembrane are of acceptable cleanliness and are free of debris;

3. All personnel working on the geomembrane refrain from smoking, wearing damaging shoes, or other activities that could damage the geomembrane;

5. The method used to unroll the panels does not cause scratches or crimps in the geomembrane and does not damage the supporting soil;

6. The method used to place the panels minimizes wrinkles (especially differential wrinkles between adjacent panels);

7. 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

8. 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.

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 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 for extrusion welds. 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 Laboratory may perform additional testing to verify that the seams meet the requirements of the specifications.

4.5.4.1 XR-5 Trial Seams

XR-5 trial seams shall conform to the manufacturer specifications. Typically, a 10-foot seam will be prepared and allowed to cure for 24-hours. The trial seam will then be cut into 1-foot sections and tested using a field tensiometer for shear and peel strength. The trial seam shall meet, at a minimum, the following criteria:

1. Adhesion: 40 lb/2in
2. Bonded Seam Strength: 550 lb

4.5.4.2 XR-5 Non-Destructive Testing

All XR-5 field seams will be non-destructively tested using the Air Lance Test. The seams will be tested for unbonded areas using a 0.188” air nozzle held 2 inches from the seam with 50 psi air pressure. The air shall be directed between the upper seam edge and the lower panel.

4.5.4.3 XR-5 Destructive Testing

All XR-5 field-bonded seams will be destructively tested at intervals not exceeding 500 ft. Three 2-foot sections will be cut at each location (one for field testing, one for lab testing, and one for archiving), and each section will be divided into five equivalent test strips. The field test strips will be tested using a field tensiometer, the lab test strips will be sent to an independent laboratory for testing, and the archive test strips will be given to Dominion. The destructive test strips shall meet, at a minimum, the following criteria:

1. Adhesion: 40 lb/2in
2. Bonded Seam Strength: 550 lb

4.5.4.4 XR-5 Repairs

XR-5 repairs will be conducted in accordance with manufacturer recommendations.

4.5.4.5 Final Inspection

A final inspection shall be completed by the Installer, ENGINEER, CQA Consultant, and OWNER prior to the Installer demobilizing from the site. All identified problem areas shall be repaired by the Installer and accepted by the CQA Consultant prior to the Installer demobilizing from the site.

4.6 Geonet Composite

4.6.1 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 and a written certification signed by an officer or the Manufacturer's Quality Control Manager indicating that the geonet composite actually delivered has properties which meet or exceed the guaranteed properties for the type of geonet composite specified. The certification shall include the following:

1. Product identification,
2. Lot number,
3. Geonet composite roll numbers affected by shipment, and
4. Manufacturer's quality control test results.

At a minimum, the Manufacturer's quality control (QC) testing frequency should be as follows:

Manufacturer QC Testing – Geonet Composite

PROPERTY	TEST METHOD	TESTING FREQUENCY	MARV
Transmissivity (m^2/sec)[1]	ASTM D4716	1 per project	5.0×10^{-4}
Ply Adhesion (lb/in)	GRI GC-7	1 per 100,000 ft^2	1.0

1. Gradient of 0.1, normal load of 10,000 psf, water at 70°, between stainless steel plates and at a 15-minute seat time.

Manufacturer QC Testing – Geonet Component

PROPERTY	TEST METHOD	TESTING FREQUENCY	MARV
Thickness (mil)	ASTM D5199	1 per 100,000 ft^2	250
Density (g/cm^3)	ASTM D1505	1 per 100,000 ft^2	0.94
Tensile Strength (ppi)	ASTM D5035	1 per 100,000 ft^2	55
Carbon Black Content (%)	ASTM D1603	1 per 100,000 ft^2	2.0

Manufacturer QC Testing – Geotextile Component

PROPERTY	TEST METHOD	TESTING FREQUENCY	MARV
Mass per Unit Area (oz/yd^2)	ASTM D5261	1 per 100,000 ft^2	8
Apparent Opening Size (US Sieve)	ASTM D4751	1 per 540,000 ft^2	70
Flow Rate (gpm/ft^2)	ASTM D4491	1 per 540,000 ft^2	90
Grab Tensile (lb)	ASTM D4632	1 per 100,000 ft^2	200
Puncture Strength (lb)	ASTM D6241 or ASTM D4833	1 per 100,000 ft^2	400 (D6241) or 100 (D4833)

1. Component properties prior to lamination.

4.6.2 Conformance Testing

The CQA Consultant or a designated independent geosynthetics laboratory will perform additional quality assurance (QA) testing to verify that the geonet composite drainage fabric meets the requirements of the specifications. These tests and frequencies are indicated below. Samples of the geonet composite drainage fabric 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.

Quality Assurance Testing – Geonet Composite

PROPERTY	TEST METHOD	TESTING FREQUENCY	MARV
Transmissivity (m^2/sec)[1]	ASTM D4716	1 Per Project	5.0 x 10^{-4}
Ply Adhesion (ppi)	GRI GC-7	1 Per 250,000 ft^2	1.0

1. Gradient of 0.1, normal load of 10,000 psf, water at 70°, between stainless steel plates and at a 15-minute seat time.

Upon delivery at the site, the CQA Consultant shall inventory all rolls and conduct a surface observation of each roll for defects or damage. The inspection will be performed without unrolling rolls 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 and those rolls with minor flaws.

4.6.3 Transportation and Delivery

All 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.

The Installer will be responsible for the storage of the geonet composite drainage fabric on-site. The OWNER will provide storage space 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 rainfall.

4.6.4 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 composites in such a manner as to ensure they are not damaged in any way, and the following shall be complied with:

1. On slopes, the geonet composites shall be secured in the anchor trench and then 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 composites shall not be placed in the horizontal direction (i.e., across the slope).

2. In the presence of excessive wind, geonet composites 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:

1. Adjacent rolls shall overlap the geonet component by at least six inches;

2. These overlaps shall be secured by tying;

3. 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:

4. 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.

5. The edges of the geotextile component shall be continuously sewn or heat bonded together using a method approved by the ENGINEER.

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 tied together every six inches.

4.7 Final Protective Cover and Vegetative Support Layer Soils

Final Protective Cover and Vegetative Support Layer soils generally consist of medium-textured soils capable of supporting vegetative growth. No cover soils shall be placed in an area until the underlying geosynthetics in that area are complete and approved by the CQA Consultant. Cover soils shall be placed in maximum 12-inch thick loose lifts using low ground pressure earthmoving equipment to prevent damage to the underlying geosynthetics. The CQA Consultant shall continuously monitor the placement of cover soils to verify the following:

1. Placement of cover soils does not produce large wrinkles or other deformation of the underlying geosynthetics;

2. The cover soil does not contain CCR;

3. The Protective Cover Soil is compacted to the requirements of the Technical Specifications; and,

4. Vehicles not designated as Low Ground Pressure are restricted to travelling on temporary haul roads at least 36 inches thick.

The thickness of the Final Cover Layer will be verified by survey comparing the top of liner subgrade to the top of Final Cover on a 50-foot grid.

5.0 CONSTRUCTION QUALITY ASSURANCE DOCUMENTATION

Upon completion of the capping construction project, the CQA Consultant will prepare the Construction Quality Assurance Record Report. This Report will be sealed by a Professional Engineer licensed in Virginia certifying that the closure has been completed in accordance with the approved Closure Plan and Technical Specifications.

5.1 CQA Report Contents

The CQA Report will contain information relating to the materials, methods, testing and other documentation to support the Engineer's certification. The Report shall contain a narrative describing the construction and CQA activities each phase of the construction project. Supporting documentation in the form of manufacturer submittals and test results (lab and field) will be submitted as appropriate for each activity. At a minimum, the report shall contain the following sections:

1. Project description, description of stakeholder parties;
2. Earthwork activities to prepare the liner subgrade;
3. Geosynthetics;
4. Protective Cover and Vegetative Support Layer installation;
5. Stormwater controls;
6. Other construction as pertinent to the project;
7. As-built drawings sealed by a Land Surveyor licensed in Virginia, showing:
    a. Existing (pre-construction conditions);
    b. Geomembrane subgrade;
    c. Geomembrane panel layout and repair locations;
    d. Geomembrane panel layout and destructive sample locations;
    e. Top of Final Cover layer with thickness verification grid (50' grid)

One copy of the CQA Report and two sets of as-built drawings will be provided to DEQ within 90 days of completion of construction.

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