

CONSTRUCTION QUALITY ASSURANCE PLAN

PLANT SCHERER - ASH POND AP-1

MONROE COUNTY, GEORGIA

FOR



Georgia
Power

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AECOM

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ACRONYMS AND ABBEVIATIONS

AP-1	Plant Scherer Ash Pond
AR	Administrative Regulations
ASTM	American Society for Testing and Materials
CCR	Coal Combustion Residuals
CFR	Code of Federal Regulations
CPT	Cone Penetrometer Testing
CQA	Construction Quality Assurance
EPA	Environmental Protection Agency
E&SC	Erosion and Sediment Control
GA	Georgia
EPD	Georgia Environmental Protection Division
GDM	Geocomposite Drainage Media
GM	Geomembrane
GPC	Georgia Power Company
GSWCC	Georgia Soil and Water Conservation Commission
LLDPE	Linear Low-Density Polyethylene
NPDES	National Pollutant Discharge Elimination System
PCM	Project Construction Manager
QA	Quality Assurance
QC	Quality Control
SCS	Southern Company Services
USEPA	United States Environmental Protection Agency
WWTS	Waste Water Treatment System

Note : Acronyms and abbreviations not included in the table are defined in the text the first time used.

1 GENERAL

1.1 Overview

This Construction Quality Assurance (CQA) Plan describes the quality assurance (QA) and quality control (QC) activities that will be undertaken during closure construction of Ash Pond 1 (AP-1) at Georgia Power Company's (GPC's) Plant Scherer in Monroe County, Georgia. The purpose of this document is to define the scope, procedures, and acceptance criteria necessary to perform QA tasks such that the construction elements of Ash Pond 1 closure (hereafter referred to as "the project") comply with the design as indicated or shown in the project drawings, project specifications, approved design changes, and other relevant design and Contract Documents (collectively referred to as "Construction Documents" in the remainder of this CQA Plan). The Construction Documents that will be developed during detailed design will incorporate the relevant requirements of the Georgia Environmental Protection Division (EPD) permit and approved permit documents including this CQA Plan.

1.2 General Requirements

1. The Georgia Environmental Protection Division (EPD) solid waste program shall be notified of each major construction or closure event prior to construction. Construction Quality Assurance (CQA) shall be provided by a third-party consulting engineering firm specializing in the inspection and testing of soils, geosynthetics, erosion and scour control materials, and proposed structures. Resumes and qualifications including experience with projects of similar type, size, and complexity shall be provided to GPC for their review and approval.
2. The services of the CQA firm (referred to as the CQA Consultant herein) shall be required during construction and installation of all surface impoundment cover components described in this document.
3. This CQA Plan is not intended to substitute for or override the construction quality control (CQC). The Contractor is instructed to bring discrepancies between the material specifications and/or CQC and this CQA Plan to the attention of the CQA Consultant who shall then notify the Design Engineer for resolution. The Design Engineer has the sole authority to determine resolution of discrepancies existing within the Contract Documents (this may also require the approval of the Owner and EPD). Unless otherwise determined by the Design Engineer, the more stringent requirement shall be the controlling resolution.
4. CQA Testing requirements for conformance: It is recognized that standards and test methods specified for CQA or CQA programs may be modified, updated, withdrawn, or replaced by the standards writing organizations. In addition, advances to design, testing, or regulatory programs could occur over the life of the Closure. The Design Engineer will update the CQA Plan as required to reflect changes to test methods, or to include new test methods or standards that best address the needs of the Final Cover design. This may result in changes to the ASTM and other standards or test methods outlined in this Plan. It is the intent of this Plan that, when conflicts exist between the material specifications and/or this CQA Plan and this CQA Plan in test methods, test frequencies, values, or other requirements, the CQA Plan is to be followed as long as all regulatory performance requirements are met as confirmed by the CQA Consultant.

1.3 CQA/CQC Approach

The approach for Construction Quality Assurance (CQA) and Construction Quality Control (CQC) are described in the list below:

1. Construction Quality Assurance (CQA): In the context of this Plan, CQA is defined as a planned and systematic program employed by the Owner to document conformity of the earthwork construction, geosynthetics installation, protective cover and other elements of the Final Cover with the approved project drawings and the material specifications and/or this CQA Plan. CQA is provided by the CQA Consultant as a representative of the Owner and is independent from the Contractor and all manufacturers. The CQA program is designed to provide adequate confidence that items or services meet contractual and regulatory requirements.
2. Manufacturer Quality Control/Construction Quality Control (MQC/CQC): A planned system of actions taken by the manufacturers, contractors, and installers to monitor, check, and control the quality of their own work (verify that they are supplying materials and providing the workmanship as required by the Construction Documents). In some cases, MQC/CQC services may be performed "in-house" by the manufacturers, contractors and installers, and other times MQC/CQC services are subcontracted to an outside organization hired by these entities. MQC refers to QC functions performed by manufacturers, and CQC refers to QC functions performed by construction contractors and installers.

1.4 Conformance and Performance Testing

In the context of this document, conformance testing and performance testing are defined as follows:

1. Conformance Testing: Testing performed to evaluate whether a construction material (e.g., soil, aggregate, geosynthetic, or other materials) to be used on the project possesses properties and characteristics that are in conformance with the specified parameters. By definition, conformance testing is conducted before a material is installed.
2. Performance Testing: Testing performed on a completed work product to evaluate whether the construction material (e.g., soil, deep soil mix (DSM), aggregate, geosynthetic, or other materials) as-constructed/installed possesses properties and characteristics that are in conformance with the specified performance parameters and work product acceptance criteria.

1.5 CQA Plan Scope

CQA services will be provided by a consulting Engineering firm, reporting to the Owner, specializing in the inspection, and testing of soils and geosynthetics. The scope of this CQA Plan includes the following:

1. Defining the qualifications and responsibilities of the CQA Consultant.
2. Establishing testing protocols for the evaluation of the closure components.
3. Establishing procedures for construction documentation.

4. Establishing procedures for providing final documentation verifying that the construction project conforms to the Construction Documents.

The CQA Plan also presents the required properties of materials that will be used during closure construction, as established through the closure design process. Construction Documents will be developed as part of detailed design and will incorporate the material properties and acceptance criteria presented in this CQA Plan.

2 DEFINITIONS AND RESPONSIBILITIES

The following project roles, definitions, qualifications, and responsibilities for the personnel and firms associated with CQA Plan activities outlined herein shall consist of the following.

2.1 CQA Consultant

1. Definition: The CQA Consultant is the party, retained by the Owner, but not affiliated with the Owner or Contractor, responsible for observing and documenting CQC activities, reviewing CQC/MQC submittals prepared by the Contractor/manufacturer related to the project, and performing CQA activities as described in this CQA Plan. The qualifications and responsibilities of the CQA Consultant are described below. Resumes and qualifications, including experience with projects of similar type, size, and complexity, will be provided to the Owner for their review and approval.
2. Qualifications: The CQA Consultant is required to meet all of the following minimum qualifications to perform the activities outlined herein.
 - a. Have specialized experience in the design of geo-environmental infrastructure involving earthwork, waste materials management, geosynthetics and piping installations, project-site water management, revegetation, Final Cover System design, and CQA of these components.
 - b. Possess the equipment, personnel, and licenses necessary to conduct the monitoring required by this CQA Plan and the Construction Documents.
 - c. Be experienced in the review of Contractor CQC submittals for conformance with the project requirements and in the resolution of non-conformances.
 - d. Be experienced in the preparation and/or review of CQA documentation including CQA plans, field documentation, field testing procedures, laboratory testing procedures, project specifications, project drawings, and CQA certification reports.
 - e. The CQA Consultant organization will be led by the CQA Certifying Engineer, who will be a professional engineer registered to practice in the state of Georgia.
 - f. The CQA Site Manager will be the onsite representative of the CQA Consultant and will have experience in construction activities required for the project.
3. Responsibilities: The CQA Consultant will be responsible for the following minimum activities throughout closure construction.
 - a. Reviewing the Construction Documents prior to the start of the construction.
 - b. Monitoring the compliance of construction materials and manufactured products (e.g. geosynthetics) delivered to the site with the CQC/MQC submittals and conformance requirements and/or shop drawings previously reviewed and approved by the Design Engineer.
 - c. Monitoring that the Contractor's construction methods and workmanship are performed in accordance with the Construction Documents.
 - d. Performing onsite field and/or laboratory CQA testing.

- e. Maintaining calibration certificates of CQC field testing equipment in the CQA Consultant's onsite project file.
 - f. Reviewing field and laboratory CQC/MQC test results in a timely manner so as not to impede or delay construction activities.
 - g. Promptly notifying the Owner of any nonconformances of the Contractor's work with any requirements of the project, including those requirements related to the prompt delivery of CQC/MQC results to the CQA consultant.
4. CQA Consultant Personnel: The following minimum personnel roles will be required for the CQA Consultant to employ throughout closure construction activities.
- a. CQA Certifying Engineer: The CQA Consultant's CQA Certifying Engineer will be responsible for the following minimum activities for closure construction:
 - i. Reviews the Construction Documents.
 - ii. Attends scheduled meetings related to project construction quality activities.
 - iii. Administers the CQA program (i.e., assigns and manages all onsite CQA personnel, reviews all field reports, provides Engineering review of all CQA-related activities).
 - iv. Provides quality control of CQA documentation.
 - v. Reviews and documents changes to the design during construction.
 - vi. Prepares and seals the final CQA Certification Report.
 - b. CQA Site Manager: The CQA Consultant's CQA Site Manager will be responsible for the following minimum activities during closure construction:
 - i. Serves as the onsite representative of the CQA Consultant.
 - ii. Familiarizes all CQA field technicians with the site, Construction Documents, and the CQA requirements.
 - iii. Manages the daily activities of the CQA field technicians.
 - iv. Attends regularly scheduled CQA-related meetings onsite.
 - v. Reviews the ongoing preparation of the construction record drawings.
 - vi. Reviews test results, certifications, and documentation provided by the Contractor, geosynthetics manufacturer, and Geosynthetics Installer and makes appropriate recommendations.
 - vii. Reviews the CQA field technicians' daily notes and logs.
 - viii. Prepares a daily report for the project.
 - ix. Oversees the collection and shipping of laboratory test samples.
 - x. Reviews the results of field and laboratory testing and makes appropriate recommendations.
 - xi. Reports any unresolved deviations from the CQA Plan and Construction Documents to the Owner's Construction Manager and CQA Certifying Engineer.
 - xii. Assists with the preparation of the final CQA Certification Report.

- xiii. Reviews the Geosynthetics MQC documentation.
- xiv. Performs duties of CQA field technician, as needed.
- c. CQA Field Technicians: The CQA Consultant's CQA Field Technicians will be responsible for the following minimum activities during closure construction:
 - i. Monitor material stockpiles for any deterioration of materials.
 - ii. Monitor surface-water drainage in the areas of soil and geosynthetic material stockpiles.
 - iii. Monitor and test earthwork placement and compaction operations.
 - iv. Monitor the unloading, storage, and onsite handling of the geosynthetics.
 - v. Monitor geosynthetic material deployment and installation operations.
 - vi. Monitor geosynthetic repair operations.
 - vii. Assist with the collection and shipping of laboratory test samples.
 - viii. Document any onsite activities that could result in damage to the soils or geosynthetic components of the construction and report them as soon as practical to the CQA Site Manager.
 - ix. Prepare notes and logs.
 - x. Report problems to the CQA Site Manager.

2.2 CQA Earthwork Laboratory

1. Definition: The CQA Earthwork Testing Laboratory (CQA Earthwork Laboratory) is a party of the CQA Consultant and will be responsible for conducting CQA geotechnical laboratory testing in accordance with standards referenced in the Construction Documents and this CQA Plan. The testing results generated by the CQA Earthwork Laboratory will be used by the CQA Consultant to verify compliance of the earthwork with the Construction Documents.
2. Qualifications: The CQA Earthwork Laboratory will be experienced in testing of soils and CCR using methods in accordance with American Society of Testing and Materials (ASTM) and other applicable soil test standards and holding appropriate and current industry certification(s)/accreditation(s). The CQA Earthwork Laboratory will be capable of providing test results within a maximum of seven (7) working days of receipt of samples, except for those tests that require longer to perform, and will maintain that capability throughout the duration of the earthwork construction. Prior to construction, the CQA Earthwork Laboratory will be required to submit their qualifications and QA/QC procedures to the CQA Consultant and the Owner for review and comment.

2.3 CQA Geosynthetics Laboratory

1. Definition: The CQA Geosynthetics Testing Laboratory (CQA Geosynthetic Laboratory) is a party of the CQA Consultant and will be responsible for conducting tests on samples of geosynthetic materials used in the construction in accordance with standards referenced in the Construction Documents and this CQA Plan. The testing results generated by the CQA

Geosynthetic Laboratory will be used by the CQA Consultant to verify compliance of geosynthetic materials with the Construction Documents.

2. Qualifications: The CQA Geosynthetic Laboratory will be currently accredited by the Geosynthetic Institute (GSI) under their Geosynthetic Accreditation Institute Laboratory Accreditation Program (GAI LAP), be approved by the Certifying CQA Consultant and the Owner and have experience in testing geosynthetics to be used for the project. The CQA Geosynthetic Laboratory will be familiar with American Society for Testing and Materials (ASTM) and other applicable geosynthetic test standards. The CQA Geosynthetic Laboratory will be capable of providing destructive test results for geomembrane field seams within 24-hours of receipt of samples and will maintain that capability throughout the duration of geosynthetic material installation. Prior to construction, the CQA Geosynthetics Laboratory will be required to submit their qualifications and QA/QC procedures to the CQA Consultant and the Owner for review and comment.

2.4 CQC Personnel

1. Definition: The Contractor is responsible for supplying materials and providing the workmanship as required by the Construction Documents. The Construction Documents may include required CQC activities for certain components of the project, and/or may give the Contractor the option to develop a CQC program for control of their own work. Under this approach, if the Contractor implements a CQC program, they may perform CQC activities "in-house", or may subcontract these activities to an outside party. Whether in-house or subcontracted, the individuals assigned to perform CQC on the Contractor's behalf are referred to herein as "CQC Personnel."
2. Qualifications: CQC Personnel should be experienced in the CQC of earthwork, geosynthetics, piping systems, and other activities required for the project. CQC Personnel should also possess the necessary equipment and materials to conduct CQC activities on behalf of the Contractor. CQC Personnel should be experienced in the preparation and/or review of CQC documentation including manufacturer and supplier documentation, field documentation, field testing procedures, and laboratory testing procedures and results.

2.5 CQC Earthwork Laboratory

1. Definition: The CQC Earthwork Testing Laboratory (CQC Earthwork Laboratory) is a party of the Contractor and will be responsible for conducting CQC geotechnical laboratory testing in accordance with standards referenced in the Construction Documents, this CQA Plan, and as necessary to fulfill the Contractor's QC program. The testing results generated by the CQC Earthwork Laboratory will be used as a supplement to the CQA Consultant's QA testing. Any discrepancy between the CQC Earthwork Laboratory and the CQA Earthwork Laboratory, the results of the CQA Earthwork Laboratory shall govern.
2. Qualifications: The CQC Earthwork Laboratory will be experienced in testing of soils and CCR using methods in accordance with ASTM and other applicable soil testing standards and holding appropriate and current industry certification(s)/accreditation(s). The CQC Earthwork Laboratory will be capable of providing test results within a maximum of 7 working days of receipt of samples, except for those tests that require longer to perform, and will maintain that capability throughout the duration of the earthwork construction. Prior to construction, the

CQC Earthwork Laboratory will be required to submit their qualifications and QA/QC procedures to the CQA Consultant and the Owner for review and comment.

2.6 Design Engineer

The Design Engineer is the Engineer-of-Record responsible for the Ash Pond 1 Closure Design. The Design Engineer will be a professional engineer licensed in the state of Georgia. The Design Engineer will be responsible for the following:

1. Approving all design and specification changes and making design clarifications that may be required during construction.
2. Assisting the Owner's PCM in reviewing and approving the Contractor's shop drawings and submittals, as necessary.
3. Periodically visiting the site during construction and attending the project coordination meetings, as required, to verify conformance with the Construction Documents and this CQA Plan.
4. Discussing and interpreting all elements of the design and having the authority to recommend changes or modifications to the Construction Documents for approval by the Owner and GA EPD, as required.

The CQA Consultant and Design Engineer may be from the same organization.

2.7 Surveyor

The Surveyor is the party acceptable to the Owner and retained by the Contractor, who will be responsible for performing surveying activities and issuing survey products in accordance with the Construction Documents, and for signing and sealing the construction survey record drawings. The Surveyor will be a state of Georgia licensed professional land surveyor, with personnel experienced in the provision of surveying services and their detailed documentation. The Owner may also retain a third-party surveyor, having similar qualifications, to perform verification surveys.

2.8 Project Construction Manager

The Project Construction Manager or Owner's Construction Manager, hereafter referred to simply as the Construction Manager or PCM, is an individual, appointed by the Owner, who will serve as the Owner's representative and who will be responsible for overall management of the construction project. The Construction Manager will give direction to the Contractor. The CQA Consultant will provide the Construction Manager with notifications, reports, and monitoring logs as requested and as described further throughout this CQA Plan.

2.9 Contractor

The term "Contractor" refers to the General Contractor (i.e. the Prime Contractor) who is retained by the Owner to conduct the Ash Pond 1 closure construction. In general, the Contractor will be responsible for furnishing and installing materials in accordance with the Construction Documents (unless certain items may be procured and/or installed under separate contracts with or on behalf of the Owner). In this role, the Contractor will be responsible for earthwork activities, CCR excavation and placement activities,

installation of the Final Cover System, and construction associated surface water management features/responsibilities and other related site work. The Contractor may subcontract with various parties to conduct certain portions of the project (e.g. geosynthetic Installer). The Owner will select a Contractor qualified for this project through experience with other construction projects involving similar work elements, and with personnel and equipment available as needed to execute a project of this magnitude.

As set forth in the Construction Documents, the Contractor will prepare various work plans for approval by the Owner. During construction, the Contractor will work with the Owner and their Construction Manager to develop an approved schedule, execute the work according to that schedule, and communicate the timing of key milestones/activities with appropriate project parties (e.g. CQA Consultant). Note that the preceding description of the Contractor's role and responsibilities is only a general summary and does not represent the comprehensive scope of work required by the Construction Documents. In the event of any discrepancies, the Construction Documents will govern.

2.10 Geosynthetics Manufacturers and Installers

Geosynthetics are manufactured materials. The manufacturers who will supply geosynthetic materials for this project (either procured by the Contractor or the Owner, as established for the scope of work set forth in the Construction Documents) are responsible for the manufacture/fabrication of such materials and for quality control during manufacture/fabrication. The manufacturer(s) of the geomembrane components of the Final Cover System should have experience manufacturing at least ten million square feet of such geomembranes. Further details of the required minimum manufacturer qualifications for the various other geosynthetic materials of the project will be provided in the Construction Documents.

The geosynthetic manufacturers must implement an MQC program. MQC refers to actions taken at their manufacturing facility (i.e., prior to shipment to the jobsite) to control the quality of their products and to monitor/verify that the materials and workmanship of the geosynthetics meet the project requirements as set forth herein and in the Construction Documents. The MQC program will be conducted by MQC personnel who are stationed at the manufacturing facility (i.e., employed or contracted by the manufacturer), and overseen by an MQC manager.

Manufactured geosynthetics products are placed and installed in the field by a Geosynthetics Installer, who will be subcontracted by the Contractor. The Geosynthetics Installer responsible for the installation of the Final Cover System geomembrane components should have experience installing at least five million square feet of geomembranes. Further details of the required minimum geosynthetics Installer qualifications for the various other geosynthetic materials of the project will be set forth in the Construction Documents.

3 EARTHWORK AND GRADING

3.1 Introduction

CQA monitoring and testing will be performed during earthwork construction. CQC monitoring and testing may be performed during earthwork construction at the option of the Contractor as set forth herein. This earthwork will include: (i) general earthwork for preparation of subgrade and installation of dikes/embankments/berms, channels, roads, ditches, and other earthwork requirements of the Construction Documents; (ii) installation of granular materials such as sand, gravel, aggregate, and riprap; and (iii) installation of CCR or soil components for the Final Cover System. Minimum acceptance criteria to be used for evaluation of acceptability of the various earthwork components are identified in Appendix A of this CQA Plan.

3.2 Record Drawings and As-Built Surveys

During construction of the earthwork components, the CQA Consultant will routinely review record drawings submitted by the Contractor. Prior to the placement of successive CCR, soil, or geosynthetic layers, the CQA Consultant will review as-built surveys that indicate compliance of the preceding layer thickness, limits, and grades with the Construction Documents.

3.3 Foundation Improvements

If required at a particular site, the CQA Consultant will visually observe and document the Contractor's foundation improvement activities. The CQA Consultant will monitor and document that the foundation improvements are implemented to conform with the requirements of the Construction Documents, including:

1. Proof-rolling over the entire bottom of excavation area.
2. Identification and characterization of cover-collapse features and soft spots.
3. Remediation of cover-collapse features as appropriate for the size and extent of the feature.
4. Excavation and backfilling around rock pinnacles or removal of the pinnacles.
5. Ground improvement of soft areas.

It will be the responsibility of the CQA Consultant to delineate any areas of non-conformance and observe their mitigation to verify that acceptable conditions are achieved. Upon completion and approval/acceptance of the above activities, placement and compaction of overlying fill will commence, and the construction will be monitored, tested, and documented as set forth in the remainder of this CQA Plan.

3.4 Subgrade

During construction, the CQA Consultant will monitor and document subgrade preparation to confirm that a firm and smooth surface free of vegetation and other deleterious materials is achieved. Material to be placed to achieve design grades will be monitored and conformance-tested by the CQA Consultant to verify that the material complies with the Construction Documents. Material placed to achieve design

grades will be monitored and performance-tested by the CQA Consultant to verify that fill placement, grading, and compaction comply with the Construction Documents.

It will be the responsibility of the CQA Consultant to delineate any areas of non-conformance and observe their mitigation to verify that acceptable results are achieved.

3.5 Conformance Observations and Testing

1. CQA Conformance Observations: The CQA Consultant will observe the earthwork components to verify they are uniform and conform to the requirements of the Construction Documents. For soil materials obtained from onsite or off-site borrow sources, visual inspections and confirmational testing will be performed by the CQA Consultant prior to the materials being used and the CQA Consultant will confirm off-site sources hold appropriate permits. Borrow source inspections may also be utilized by the CQA Consultant to verify that only suitable soil materials are transported to the site.

The CQA Consultant will confirm that granular materials (i.e., sand, gravel, base aggregate, and riprap) are certified by the Contractor's supplier to meet the requirements of the material type shown on the Construction Documents and are free of deleterious materials. All materials failing to comply with conformance standards will be rejected for use at the site.

Initial onsite evaluation of various soil types by CQA personnel during construction will be largely by visual and manual methods; therefore, the CQA personnel will be experienced with visual and manual soil classification procedures.

2. Conformance Test Methods and Frequencies: Conformance testing to evaluate the suitability of soil and granular materials during construction will be performed by the CQA Consultant in accordance with the current American Society for Testing and Methods (ASTM) or other applicable test procedures. The specified methods and minimum frequencies are presented for each soil and granular material in Appendix A of this CQA Plan. The CQA Consultant may also conduct additional conformance testing if deemed necessary by the Owner and/or CQA Certifying Engineer.

3.6 Construction Monitoring

During installation of the earthwork components, the CQA Consultant will observe and document the earthwork components to verify they are installed in accordance with the requirements of the Construction Documents and this CQA Plan. The CQA Consultant will also evaluate the procedures, methods, and equipment used by the Contractor to install the earthwork components. This will include visual observation and documentation of the Contractor's earthwork activities for the following:

1. Changes in soil consistency.
2. Thickness of lifts as loosely placed and compacted.
3. Soil conditioning prior to placement including general observations regarding moisture distribution, clod size, etc.
4. Condition of final surfaces.

5. Placement methods which may damage or cause displacement or wrinkling of geosynthetics.
6. The action of the compaction and heavy hauling equipment on the construction surface (sheepsfoot penetration, pumping, cracking, rutting, etc.).
7. The number of passes used to compact each lift.
8. Desiccation cracks or the presence of ponded water.

3.7 Performance Testing

Performance tests that are used to evaluate the suitability of in-place constructed CCR, soil, and granular components will be performed by the CQA Consultant in accordance with the current American Society for Testing and Methods (ASTM) or other applicable test procedures. The specified methods and minimum frequencies are indicated in the tables for each material type, as presented in Appendix A. The CQA Consultant may also conduct additional performance testing if deemed necessary by the Owner and/or CQA Certifying Engineer.

3.8 Deficiencies

If a deficiency (i.e., non-conformance of the materials or workmanship with the requirements of the Construction Documents) is discovered in the earthwork construction, the CQA Consultant will assess the extent and nature of the deficiency by performing additional tests, observations, review of records, or other means that the CQA Consultant deems appropriate. If the defect is related to adverse site conditions, such as overly wet materials or surface desiccation, the CQA Consultant will define the limits and nature of the defect.

If the deficiency cannot be resolved by the Contractor immediately or as soon as practical after identification, the CQA Site Manager will schedule appropriate re-tests for after the work deficiency is corrected.

The CQA Consultant will verify that:

1. The Contractor has corrected all noted deficiencies before any additional work can be performed in the area of the deficiency.
2. If a specified criterion cannot be met because of site-specific reasons or unusual weather conditions hindering the work, the Contractor will submit suggested solutions or alternatives to the Design Engineer and Construction Manager for review.

3.9 Protection of Subgrades and Fill Surfaces

1. The CQA Consultant shall monitor newly graded areas to verify the Contractor is protecting these areas from traffic and erosion until construction is complete.

3.10 Documentation

CQA monitoring and testing will be documented by the CQA Consultant on forms specifically designed for this purpose. Reports and forms will be submitted to the Construction Manager.

4 CCR REMOVAL AND PLACEMENT

4.1 Introduction

This Section describes the construction oversight activities that will be performed by the CQA Consultant to verify the removal of CCR to the extents and grades shown on the Construction Documents and replacement of the excavated materials within the closure-in-place footprint indicated or shown on the project drawings.

In addition to the activities listed in the subsections below, the CQA Consultant will photograph the work being conducted and will document monitoring observations on forms specifically designed for this purpose.

4.2 CCR Removal and Verification Protocol

Dewatered CCR will be excavated and transported using haul trucks or other means (e.g., conveyors). CCR removal activities will be observed and documented by the CQA Consultant. The CCR removal area indicated or shown on the project drawings will be excavated to remove visible CCR plus a minimum 6-inches of additional soil to the extent practicable. Observations will be made with reference to a 100-foot by 100-foot alphanumeric grid system established for the project so that each grid location is assigned a unique label for reference and documentation purposes. When the interface between the CCR and the underlying soil material is located during excavation, the following CCR removal verification protocol will be conducted:

1. The excavated surface (bottom of CCR) will be jointly observed and documented to confirm removal of visible CCR by a representative of the Owner and the CQA Consultant. Visual observations and the Munsell Soil Color Chart will be used as the basis to confirm that visible CCR has been excavated from the former CCR unit footprint to the extent practicable. At a minimum frequency of one per 100-foot grid, using the approximate centers of the 100-foot by 100-foot project grid system, the interface will be photographed by the CQA Consultant and the area will be surveyed to develop a topographic map denoting the bottom of CCR. A description of the soil using the Unified Soil Classification System (ASTM D2488) together with a determination of the color of the soil based on the Munsell Color Chart will be documented by the CQA Consultant.
2. Following the CQA Consultant's approval, concurrence by the Owner, and completion of the bottom of CCR survey, excavation will continue by removing at least six inches of additional soil underlying the bottom of CCR to the extent practicable. Verification of removal thicknesses will be performed by the Surveyor by surveying the excavated area using the project grid system and comparing the elevations of the bottom of excavation to the elevations of the surveyed bottom of CCR. If the bottom of excavation is found to be at least six inches below the surveyed bottom of CCR (provided that it is practicable to achieve the excavation (e.g., competent bedrock has not been encountered)), then the excavated surface will be jointly observed and documented consistent with the procedures in the first bullet point above. The CQA Consultant will confirm that the area has been re-excavated and re-surveyed and that the work conforms with the Construction Documents.

A summary of CQC and CQA activities and tests with their respective frequencies is presented in Appendix B.

4.3 CCR Dewatering with Geotextile Tubes

Hydraulic dredging of CCR and the use of geotextile tubes (often referred to as "geotubes") are no longer considered for this project.

4.4 CCR Placement

The CQA Consultant will monitor CCR placement and stacking for conformance with the Construction Documents. The CQA Consultant will also evaluate the procedures, methods, and equipment used by the Contractor to place or stack the CCR. This will include visual observation and documentation of the Contractor's CCR placement and stacking activities for the following:

1. Changes in CCR consistency.
2. Lift thicknesses as placed and compacted, and placement of CCR in relatively horizontal lifts.
3. CCR conditioning prior to placement including general observations regarding moisture distribution, clod size, etc.
4. The action of compaction equipment and heavy hauling equipment on the CCR surface for evidence of it being relatively firm and unyielding after several passes of the compaction equipment.
5. Grading of the working surface in such a way to minimize stormwater run-on and water pooling.
6. Desiccation cracks or the presence of ponded water.
7. Sealing of the surface to the extent possible at the end of each day's activities.
8. Scarification of the sealed CCR surface prior to the placement of the next lift to promote lift bonding.
9. Condition of final surfaces.

The CQA Consultant will also monitor any field pilot studies implemented at the Contractor's discretion during construction to evaluate appropriate CCR placement methods (i.e., lift thickness, optimum moisture window, type of compaction equipment, and number of passes). The CQA Consultant will review results of any QC testing performed by the Contractor related to the foregoing activities.

4.5 Performance Testing

Performance tests to evaluate the suitability of in-place and newly placed CCR material will be performed by the CQA Consultant in accordance with the current American Society for Testing and Methods (ASTM) or other applicable test procedures. The specified methods and minimum frequencies are indicated in Appendix B. The CQA Consultant may also conduct additional performance testing if deemed necessary by the Owner and or CQA Certifying Engineer. Such additional testing may only be performed after the CQA Consultant submits, and the Owner approves, a written request that described the reason(s) for additional testing.

4.6 Deficiencies

If a deficiency (i.e., non-conformance of the materials or workmanship with the requirements of the Construction Documents) is discovered during CCR placement or staking, the CQA Consultant will assess the extent and nature of the deficiency by performing additional tests, observations, review of records, or other means that the CQA Consultant deems appropriate. If the defect is related to adverse site conditions, such as overly wet CCR or surface desiccation or other defects, the CQA Consultant will define the limits and nature of the defect.

If the deficiency cannot be resolved by the Contractor immediately or as soon as practical after identification, the CQA Site Manager will schedule appropriate re-tests for after the work deficiency is corrected.

The CQA Consultant will verify that:

1. The Contractor has corrected all noted deficiencies before any additional work can be performed in the area of the deficiency.
2. If a specified criterion cannot be met because of site-specific reasons or unusual weather conditions hindering the work, the Contractor will submit suggested solutions or alternatives to the Design Engineer and Construction Manager for review.

5 FINAL COVER GEOMEMBRANE

5.1 General

This Section of the CQA Plan addresses the geomembrane component of the final cover and outlines the CQA program to be implemented with regard to the manufacturer and Geomembrane Installer acceptance, material acceptance, subgrade acceptance, field and laboratory control and record tests, repairs, and resolution of problems.

5.2 Geomembrane Manufacturer and Installer Acceptance

1. The Contractor shall submit the qualifications of the geomembrane manufacturer and the Geomembrane Installer, as described in the material specifications and/or this CQA Plan, to the Owner and CQA Consultant for acceptance.
2. The CQA Consultant will review the Contractor's submittals for conformance with the material specifications and/or this CQA Plan.
3. Geomembrane for the final cover will only be shipped to the site once submittals and MQC and CQA conformance testing is completed and the material approved by the Owner and CQA Consultant.

5.3 Cap Geomembrane Material Acceptance and Conformance Testing

1. Samples for CQA conformance tests, as shown in Appendix C, will be obtained by the CQA Consultant at the indicated frequencies upon delivery of the geomembrane. Alternatively, samples may be randomly obtained at the manufacturing site by the CQA Consultant or representatives of the CQA Geosynthetic Laboratory.
 - a. Unless otherwise specified, samples will be 3-feet-long by the roll or sheet width. The CQA Consultant will mark the machine direction on the samples with an arrow.
 - b. All material control tests will be performed by the CQA Geosynthetics Laboratory.
2. The following procedure will apply whenever a sample fails a material control test:
 - a. The Geomembrane Installer will replace each roll or sheet of geomembrane that is in non-conformance with the material specifications and/or this CQA Plan with a roll or sheet that meets material specifications and/or this CQA Plan.
 - b. The Geomembrane Installer will remove conformance samples for testing by the CQA Geosynthetics Laboratory from the closest numerical roll or sheet on both sides of the failed roll or sheet. These two samples must both conform to material specifications and/or this CQA Plan. If either of these samples fail, then the next numerical roll or sheet will be tested until a passing roll or sheet is found. This additional conformance testing will be at the expense of the Geomembrane Installer. If either of the two closest rolls or sheets fail, the CQA Consultant will dictate the frequency of additional testing.
3. The CQA Consultant will document actions taken in conjunction with material control test failures.

4. During shipment and storage, all geomembrane will be protected as required by the material specifications and/or this CQA Plan. The CQA Consultant will observe rolls upon delivery at the site.
5. Upon delivery, the CQA Consultant will document that the MQC certificates have been provided at the specified frequency and that each certificate identifies the rolls or sheets related to it; and review the Manufacturer's quality control certificates and document that the certified properties meet the material specifications and/or this CQA Plan.
6. All test results must be available at the site prior to the deployment of all geomembrane. The CQA Consultant will examine all results from laboratory conformance testing.

5.4 Geomembrane Installation

1. A geomembrane pre-construction meeting will be held at the site prior to placement of the geosynthetics as outlined in the material specifications and/or this CQA Plan. At a minimum, the meeting will be attended by the Owner, Design Engineer, CQA Consultant, Contractor, and Geosynthetic Installation Superintendent(s).
2. The purpose of this meeting is to begin planning for coordination of tasks, anticipate any problems which might cause difficulties and delays in construction, and, above all, review the CQA Plan with all parties involved. It is very important that the requirements regarding submittals, testing, repair, recordkeeping, etc. be known and accepted by all.
3. This meeting should include all of the activities referenced in this CQA Plan and the material specifications. The meeting will be documented by the CQA Consultant and minutes will be transmitted to all parties.
4. The Geomembrane Installer will provide the CQA Consultant with a list of proposed seaming personnel and their experience records. This document will be reviewed by the CQA Consultant for compliance with material specifications and/or this CQA Plan. The Geomembrane Installer Supervisor will provide a list of personnel present onsite each day the geomembrane installation crew is onsite.
5. Subgrade Preparation: The Geomembrane Installer will document in writing that the surface on which that day's geomembrane will be installed meets the surface preparation requirements of the material specifications and/or this CQA Plan. The certificate of acceptance will be given to the CQA Consultant prior to commencement of geomembrane installation in the area under consideration. To facilitate a timely covering of the underlying surface, the CQA Consultant may allow subgrade acceptance in areas as small as one acre. After the supporting subgrade has been accepted by the Geomembrane Installer, it will be the Geomembrane Installer's responsibility to indicate to the CQA Consultant any change in the supporting subgrade condition that may require repair work. If the CQA Consultant concurs with the Geomembrane Installer, then the CQA Consultant will notify the Contractor that the supporting subgrade is required to be repaired.
 - a. The CQA Consultant must visually inspect and approve the subgrade before the day's placement and before placement of each geomembrane panel. The subgrade surface must meet grades, consistency, and particle size limitations outlined in the material specifications. Report any non-conforming areas to the Contractor for repair.

6. The CQA Consultant will document that anchor trenches have been constructed and backfilled as indicated or shown on the project drawings and material specifications and/or this CQA Plan.
7. Field Panel Identification: The CQA Consultant will document that the Geomembrane Installer labels each field panel with a unique "identification code" (number or letter-number consistent with the layout plan) agreed upon by the Geomembrane Installer and CQA Consultant at the geosynthetics pre-construction meeting and consistent with the approved panel layout drawing.
 - a. The Geomembrane Installer will establish a table or chart showing correspondence between roll or sheet numbers and field panel identification codes. This documentation shall be submitted to the CQA Consultant weekly for review and verification. The field panel identification code will be used for all quality control and quality assurance records.
8. Field Panel Placement: The CQA Consultant will document that field panels are installed at the location indicated in the approved panel layout drawing. The CQA Consultant will record the identification code, location, and date of installation of each field panel.
 - a. The CQA Consultant will document that CQA Plan-related restrictions on placement of geomembrane are fulfilled. Additionally, the CQA Consultant will document that the supporting subgrade has not been damaged by weather conditions or the Geomembrane Installer or others during placement activities.
 - b. The CQA Consultant will visually observe each panel, after placement and prior to seaming, for damage. The CQA Consultant will advise the Design Engineer and Geomembrane Installer which panels, or portions of panels, should be rejected, repaired, or accepted. Damaged panels or portions of damaged panels which have been rejected will be marked and their removal from the work area recorded by the CQA Consultant. Repairs will be made according to procedures described in this Section.
 - c. As a minimum, the CQA Consultant will document that:
 - i. The panel is placed in such a manner that it is unlikely to be damaged; and
 - ii. Any tears, punctures, holes, thin spots, etc. are either marked by the Geomembrane Installer for repair or the panel is rejected
 - iii. Slack or wrinkles in the panel have been managed in accordance with the material specifications and/or this CQA Plan,
 - iv. Anchor trenches and other anchorage methods are in place.
9. Field Seaming: The Geomembrane Installer will provide the CQA Consultant with panel layout drawing (i.e., a drawing of the area to be lined showing all expected seams). The CQA Consultant will review the panel layout drawing and document that it is consistent with the accepted state of practice and this CQA Plan. In addition, panels not specifically shown on the panel layout drawing may be used without the CQA Consultant's prior acceptance.
 - a. A seam numbering system compatible with the panel numbering system will be agreed upon at the geosynthetics pre-construction meeting. An on-going written record of the seams and repair areas shall be maintained by the Geomembrane Installer with weekly review by the CQA Consultant.

- b. Field seaming processes must comply with material specifications and/or this CQA Plan. Proposed alternate processes will be documented and submitted to the Design Engineer and CQA Consultant for their acceptance. Only seaming apparatuses which have been specifically accepted by make and model will be used. The CQA Consultant will submit all documentation to the Design Engineer for his concurrence.
10. Field Seam Control Testing: Each field seam, regardless of the size and type of seam, is to be tested using an approved non-destructive and destructive test method. Non-destructive seam testing is intended to cover the entire length of the seam and destructive seam testing is intended to examine representative portions of the selected seam for conformance.
 - a. Prior to the start of each shift during production seaming, the Geomembrane Installer will complete trial seams on appropriate sized pieces of identical or equivalent geomembrane material to verify seams meet the minimum seam strength requirements as according to the material specifications. Trial seams are made in the field adjacent to or in the work area.
 - b. Trial seams are performed for each welder to be used and by each operator of extrusion welders, and by the primary operator of each fusion welder. Each trial seam is assigned a number and the test results recorded in the appropriate log by the Geomembrane Installer. The CQA Consultant observes trial seams and compiles trial seam logs.
 - c. The Geomembrane Installer will test and document all seam welds continuously over their full length using nondestructive seam tests, or as outlined in the material specifications and/or this CQA Plan. This testing is performed simultaneously with geomembrane deployment as the work progresses and not at the completion of all field seaming.
 - d. The CQA Consultant observes the nondestructive testing on a full-time basis to document conformance with this CQA Plan and the material specifications and/or this CQA Plan. Observe the completed seams to identify areas where over-grinding or overheating of the geomembrane have occurred. Such areas are to be repaired in accordance with this CQA Plan, and the Geomembrane Installer will modify equipment or methods to eliminate these conditions.
 - e. The Geomembrane Installer will obtain 12 inches by 36 inches (or longer as needed) samples of field seams with the seam centered lengthwise, suitable for testing, at an average frequency of one sample per 1,000 linear feet of weld, to verify the seams meet the minimum seam strength requirements as listed in the material specifications and/or this CQA Plan. The sample is to be cut into three equal-length pieces, one to be given to the Geomembrane Installer for field destructive testing, one given to the CQA Consultant for laboratory destructive testing, and one given to the CQA Consultant as an archive sample. The date, time, equipment, seam number, and seaming parameters will be marked on each sample and recorded by the CQA Consultant.
 - f. All holes in the geomembrane resulting from destructive seam sampling will be immediately repaired in accordance with repair procedures described in the material specifications and/or this CQA Plan.
 - g. The laboratory destructive test samples will be packaged and shipped to the CQA Geosynthetics Laboratory by the CQA Consultant in a manner that will not damage the test sample.

- h. The CQA Consultant will review laboratory test results as soon as they become available and transmit the results to the affected parties.
 - i. The CQA Consultant may require additional random samples to be taken for testing in areas which visually appear defective and not in accordance with the project requirements.
11. Field Seam Record Test Failure: For noncomplying tests, the CQA Consultant will:
 - a. Observe continuity testing of the repaired areas performed by the Geomembrane Installer.
 - b. Confirm the record location, date, test unit number, name of tester, and compile the record of testing provided by the Geomembrane Installer.
 - c. Conduct a walk-through inspection of all impacted seam areas and document that the areas have been tested in accordance with the CQA Plan and material specifications and/or this CQA Plan.
 - d. Document that the Geomembrane Installer has marked repair areas.
 - e. All defective seam test failures must be bounded by acceptable destructive tests as directed by the CQA Consultant. The CQA Consultant will document repair actions taken in conjunction with any seam test failures.
12. Repairs and Verification: All repair procedures must be completed in accordance with the material specifications and/or this CQA Plan. The CQA Consultant will observe and document repair procedures.
 - a. Each repair is to be numbered and logged by the Geomembrane Installer and recorded by the CQA Consultant.
 - b. Each repair will be non-destructively tested by the Geomembrane Installer using the methods required by the material specifications and/or this CQA Plan. Repairs which pass non-destructive testing are considered to be an indication of an adequate repair.
 - c. A failed test indicates that the repair must be redone and retested until passing test results are achieved.
13. Liner System Acceptance: The Geomembrane Installer and the geosynthetic manufacturers will retain all ownership and responsibility for the geomembrane installed for the Final Cover System until acceptance by the Owner. The geomembrane will be accepted for placement of overlying Final Cover System components once the following conditions are met:
 - a. Installation is completed.
 - b. Verification of the adequacy of all seams and repairs, including associated testing, is complete.
 - c. CQA Consultant provides the Design Engineer with a final copy of the nondestructive test documentation, repair information, and as-built drawings, as submitted by the Geomembrane Installer.
 - d. CQA Consultant furnishes the Design Engineer with documentation, submitted by the Geomembrane Installer that the geomembrane was installed in accordance with the geomembrane manufacturer's recommendations as well as the project drawings and material specifications and/or this CQA Plan.

- e. The CQA Consultant will document that the installation has proceeded in accordance with the material specifications and/or this CQA Plan for the project except as noted to the Design Engineer.
14. Materials in Contact with Geomembranes: The quality assurance procedures indicated in this paragraph are only intended to monitor that the installation of these materials does not damage the geomembrane, that reasonable measures are taken to protect the geomembrane, and to provide additional quality assurance procedures as necessary to monitor that systems built with these materials will be constructed to achieve proper performance.
- a. Soils (for the Alternative Final Cover System Only): Prior to placement of overlying soils, the CQA Consultant will visually confirm that soil materials to be placed against the geomembrane comply with material specifications and/or this CQA Plan. The Geomembrane Installer will provide the CQA Consultant a written surface acceptance certificate in accordance with the material specifications and/or this CQA Plan. All soil materials are to be placed and compacted in accordance with material specifications and/or this CQA Plan.
 - b. Sumps and Connections to Appurtenances: The CQA Consultant will document that installation of the geomembrane in appurtenance areas, and connection of the geomembrane to appurtenances have been made according to the material specifications and/or this CQA Plan, and the geomembrane or appurtenances have not been visibly damaged while making connections.

6 GEOTEXTILES

6.1 General

The CQA Consultant will perform conformance testing, review the MQC documentation, and monitor the installation of geotextile layers to verify that the manufacturer's specifications and the requirements of the Construction Documents and this CQA Plan are met.

6.2 Transportation, Handling, and Storage

The CQA Consultant will monitor the transportation, handling, and storage of the geotextile on the project site. The CQA Consultant will verify that the geotextile is protected from ultraviolet light exposure, precipitation or other inundation, mud, dirt, dust, puncture, cutting or any other damaging or deleterious conditions.

The CQA Consultant will monitor that transportation, handling, and storage of geotextile conforms with the Construction Documents, including:

1. Handling of the geotextile rolls is performed in a competent manner such that damage does not occur to the geotextile or to its protective wrapping.
2. Geotextile rolls are not stacked upon one another to the extent that deformation of the core occurs or to the point where accessibility can cause damage in handling.
3. Geotextile rolls are stacked in such a way that access for conformance sampling is possible.
4. Protective wrappings are removed less than one hour prior to unrolling the geotextile.
5. After unrolling, a geotextile is not exposed to ultraviolet light for more than 30 calendar days.
6. Outdoor storage of geotextile rolls does not exceed the manufacturer's recommendations or longer than 6 months, whichever is less.
7. For storage periods longer than manufacturer's recommendations or six months (whichever is less), a tarp or temporary enclosure is placed over the rolls, or they are moved to an enclosed facility.
8. The location of temporary field storage is not in areas where water can accumulate, and the rolls are elevated off the ground to prevent contact with ponded water.

Upon delivery at the site, the Contractor, Geotextile Installer, and CQA Consultant will conduct an inspection of the rolls for defects and/or damage. This inspection will be conducted without unrolling the materials unless defects or damages are found or suspected. The CQA Consultant will indicate to the Construction Manager of any rolls, or portions thereof, that will be rejected and need to be removed from the site because of severe flaws; and rolls that include minor repairable flaws that do not compromise geotextile functionality.

The CQA Consultant will also monitor that equipment used to handle the geotextiles onsite is adequate and does not pose any risk of damage to the geotextiles during handling.

6.3 MQC Testing and Conformance Testing

1. Geotextile Material MQC Testing Requirements: The geotextile manufacturer will perform QC testing on the geotextile materials that will be used on this project in accordance with the current versions of the ASTM and other applicable test procedures, and at the minimum MQC frequencies presented in Appendices D and E. The CQA Consultant will review the MQC certifications and test results to verify that the Manufacturer's specifications and the requirements of the Construction Documents and this CQA Plan are met. The conformance testing program that will be conducted by the CQA Consultant is described in this Section.
2. Conformance Testing Requirements: The CQA Consultant will coordinate, and the qualified laboratory (i.e., the CQA Geosynthetics Laboratory) will perform geotextile conformance testing to evaluate the conformance with the requirements of the Construction Documents. The testing will be performed in accordance with the current versions of ASTM and other applicable test procedures and at the minimum frequencies indicated in Appendices D and E tables, corresponding to each geotextile material type that will be used. The CQA Consultant may conduct additional conformance testing if deemed necessary by the Owner and/or the CQA Certifying Engineer.
3. Test Results: All MQC and conformance test results will be reviewed, accepted, and reported by the CQA Consultant before deployment of geotextiles. Any non-conformance of the material properties with the requirements of the Construction Documents will be reported to the Contractor and PCM.
4. Test Failure: In the case of failing test results, the Contractor may request that another sample from the failing roll be re-tested. If the re-test fails or if the option to re-test is not exercised, then two isolation conformance samples will be obtained by the CQA Consultant. These isolation samples will be taken from rolls that have been determined by correlation with the manufacturer's roll number to have been manufactured prior to and after the failing roll. This method for choosing isolation rolls for testing will continue until passing tests are achieved. All rolls that fall numerically between the passing roll numbers will be rejected.

The CQA Consultant will verify that the Contractor has replaced all rejected rolls. The CQA Consultant will document all actions taken in conjunction with geotextile conformance failures.

6.4 Placement

The CQA Consultant will monitor, verify, and document that geotextile placement is conducted in accordance with the Construction Documents and that CQA activities are performed as described below. The CQA Consultant will monitor the placement of all geotextiles to verify that they are not damaged in any way, and the following requirements of the Construction Documents are met:

1. On slopes, the geotextiles are securely anchored in the anchor trench and then deployed down the slope in such a manner as to continually keep the geotextile in tension.
2. In the presence of wind, weight the geotextiles with sandbags or equivalent; such sandbags are installed during placement and will remain until replaced with earth cover material.

3. Trimming of the geotextiles should be performed using only an upward cutting hook blade and special care to protect other materials from damage which could be caused by the cutting of the geotextiles.
4. The Installer should take necessary precautions to prevent damage to underlying layers during placement of the geotextile.
5. During placement of geotextiles, care should be given not to entrap stones, excessive dust, or moisture that could generate clogging of drains or filters.
6. A visual examination of the geotextile should be over the entire surface, after installation, to verify that no potentially harmful foreign objects, (e.g., stones, sharp objects, small tools, sandbags, etc.) are present.

6.5 Seams and Overlaps

The CQA Consultant will monitor, verify, and document that geotextile seams and overlaps are in accordance with the Construction Documents and that CQA activities are performed as described below. The CQA Consultant will monitor that the following requirements of the Construction Documents are met:

1. All geotextiles are continuously sewn (i.e., no spot sewing).
2. Geotextiles are overlapped 6 inches prior to seaming.
3. No horizontal seams are constructed on side slopes that are steeper than 10H:1V (horizontal: vertical) (i.e., seams to be aligned along, not across the slope), except as part of a patch.
4. Sewing uses polymeric thread with chemical and ultraviolet resistance properties equal to or exceeding those of the geotextile.
5. Seams are sewn using a single row Stich Type 401 two-thread chain stitch.

6.6 Repairs

The CQA Consultant will monitor, verify, and document that geotextile repairs are made in accordance with the Construction Documents and that CQA activities are performed as described below. The CQA Consultant will monitor that any holes or tears in the geotextile are repaired as follows:

1. For slopes steeper than 10H:1V, a patch made from the same geotextile is double seamed into place (with each seam 1/4 inches to 3/4 inches apart and no closer than 1 inch from any edge) with a minimum 12-inch overlap. Should any tear exceed 50 percent of the width of the roll, that roll is removed from the slope and replaced.
2. For slopes flatter than 10H:1V, a patch made from the same geotextile is sewn in place with a minimum of 12-inch overlap in all directions away from the repair area.

The CQA Consultant will observe that care is given to remove any soil or other material which may have penetrated the torn geotextile and all repairs and verify that any non-conformance with the above requirements is corrected.

6.7 Placement of Materials on Geotextiles

The CQA Consultant will monitor, verify, and document that placement of soils or granular materials on top of geotextiles is conducted in accordance with the Construction Documents and that CQA activities are performed as described below. The CQA Consultant will monitor that the Contractor's placement of soil or granular materials on top of the geotextile is in conformance with the Construction Documents, including:

1. That no damage occurs to the geotextile.
2. That no shifting of the geotextile from its intended position occurs and underlying materials are not exposed or damaged.
3. That excess tensile stress does not occur in the geotextile.
4. That equipment does not drive directly on the geotextile.
5. The Contractor uses only LGP equipment on cover material layers less than 3-feet-thick above the geomembrane and geotextile separator or cushion layer.

The CQA Consultant will monitor that covering of the geotextile with overlying material layers is completed within 30 days of installation to prevent UV degradation and on side slopes, that soil and granular layers are placed over the geotextile from the bottom of the slope upward.

7 GEOCOMPOSITE DRAINAGE MEDIA (GDM)

7.1 General

This Section of the CQA Plan addresses Geocomposite Drainage Media (GDM) as required for the Alternative Final Cover System and outlines the CQA program to be implemented with regard to material acceptance, material control tests, repairs, and resolution of problems. GDM is generally comprised of a geotextile and geonet. The geotextile may be connected to the HDPE bi-planar geonet by heat bonding in the factory. A geotextile may be bonded to one or both sides of the geonet. Material thickness is assumed to be a minimum of 250 mils. The minimum transmissivity on the 5H:1V slopes is 7.4×10^{-4} meters squared per second. This Section is intended to cover all types of GDM described above.

7.2 GDM Manufacturer and Installer Acceptance

1. The Contractor shall submit the qualifications of the GDM manufacturer and the Geomembrane Installer, as described in the material specifications and/or this CQA Plan, to the Owner and CQA Consultant for acceptance.
2. The CQA Consultant will review the Contractor's submittals for conformance with the material specifications and/or this CQA Plan.
3. GDM will only be shipped to the site once submittals and CQA conformance testing is completed and the material is approved by the Owner and CQA Consultant.

7.3 GDM Material Acceptance and Conformance Testing

1. Samples for CQA conformance tests will be obtained by the CQA Consultant at the indicated frequencies upon delivery of the GDM. Alternatively, samples may be randomly obtained at the manufacturing site by the CQA Consultant or representatives of the CQA Geosynthetics Laboratory.
 - a. Conformance tests and frequencies for the GDM and the geonet component of the GDM are shown in Appendix E. Conformance tests and frequencies for the geotextile component of the GDM are shown in Appendix E.
2. Unless otherwise specified, samples will be 3-feet-long by the roll or sheet width. The CQA Consultant will mark the machine direction on the samples with an arrow.
3. All material control tests will be performed by the CQA Geosynthetics Laboratory.
4. The following procedure will apply whenever a sample fails a material control test:
 - a. The Geosynthetic Installer will replace the roll of GDM that is in non-conformance with the material specifications and/or this CQA Plan with a roll that meets material specifications and/or this CQA Plan.
 - b. The Geosynthetic Installer will remove samples for testing by the CQA Geosynthetics Laboratory from the closest numerical roll on both sides of the failed roll. These two samples must both conform to material specifications and/or this CQA Plan. If either of these samples fail, then the next numerical roll will be tested until a passing roll is found.

This additional testing will be at the expense of the Geosynthetic Installer. If either of the two closest rolls fail, the Design Engineer will dictate the frequency of additional testing.

- c. The CQA Consultant will document actions taken in conjunction with material control test failures.
5. Document that the manufacturer's quality control certificates have been provided at the specified frequency and that each certificate identifies the rolls related to it.
6. Review the manufacturer's quality control certificates and document that the certified properties meet the material specifications and/or this CQA Plan.
7. During shipment and storage, all GDM will be protected as required by the material specifications and/or this CQA Plan. The CQA Consultant will observe rolls upon delivery at the site.
8. Upon delivery, the CQA Consultant will document that the manufacturer's quality control certificates have been provided at the specified frequency and that each certificate identifies the rolls or sheets related to it, and review the manufacturer's quality control certificates and document that the certified properties meet the material specifications and/or this CQA Plan.
9. All quality control test results must be available at the site prior to the deployment of all GDM. The CQA Consultant will examine all results from laboratory conformance testing.

7.4 GDM Installation

1. Handling and Placement: The Geosynthetic Installer will handle and place all GDM in such a manner as required by the material specifications and/or this CQA Plan and Manufacturer. Installation must not result in damage to the underlying geomembrane.
2. When several layers of GDM are overlapped, care should be taken to ensure that overlapped GDM are placed in the same flow direction. The CQA Consultant will observe the overlapping of GDM. Overlapping GDM should not be laid in perpendicular directions to the underlying GDM unless otherwise specified by the Design Engineer. This may be a challenge for relatively flat final cover slopes and the installation sequence should be evaluated in the field by the CQA Consultant and the Geosynthetic Installer.
3. Adjacent rolls of GDM will be joined as indicated or shown on the project drawings and material specifications and/or this CQA Plan.
4. Any holes or tears in the GDM will be repaired in accordance with the material specifications and/or this CQA Plan. The CQA Consultant will observe and document repairs.
5. All soil, crushed stone aggregate, or revetment materials installed over the GDM shall be placed in accordance with the material specifications and/or this CQA Plan.
6. Deficiencies: The CQA Consultant will immediately determine the extent and nature of all defects and deficiencies and report them to the Design Engineer. All defects and deficiencies will be documented by the CQA Consultant. The Contractor will correct defects and deficiencies to the satisfaction of the CQA Consultant. The CQA Consultant will observe all retests on repaired defects.

8 GEOGRID

8.1 General

The CQA Consultant will perform conformance testing, review the MQC documentation, and monitor the installation of the geogrid to verify that the manufacturer's specifications and the requirements of the Construction Documents and the CQA Plan are met.

8.2 Transportation, Handling, and Storage

The CQA Consultant will monitor the transportation, handling, and storage of the geogrid on the project site. The CQA Consultant will verify that during transportation, handling, and storage, the geogrid is protected from precipitation or other inundation, mud, dirt, dust, puncture, cutting, or any other damaging or deleterious conditions. The CQA Consultant will monitor that transportation, handling, and storage of geogrid conforms with the Construction Documents, including:

1. Geogrid rolls are handled in a competent manner such that damage does not occur to the geogrid.
2. Geogrid rolls are not to be stacked upon one another to the extent that deformation of the roll occurs or to the point where accessibility can cause damage in handling.
3. Geogrid rolls are stacked in such a way that access for conformance sampling is possible.

Upon delivery at the site, the Contractor, Geogrid Installer, and CQA Consultant will conduct an inspection of the rolls for defects and/or damage. This inspection will be conducted without unrolling the materials unless defects or damages are found or suspected. The CQA Consultant will indicate to the Construction Manager when rolls, or portions thereof, that will be rejected and need to be removed from the site because of severe flaws; and rolls that include minor repairable flaws, that do not compromise geogrid functionality.

The CQA Consultant will also monitor that equipment used to handle the geogrid onsite is adequate and does not pose any risk of damage to the geogrid when used properly.

8.3 MQC Testing and Conformance Testing

1. **Geogrid** Material MQC Testing Requirements: The geogrid manufacturer will perform QC testing on the geogrid materials and rolls that will be used on this project in accordance with the current versions of the ASTM and other applicable test procedures, and at the minimum MQC frequencies as indicated in Table 8.7.1. The CQA Consultant will review the MQC certifications and test results to verify that the manufacturer's specifications and the requirements of the Construction Documents and this CQA Plan are met.
2. Conformance Testing Requirements: If deemed necessary by the Owner and/or the CQA Certifying Engineer, the CQA Consultant will coordinate, and a qualified laboratory (i.e., the CQA Geosynthetics Laboratory) will perform geogrid CQA testing to evaluate the conformance of the geogrid with the requirements of the Construction Documents. The testing will be performed in accordance with the current versions of the ASTM and other applicable test procedures and at the minimum frequencies indicated in Table 8.7.1.

3. Test Results: All MQC and conformance test results will be reviewed, accepted, and reported by the CQA Consultant before deployment of geogrid. Any non-conformance of the material properties with the requirements of the Construction Documents will be reported to the Contractor and Construction Manager.
4. Test Failure: In the case of failing test results, the Contractor may request that another sample from the failing roll be re-tested. If the re-test fails or if the option to re-test is not exercised, then two isolation conformance samples will be obtained by the CQA Consultant. These isolation samples will be taken from rolls that have been determined by correlation with the manufacturer's roll number to have been manufactured prior to and after the failing roll. This method for choosing isolation rolls for testing will continue until passing tests are achieved. All rolls that fall numerically between the passing roll numbers will be rejected. The CQA Consultant will verify that the Contractor has replaced all rejected rolls. The CQA Consultant will document all actions taken in conjunction with geogrid conformance failures.

8.4 Placement

The CQA Consultant will monitor, verify, and document that placement of geogrid is conducted in accordance with the Construction Documents and that CQA activities are performed as described below. The CQA Consultant will monitor the placement of all geogrid to verify that they are not damaged in any way and the following conditions are met:

1. On slopes, the geogrid rolls are securely anchored in the anchor trench and then deployed down the slope in such a manner as to continually keep the geogrid rolls in tension.
2. In the presence of wind, the geogrid is weighted with sandbags or equivalent. Such sandbags should be installed during placement and remain until replaced with cover material.
3. Trimming of the geogrid is performed using only manufacturer's recommended tools. Special care must be given to protect other materials from damage which could be caused by the cutting of the geogrid.
4. The Geogrid Installer is taking necessary precautions to prevent damage to underlying layers during placement of the geogrid.
5. A visual examination of the geogrids is completed over the entire surface, after installation, to verify that no potentially harmful foreign objects, (e.g., stones, sharp objects, small tools, sandbags, etc.) are present.

8.5 Joining, Seams and Overlaps

The CQA Consultant will monitor, verify, and document that geogrid joining and/or overlaps are made in accordance with the Construction Documents and that CQA activities are performed as described below. The CQA Consultant will monitor that the geogrids are joined and/or overlapped in conformance with the Construction Documents and manufacturer's recommendations.

8.6 Repairs

The CQA Consultant will monitor, verify, and document that geogrid repairs are made in accordance with the Construction Documents and that CQA activities are performed as described below. The CQA

Consultant will monitor that any holes or tears in the geogrids are repaired in accordance with the Construction Documents including:

1. A patch made from the same geogrid needing repair.
2. The patch extends 2 feet beyond the edges of the hole or tear.
3. The patch is secured every 6 inches by tying plastic fasteners.
4. If the hole or tear is more than 50 percent of the width of the roll, the damaged area will be cut out and the two portions of the geogrid will be joined.

The CQA Consultant will observe repairs and verify that any non-conformance with the above requirements is corrected.

8.7 Placement of Materials on Geogrid

The CQA Consultant will monitor, verify, and document that placement of soils or granular materials on top of geogrid is conducted in accordance with the Construction Documents and that CQA activities are performed as described below. The CQA Consultant will monitor that the Contractor's placement of soil or granular materials on top of the geogrid is in conformance with the Construction Documents, including:

1. No damage occurs to the geogrid.
2. No shifting of the geogrid from its intended position occurs and underlying materials are not exposed or damaged.
3. Excess tensile stress does not occur in the geogrid.

TABLE 8.7.1 - GEOGRID MQC/CQA TESTING REQUIREMENTS

TEST NAME	MINIMUM CQA TESTING FREQUENCY
<u>Index Properties</u>	
Aperture Dimensions ²	Note 1
Minimum Rib Thickness ²	Note 1
Tensile Strength @ 2% Strain ³	Note 1
Tensile Strength @ 5% Strain ³	Note 1
Ultimate Tensile Strength ³	Note 1
<u>Structural Integrity</u>	
Junction Efficiency ⁴	Note 1
Flexural Stiffness ⁵	Note 1
Aperture Stability ⁶	Note 1
<u>Durability</u>	
Resistance to Installation Damage ⁷	Note 1
Resistance to Long Term Degradation ⁸	Note 1
Resistance to UV Degradation ⁹	Note 1

Notes:

- 1) Conformance testing is typically not performed but may be performed at the request of the Construction Manager. The testing protocol (properties, methods, and frequencies) will be developed by the Design Engineer.
- 2) Nominal dimensions.
- 3) Determined in accordance with ASTM D 6637-10 Method A.
- 4) Load transfer capability determined in accordance with ASTM D 7737-11.
- 5) Resistance to bending force determined in accordance with ASTM D 7748-12, using specimens of width two ribs wide, with transverse ribs cut flush with exterior edges of longitudinal ribs, and of length sufficiently long to enable measurement of the overhang dimension.
- 6) Resistance to in-plane rotational movement measured by applying a 20 kg-cm (2 m-N) moment to the central junction of a specimen with dimensions of 9 inches by 9 inches restrained at its perimeter in accordance with GRI GG9.
- 7) Resistance to loss of load capacity or structural integrity when subjected to mechanical installation stress in clayey sand (SC), well graded sand (SW), and crushed stone classified as poorly graded gravel (GP). The geogrid shall be sampled in accordance with ASTM D 5818 and load capacity shall be determined in accordance with ASTM D 6637.
- 8) Resistance to loss of load capacity or structural integrity when subjected to chemically aggressive environments in accordance with EPA 9090 immersion testing.
- 9) Resistance to loss of load capacity or structural integrity when subjected to 500 hours of ultraviolet light and aggressive weathering in accordance with ASTM D 4355-05.

9 ENGINEERED TURF BARRIER LAYER

9.1 General

This Section of the CQA Plan addresses the Final Cover System geosynthetic barrier that consists of an engineered composite of a 40-mil linear low-density polyethylene (LLDPE) geomembrane liner with a synthetic turf cover. An infill material comprised of sand may be used to anchor the engineered turf. Other anchoring systems, including mechanical and crushed stone aggregate, may be used, as outlined in the material specifications and/or this CQA Plan. The CQA program to be implemented with regard to manufacturer and installer acceptance, material acceptance, subgrade acceptance, field and laboratory control and record tests, repairs, and resolution of problems are addressed in this Section.

9.2 Manufacturing Plant Visit

At the request of the Owner, the CQA Consultant or the Owner's Representative will visit the plant of the engineered turf manufacturer to verify that manufacturing quality control procedures are in conformance with the Construction Documents. If possible, such a visit will be performed prior to or during the manufacturing of the engineered turf rolls for the project.

During the project-specific manufacturing plant visit, the CQA Consultant will:

1. Verify that the measurements of properties by the manufacturer are properly documented and test methods used are acceptable.
2. Spot-inspect the rolls and verify that they are free of holes, blisters, or any sign of contamination by foreign matter.
3. Review packaging and transportation procedures to verify that these procedures are not damaging the engineered turf.
4. Verify that all rolls are properly labeled.

Upon completion of the manufacturing plant visit, a report describing the findings and observations will be completed by the CQA Consultant or Construction Manager and be included as an attachment to the final CQA Certification Report.

9.3 Engineered Turf Manufacturer and Installer Acceptance

1. The Contractor shall submit the qualifications of the engineered turf manufacturer and the Engineered Turf Installer, as described in the material specifications and/or this CQA Plan, to the Owner and CQA Consultant for acceptance.
2. The CQA Consultant will review the Contractor's submittals for conformance with the material specifications and/or this CQA Plan.
3. Engineered turf will only be shipped to the site once submittals and CQA conformance testing is completed and the material approved by the Owner and CQA Consultant.

9.4 Manufacturer Quality Control (MQC) Testing

The engineered turf manufacturer will perform QC testing on the engineered turf rolls that will be used on this project in accordance with the current versions of the ASTM and other applicable test procedures, and at the minimum MQC frequencies as presented in Appendix G.

The CQA Consultant will review the MQC certifications and test results to verify that the manufacturer's specifications and the requirements of the Construction Documents and this material specifications and/or CQA Plan are met.

9.5 Engineered Turf Material Acceptance and Conformance Testing

1. Samples for CQA conformance tests, as shown in Appendix G will be obtained by the CQA Consultant at the indicated frequencies upon delivery of the engineered turf. The geomembrane component of the engineered turf will be tested separately from the composite material. Alternatively, samples may be randomly obtained at the manufacturing site by the CQA Consultant or representatives of the CQA Geosynthetics Laboratory.
 - a. Unless otherwise specified, samples will be 3 feet long by the roll or sheet width and exclude the outer lap of the roll. The CQA Consultant will mark the machine direction on the samples with an arrow.
 - b. All material control tests will be performed by the CQA Geosynthetics Laboratory.
2. The following procedure will apply whenever a sample fails a material control test:
 - a. The engineered turf manufacturer will replace each roll or sheet of engineered turf that is in non-conformance with the material specifications and/or this CQA Plan with a roll or sheet that meets material specifications and/or this CQA Plan.
 - b. The Engineered Turf Installer will remove conformance samples for testing by the CQA Geosynthetics Laboratory from the closest numerical roll or sheet on both sides of the failed roll or sheet. These two samples must both conform to material specifications and/or this CQA Plan. If either of these samples fail, then the next numerical roll or sheet will be tested until a passing roll or sheet is found. This additional conformance testing will be at the expense of the Engineered Turf Installer. If either of the two closest rolls or sheets fail, the CQA Consultant will dictate the frequency of additional testing.
3. The CQA Consultant will document actions taken in conjunction with material control test failures.
4. During shipment and storage, all engineered turf will be protected as required by the material specifications and/or this CQA Plan. The CQA Consultant will observe rolls upon delivery at the site.
5. Upon delivery, the CQA Consultant will document that the manufacturer's quality control certificates have been provided at the specified frequency and that each certificate identified the rolls or sheets related to it; and review the manufacturer's quality control certificates and document that the certified properties meet the material specifications and/or this CQA Plan.
6. All control test results must be available at the site prior to the deployment of all engineered turf. The CQA Consultant will examine all results from laboratory conformance testing.

9.6 MQC and CQA Conformance Test Results

1. All MQC and conformance test results will be reviewed, accepted, and reported by the CQA Consultant before deployment of engineered turf. Any non-conformance of the material properties with the requirements of the Construction Documents will be reported to the Contractor and Construction Manager.
2. In the case of failing test results, the Contractor may request that another sample from the failing roll be re-tested. If the re-test fails or if the option to re-test is not exercised, then two isolation conformance samples will be obtained by the CQA Consultant. These isolation samples will be taken from rolls, that have been determined by correlation with the manufacturer's roll number, to have been manufactured prior to and after the failing roll. This method for choosing isolation rolls for testing will continue until passing tests are achieved. All rolls that fall numerically between the passing roll numbers will be rejected. The CQA Consultant will verify that the Contractor has replaced all rejected rolls. The CQA Consultant will document all actions taken in conjunction with conformance failures.

9.7 Transportation, Handling, and Storage

The CQA Consultant will monitor the transportation, handling, and storage of the engineered turf on the project site. The CQA Consultant will verify that during transportation, handling, and storage, the engineered turf is protected from precipitation or other inundation, mud, dirt, dust, puncture, cutting, or any other damaging or deleterious conditions.

The CQA Consultant will monitor that transportation, handling, and storage of engineered turf conforms with the Construction Documents, including:

1. Handling of the engineered turf rolls is performed in a competent manner such that damage does not occur to the engineered turf or to its protective wrapping.
2. Engineered turf rolls are not stacked upon one another to the extent that deformation of the core occurs or to the point where accessibility can cause damage in handling.
3. Engineered turf rolls are stacked in such a way that access for conformance sampling is possible.

Upon delivery at the site, the Contractor, Engineered Turf Installer, and CQA Consultant will conduct an inspection of the rolls for defects and damage. This inspection will be conducted without unrolling the materials unless defects or damages are found or suspected. The CQA Consultant will indicate to the Construction Manager of any rolls, or portions thereof, that will be rejected and need to be removed from the site because of severe flaws, and rolls that include minor repairable flaws that do not compromise engineered turf functionality.

9.8 Engineered Turf Installation

1. A Geosynthetics Pre-Construction Meeting will be held at the site prior to placement of the engineered turf as outlined in the material specifications and/or this CQA Plan. At a minimum, the meeting will be attended by the Owner, Design Engineer, the CQA Consultant, the Contractor, and the Engineered Turf Installer Superintendent(s).

2. The purpose of this meeting is to begin planning for coordination of tasks, anticipate any problems which might cause difficulties and delays in construction, and, above all, review the CQA Plan with all parties involved. It is very important that the requirements regarding submittals, testing, repair, recordkeeping, etc. be known and accepted by all.
3. This meeting should include all of the activities referenced in the material specifications and/or this CQA Plan. The meeting will be documented by the CQA Consultant and minutes will be transmitted to all parties.
4. The Engineered Turf Installer will provide the CQA Consultant with a list of proposed seaming personnel and their experience records. This document will be reviewed by the CQA Consultant for compliance with material specifications and/or this CQA Plan. The Engineered Turf Installer Supervisor will provide a list of personnel present onsite each day the geomembrane installation crew is onsite.
5. Subgrade Preparation: The Engineered Turf Installer will document in writing that the surface on which that day's engineered turf will be installed meets the surface preparation requirements of the material specifications and/or this CQA Plan. The certificate of acceptance will be given to the CQA Consultant prior to commencement of engineered turf installation in the area under consideration. To facilitate a timely covering of the underlying surface, the CQA Consultant may allow subgrade acceptance in areas as small as one acre. After the supporting surface has been accepted by the Engineered Turf Installer, it will be the Engineered Turf Installer's responsibility to indicate to the CQA Consultant any change in the supporting subgrade condition that may require repair work. If the CQA Consultant concurs with the Engineered Turf Installer, then the CQA Consultant will notify the Contractor that the supporting subgrade is required to be repaired.
 - a. The CQA Consultant must visually inspect and approve the subgrade before the day's placement and before placement of each engineered turf panel. The subgrade surface must meet grades, consistency, and particle size limitations outlined in the material specifications and/or this CQA Plan. Report any non-conforming areas to the Contractor for repair.
 - b. Equipment proposed by the Engineered Turf Installer for installation of the engineered turf or anchoring systems must not rut or otherwise damage the subgrade. A test section using the actual materials and equipment proposed should be completed prior to production installation of the engineered turf.
6. The CQA Consultant will document that anchor trenches and other anchoring methods have been constructed and backfilled indicated or shown on the project drawings and material specifications and/or this CQA Plan.
7. Field Panel Identification: The CQA Consultant will document that the Engineered Turf Installer labels each field panel with an "identification code" (number or letter-number consistent with the layout plan) agreed upon by the Engineered Turf Installer and CQA Consultant at the Geosynthetics Pre-Construction Meeting and consistent with the approved Panel Layout Drawing.
 - a. The Engineered Turf Installer will establish a table or chart showing correspondence between roll or sheet numbers and field panel identification codes. This documentation

shall be submitted to the CQA Consultant weekly for review and verification. The field panel identification code will be used for all quality control and quality assurance records.

8. Field Panel Placement: The CQA Consultant will document that field panels are installed at the location indicated in the approved panel layout drawing. Where filaments of the engineered turf are directional, the filaments should be oriented in the direction specified. The CQA Consultant will record the identification code, location, and date of installation of each field panel.
 - a. The CQA Consultant will document that specification-related restrictions on placement of engineered turf are fulfilled. Additionally, the CQA Consultant will document that the supporting subgrade has not been damaged by weather conditions or the Engineered Turf Installer during placement activities.
 - b. The CQA Consultant will visually observe each panel, after placement and prior to seaming, for damage. The CQA Consultant will advise the Design Engineer and Engineered Turf Installer which panels, or portions of panels, should be rejected, repaired, or accepted. Damaged panels or portions of damaged panels which have been rejected will be marked and their removal from the work area recorded by the CQA Consultant. Repairs will be made according to procedures described in this Section.
 - c. The CQA Consultant will visually monitor each panel after placement, during and after seaming to observe and document that temporary anchorage, control of wrinkles in the panel, and backfilling of anchor trenches are completed by the Engineered Turf Installer in accordance with the material specifications and/or this CQA Plan.
9. As a minimum, the CQA Consultant will document that:
 - a. Anchor trenches and other anchorage methods are in place.
 - b. On slopes, the engineered turf is securely anchored in the anchor trench and then deployed down the slope in such a manner as to continually keep the geocomposites in tension.
 - c. The engineered turf is laid substantially smooth.
 - d. All panels are deployed from the top of the slope in a way that the engineered turf filaments are pointing upslope after deployment is complete.
 - e. The panel is placed in such a manner that it is unlikely to be damaged.
 - f. Any tears, punctures, holes, thin spots, etc. are either marked by the Engineered Turf Installer for repair or the panel is rejected.
 - g. Slack or wrinkles in the panel have been managed in accordance with the material specifications and/or this CQA Plan.
 - h. In the presence of wind, the engineered turf is weighted with sandbags or equivalent and that sandbags will remain until replaced with ballast material.
 - i. Trimming of the engineered turf is performed using only an upward cutting hook blade and special care is taken to protect other materials from damage which could be caused by the cutting of the engineered turf.
 - j. The Engineered Turf Installer is taking necessary precautions with the use of equipment to prevent damage to underlying layers during placement of the engineered turf.

- k. During placement of engineered turf, care is given not to entrap stones, or excessive dust.
- l. A visual examination of the engineered turf is completed over the entire surface, after installation, to verify that no potentially harmful foreign objects, (e.g., stones, sharp objects, small tools, etc.) are present.

9.9 Field Seaming

The Engineered Turf Installer will provide the CQA Consultant with a panel layout drawing (i.e., a drawing of the area to be lined showing all expected panels). The CQA Consultant will review the panel layout drawing and document that it is consistent with the accepted state of practice and this CQA Plan. In addition, no panels not specifically shown on the panel layout drawing may be used without the CQA Consultant's prior acceptance.

1. A seam numbering system compatible with the panel numbering system will be agreed upon at the geosynthetics pre-construction meeting. An on-going written record of the seams and repair areas shall be maintained by the Engineered Turf Installer with weekly review by the CQA Consultant.
2. Field seaming processes must comply with material specifications and/or this CQA Plan. Proposed alternate processes will be documented and submitted to the Design Engineer and CQA Consultant for their acceptance. Only seaming apparatuses which have been specifically accepted by make and model will be used. The CQA Consultant will submit all documentation to the Design Engineer for his concurrence.

Field Seam Control Testing: Each field seam, regardless of the size and type of seam, is to be tested using an approved nondestructive and destructive test method. Nondestructive seam testing is intended to cover the entire length of the seam and destructive seam testing is intended to examine representative portions of the selected seam for conformance. **Nondestructive seam tests to be completed on the deployed geomembrane component of the Final Cover System.**

1. Prior to the start of each shift during production seaming, the Engineered Turf Installer will complete trial seams on appropriate sized pieces of identical or equivalent geomembrane material to verify seams meet the minimum seam strength requirements listed in the material specifications and/or this CQA Plan and that seaming conditions and procedures are adequate. Trial seams should be made in the field adjacent to or in the work area.
2. Trial seams should be performed for each welder to be used and by each operator of extrusion welders, and by the primary operator of each fusion welder. Each trial seam should be assigned a number and the test results recorded in the appropriate log by the Engineered Turf Installer. The CQA Consultant will observe trial seams and complete trial seam logs.
3. The Engineered Turf Installer will test and document all seam welds continuously over their full length using one of the following nondestructive seam tests, or as outlined in the material specifications and/or this CQA Plan. This testing is performed simultaneously with engineered turf deployment as the work progresses and not at the completion of all field seaming.
4. The CQA Consultant will observe the nondestructive testing on a full time basis to document conformance with the material specifications and/or this CQA Plan. Observe the completed seams to identify areas where over-grinding or overheating of the Engineered Turf

geomembrane component have occurred. Such areas are to be repaired in accordance with the material specifications and/or this CQA Plan, and the Engineered Turf Installer will modify equipment or methods to eliminate these conditions.

5. The Engineered Turf Installer will obtain 12 inches by 36 inches (or longer as needed) samples of field seams with the seam centered lengthwise, suitable for testing, at an average frequency of one sample per 1,000 linear feet of weld, to verify the seams meet the minimum seam strength requirements as shown in the material specifications and/or this CQA Plan. The sample is to be cut into three equal-length pieces, one to be given to the Engineered Turf Installer for field destructive testing, one given to the CQA Consultant for laboratory destructive testing, and one given to the CQA Consultant as an archive sample. The date, time, equipment, seam number, and seaming parameters should be marked on each sample and recorded by the CQA Consultant.
6. All holes in the engineered turf resulting from destructive seam sampling will be immediately repaired in accordance with repair procedures described in the material specifications and/or this CQA Plan.
7. The laboratory destructive test samples will be packaged and shipped to the CQA Geosynthetics Laboratory by the CQA Consultant in a manner that will not damage the test sample.
8. The CQA Consultant will review laboratory test results as soon as they become available and transmit to the affected parties.
9. The CQA Consultant may require additional random samples to be taken for testing in areas which visually appear defective and not in accordance with the project requirements.
10. Field Seam Record Test Failure - For noncomplying tests, the CQA Consultant will:
 - a. Observe continuity testing of the repaired areas performed by the Engineered Turf Installer.
 - b. Confirm the record location, date, test unit number, name of tester, and compile the record of testing provided by the Engineered Turf Installer.
 - c. Conduct a walk-through inspection of all impacted seam areas and document that the areas have been tested in accordance the material specifications and/or this CQA Plan.
 - d. Document that the Engineered Turf Installer has marked repair areas.
 - e. All defective seam test failures must be bounded by acceptable destructive tests as directed by the CQA Consultant. The CQA Consultant will document repair actions taken in conjunction with any seam test failures.
11. Repairs and Verification: All repair procedures must be completed in accordance with the material specifications and/or this CQA Plan. The CQA Consultant will observe and document repair procedures.
 - a. Each repair is be numbered and logged by the Engineered Turf Installer and recorded by the CQA Consultant.

- b. Each repair will be non-destructively tested by the Engineered Turf Installer using the methods required by the material specifications and/or this CQA Plan. Repairs which pass non-destructive testing are considered to be an indication of an adequate repair.
 - c. A failed test indicates that the repair must be redone and retested until passing test results are achieved.
12. Engineered Turf Acceptance: The Engineered Turf Installer and the engineered turf manufacturer will retain all ownership and responsibility for the engineered turf until acceptance by the Owner. The engineered turf will be accepted for placement of overlying aggregate materials (where applicable) once the following conditions are met:
- a. Installation is completed.
 - b. Folds, wrinkles, or other surface conditions outside the criteria outlined in the material specifications and/or this CQA Plan are not observed.
 - c. Verification of the adequacy of all seams and repairs, including associated testing, is complete.
 - d. CQA Consultant provides the Design Engineer with a final copy of the nondestructive test documentation, repair information, and as-built drawings, as submitted by the Engineered Turf Installer.
 - e. CQA Consultant furnishes the Design Engineer with documentation, submitted by the Engineered Turf Installer that the engineered turf was installed in accordance with the engineered turf manufacturer's recommendations as well as the project drawings and material specifications and/or this CQA Plan.
 - f. The CQA Consultant will document that the installation has proceeded in accordance with this CQA Plan and the material specifications and/or this CQA Plan for the project except as noted to the Design Engineer.
13. Materials in Contact with Engineered Turf: The quality assurance procedures indicated in this paragraph are only intended to monitor that the installation of these materials does not damage the engineered turf, that reasonable measures are taken to protect the engineered turf, and to provide additional quality assurance procedures as necessary to monitor that systems built with these materials will be constructed to achieve proper performance.
- a. Placement of soil or aggregate materials over the engineered turf may be required for access roadways, etc. Prior to placement of overlying soils, the CQA Consultant will visually confirm that soil materials to be placed against the Engineered Turf comply with material specifications and/or this CQA Plan. The Engineered Turf Installer will provide the CQA Consultant a written surface acceptance certificate in accordance with the material specifications and/or this CQA Plan. All soil materials are to be placed and compacted in accordance with material specifications and/or this CQA Plan.
 - b. The CQA Consultant will document that Installation of the engineered turf in appurtenance areas, and connection of the engineered turf to appurtenances have been made according to the material specifications and/or this CQA Plan, and the engineered turf or appurtenances have not been visibly damaged while making connections.
14. CQA Consultant Responsibilities During Fusion Seaming:

- a. Verify the fusion seaming device is a DemTech VM20/4/A fusion welder or a manufacturer-approved equivalent.
 - b. There is a minimum of 5 inches of overlap between seams.
 - c. Frayed or loose turf strands are cut off or removed.
 - d. Prior to starting the production fusion seaming, trial seams are to be performed.
 - e. Mechanical or hot knife trimming and cutting devices are to be utilized for salvage trimming.
 - f. Defects are should be repaired in accordance with material specifications.
15. CQA Consultant Responsibilities During Sewn Seaming:
- a. A single stitch prayer type seam is to be constructed using an American Newlong sewing machine or a manufacturer-approved equivalent.
 - b. The thread should be Polyester or equivalent.
 - c. Sewing should occur between the 1st and 2nd row of tufts from the edges of the two turf panels being joined.

9.10 Defects and Repairs

The CQA Consultant will monitor, verify, and document that engineered turf defects are addressed and repairs are made in accordance with the Construction Documents, and that the following requirements are met:

1. Repairs are completed by using a heat-bonded seam.
2. All tie-in seams along flatter slopes (i.e., 15 percent or less) with lengths greater than 25 feet use an approved heat bonded seam so a consistent pressure is achieved throughout the seam.
3. A hand-held heat gun with a pressure wheel is used in smaller/concentrated areas.

The Installer may also demonstrate alternative techniques and practices for the Manufacturer's approval. A field demonstration and approval by the CQA Consultant, Design Engineer, and Owner is required before incorporating any alternative techniques.

9.11 Equipment on Engineered Turf

The procedures outlined in this Section are intended to allow the CQA Consultant to verify that the installation of materials in contact with the engineered turf do not cause damage to it. The CQA Consultant will monitor, verify, and document that the following requirements are met:

1. No equipment is allowed until the sand infill is in place on slopes exceeding 15 percent.
2. ATV-type vehicles are allowed prior to sand infill placement if the tire/track pressure is less than 5 psi on slopes less than 15 percent.
3. Once the full specified sand infill thickness is in place, drivability tire/track pressure are limited to less than 35 psi.

9.12 Ballast Sand Installation over Engineered Turf

The CQA Consultant will monitor, verify, and document that the sand infill placement over engineered turf is made in accordance with the Construction Documents and the following requirements are met:

1. Ballast sand may be required as part of the engineered turf system to anchor the geosynthetic components.
2. Review the material specifications and/or this CQA Plan for ballast requirements in Appendix G.
3. Review the sand and installation data provided by the engineered turf Installer for conformance with the material specifications and/or this CQA Plan.
4. If a test section using the proposed materials and equipment for ballast installation is required, the test section must be completed by the Engineered Turf Installer and approved by the CQA Consultant prior to the start of production installation. Identify limits on equipment access.
5. Sand infill is to be placed between a minimum of 1/2-inches-thick and a maximum of 3/4-inches-thick.
6. Sand infill consists wholly of sand meeting ASTM C 33-03 for fine aggregates.
7. Installation of sand infill is only to be performed by a manufacturer's licensed and approved installer.
8. Sand infill is to be worked into the engineered turf between the synthetic tuft blades.
9. Conveyor systems, spreaders, or blowers that meet the requirements outlined in this CQA Plan and/or approved by the engineered turf manufacturer may be used to spread and place sand infill.
10. Previously installed engineered turf is not to be displaced or damaged as a result of the sand infill component installation.
11. Sand infill placement should not occur with snow or ice on the engineered turf component.
12. The method for measuring the sand infill thickness is to be performed utilizing a digital caliper, or a Owner-approved alternate measuring device.
13. Final thickness checks of sand infill are to be made at a minimum frequency of 20 tests per acre in coordination with the CQA Consultant.

9.13 Alternative Infill – Cementitious Binder

The cementitious binder infill layer may be placed using any appropriate equipment capable of completing the work without damage to the engineered turf. Manual hand spreading is acceptable when equipment use or access isn't practical. The CQA Consultant will monitor, verify, and document that the cementitious binder infill layer is placed in accordance with the Construction Documents and confirm that the following requirements are met:

1. Installation of cementitious binder infill layer is only to be performed by a manufacturer's licensed and approved installer.
2. The cementitious binder is to be placed into the engineered turf while it is in a dry state.
3. The cementitious binder is to be worked into the tuft blades so the tufts are in an upright position.
4. The cementitious binder infill layer is to be placed between a minimum of 3/4-inches-thick and a maximum 1-inch-thick.
5. The cementitious binder thickness is to be checked using a digital caliper, or a Owner-approved alternate measuring device.
6. Final thickness checks of the dry cementitious binder are made at a frequency of twenty tests per acre.
7. The desired cementitious binder thickness is to be achieved and confirmed by the CQA Consultant prior to the hydration process.
8. Engineered turf tufts are to be free and upright before hydration process begins.
9. The hydration process must occur the same day as the cementitious binder infill layer placement.
10. Checks are to be made to assure cementitious binder is hydrated thoroughly through the full thickness, without causing excessive runoff using the following methods in coordination with the CQA Consultant:
 - a. Hydration checks are to be made with a probe at a minimum frequency of 1 test per 100 square feet.
 - b. Checks are to be made for full hydration by tapping on hydrated surface forcing water to be visually seen pooling at the surface.
 - c. After 24 hours, checks are to be made on the completed cementitious binder to ensure the hardening process is taking place.

9.14 Alternative Infill – Armored Fill Polymer Emulsion

The CQA Consultant will monitor, verify, and document that the armored fill is prepared and placed in accordance with the Construction Documents and the following requirements are met:

1. Installation of armored fill is only to be performed by a manufacturer's licensed and approved installer.
2. Armored fill and water mix ratio by logging volume mixed of each component is to be documented.
3. Armored fill is to be verified to have fully saturated the sand by inserting a probe and displacing a 1 square inch area of sand.

4. Saturation checks are to be made at a frequency of twenty per acre.
5. Unnecessary foot traffic on the applied product is to be avoided for 48 hours.
6. No vehicle traffic is to be allowed on the applied product for 7 calendar days.

10 PROTECTIVE COVER SOIL

10.1 General

1. This Section of the CQA Plan addresses placement, spreading, and (nominal) compaction of the Protective Cover soil for the Alternative Final Cover System and outlines the soils CQA program to be implemented with regard to material acceptance, subgrade acceptance, field control and record tests, and resolution of problems.
2. The CQA Consultant or his representative will observe and document all grading activities and test the placement of materials used for the protective soil cover. The CQA Consultant is responsible for certifying that the materials and construction were in accordance with the plans, specifications, and this CQA Plan. The CQA Consultant will verify that the Protective Cover is placed in accordance with the approved material specifications, project drawings, and/or this CQA Plan.
3. Protective cover soil should only be placed over geosynthetic barrier or drainage layers after placement these layers have been approved by the CQA Consultant and accepted by the Owner.

10.2 Material Acceptance

1. All material to be used as protective cover will be required to be accepted in advance by the CQA Consultant. Acceptance is based upon successful completion of the CQA control testing outlined below. Such testing can be performed either during excavation and stockpiling or from onsite or off-site stockpiles prior to use.
2. Material Control Tests: Acceptance of materials used for protective cover soil is outlined in the material specifications and/or this CQA Plan. In general, protective cover soil does not have a specified hydraulic conductivity requirement. Maximum particle size and other criteria will be listed in the material specifications and/or this CQA Plan.
 - a. Nominal compaction is generally all that is required for protective cover soil. For this reason, moisture-density relationship (i.e. Proctor) and in-place density testing are usually not included in CQA conformance testing for the protective cover soil placement.
3. Topsoil may be specified and be considered as a separate layer of the protective cover. Do not mix topsoil and protective cover soil in stockpiles or during placement.
4. For protective cover soil originating from onsite borrow areas, the soil will need to be examined during excavation activities and prior to placement into stockpiles. Unsuitable material will be rejected or routed to separate stockpiles consistent with its end use. Appropriate entries shall be made in the daily log, and the identification and stockpiling of unsuitable soil should be coordinated with the CQA Consultant.
5. For protective cover soil originating from off-site borrow areas, soil will be examined after delivery and placement at onsite stockpile(s). Any unsuitable material found will be rejected or routed to separate stockpiles consistent with its end use. Appropriate entries shall be made in the daily log, and the identification and stockpiling of unsuitable soil should be coordinated with the CQA Consultant.

6. During excavation and stockpiling operations, control tests, as listed below and specified in the material specifications and/or this CQA Plan, will be performed by the CQA Consultant prior to placement.
 - a. Visual Classification, ASTM D 2488.
 - b. Grain Size (sieves only), ASTM D 422.
 - c. Atterberg Limits, ASTM D 4318.

10.3 Protective Cover Subgrade

1. During construction, close, continuous visual monitoring of the geosynthetic subgrade is performed by the CQA Consultant. Protective cover soil cannot be placed on areas where the geomembrane is damaged, or if excessive wrinkles develop in any of the geosynthetics during placement.
2. The CQA Consultant will review the equipment proposed by the Contractor to place and spread the protective cover soil. Low ground pressure (LGP) equipment is generally specified, but the material specifications and/or this CQA Plan should be reviewed. A test section for the Contractor to demonstrate placement equipment and methods may be required by the CQA Consultant or Owner.
3. The CQA Consultant will review the equipment and haul path locations and geometry proposed by the Contractor to transport the protective cover soil along the final cover area.
4. During placement of the protective cover soil, monitor for the presence of oversized particles, debris, and other unsuitable material. If observed, the CQA Consultant will contact the Contractor and have unsuitable materials removed. If any damage to any of the underlying geosynthetics is suspected or observed, these materials must be inspected immediately and any repairs completed in accordance with the material specifications and/or this CQA Plan and the repairs documented, including surveying the location.
5. The CQA Consultant will monitor the thickness of the protective cover soil (and overlying vegetative soil layer where applicable). Visually monitor the protective cover soil thickness using hand excavation, telltales (e.g. blunt tip probe rod), or survey methods on a regular basis. The top of the protective cover soil is to be verified by the Contractor using the specified survey methods. The CQA Consultant will review the protective soil cover survey data to verify the specified minimum thickness is achieved.

11 CONCRETE

11.1 General

The CQA Consultant will monitor the Contractor's placement of all concrete and related construction activities/workmanship and materials and the finished products to verify compliance with the Construction Documents.

11.2 Inspections

The CQA Consultant will monitor concrete workmanship to verify that the Contractor does not place concrete until subgrades or foundations, forms, reinforcing steel, pipes, conduits, sleeves, anchors, hangers, inserts, and other work required to be built into concrete has been inspected and approved by the CQA Consultant and Construction Manager.

11.3 Field Testing and Verification

Testing to evaluate the conformance of fresh concrete and performance of as-placed concrete will be performed by the CQA Consultant in accordance with current ASTM or other applicable test procedures. The concrete testing requirements are outlined within the Construction Documents and specifications.

The CQA Consultant may conduct additional performance testing if deemed necessary by the Owner and/or Certifying Engineer. Any nonconformances will be reported to the Contractor and Construction Manager.

12 HDPE PIPES AND FITTINGS

12.1 General

The CQA Consultant will review the MQC documentation and will monitor the installation of HDPE pipes and fittings to verify that the manufacturer's and material specifications and the requirements of the Construction Documents and this CQA Plan are met.

12.2 Butt-Fusion Welding Process

The CQA Consultant will monitor the assembling of lengths of HDPE pipe into suitable installation lengths by the butt-fusion welding process. Butt-fusion welding is the butt-joining of the pipe by heat-softening the aligned faces of the pipe ends in a suitable apparatus and pressing them together under controlled pressure. The CQA Consultant will monitor that butt-fusion welding of the HDPE pipes and fittings is performed by the Contractor in accordance with the Construction Documents and pipe manufacturer's recommendations as to equipment and technique.

12.3 Transportation, Handling, and Storage

The CQA Consultant will monitor:

1. The off-loading of the pipes to verify that handling is to be done in a competent manner and that the pipes are stored in a proper location and not placed in areas where water, sediment, or debris can accumulate.
2. The pipes are not to be stacked more than three layers high or in such a manner that could cause damage to the pipe.
3. For outdoor storage periods longer than 12 months, a temporary covering is to be placed over the pipes, or they are to be moved to within an enclosed facility.

12.4 Installation

The CQA Consultant will monitor that pipes are installed in accordance with the Construction Documents, including:

1. Care is to be taken during installation of the pipes to ensure pipes are not cut, kinked, or otherwise damaged.
2. Ropes, fabric, or rubber-protected slings and straps are to be used by the Contractor when lifting or installing pipes. Chains, cables, or hooks inserted into the pipe are not to be used for this purpose.
3. The Contractor is to install pipe and fittings in such a manner that the materials are not damaged.
4. Slings for handling the pipe are not to be positioned at butt-fused joints of HDPE pipes.
5. Sections of the pipes with deep cuts and/or gouges are to be removed and the ends of the pipeline re-joined.

6. Care is to be taken when lowering pipe into trenches to prevent damage or twisting of the pipe.

12.5 Testing

The CQA Consultant will perform the testing of all pipes as required by the Construction Documents and as necessary to verify that workmanship conforms to the material specification and/or this CQA Plan and to the manufacturer' specifications and the state-of-practice.

13 ROAD CONSTRUCTION

13.1 General

The CQA Consultant will review the supplier documentation and will monitor construction of all permanent roads to verify that the materials used in the construction of roads and the completed roadways are in conformance with the requirements of the Construction Documents and Section 5 of the CQA Plan.

13.2 Subgrade Preparation

The CQA Consultant will monitor that road subgrade is prepared in accordance with requirements in the Construction Documents and Section 5 of the CQA Plan.

13.3 Geotextile Separator

The CQA Consultant will review the relevant geotextile submittal(s) to confirm that the specified geotextile properties are met. The CQA Consultant will monitor that the geotextile separator is installed in accordance with requirements of the Construction Documents and Section 6: Geotextiles of this CQA Plan. The CQA Consultant will provide CQA relative to the geotextile separator in accordance with Section 6: Geotextiles of the CQA Plan.

13.4 Base Aggregate Layer

The CQA Consultant will monitor the base aggregate to verify it is constructed to the thickness, grades, and limits shown on Construction Documents. The CQA Consultant will confirm that base aggregate material is certified by the supplier to meet the requirements of the material type shown on Construction Documents. The CQA Consultant will provide CQA relative to the base aggregate layer in accordance with Section 3: Earthwork and Grading of the CQA Plan.

13.5 Repairs

If a defective area of road is discovered during construction, the CQA Consultant will evaluate the extent and nature of the defect. After this evaluation, the CQA Consultant will observe that the Contractor corrects the deficiency to the satisfaction of the Construction Manager and does not perform additional work in the area until the Construction Manager approves the correction of the defect. In the event of damage, the CQA Consultant will observe the repairs and replacements made by the Contractor, as necessary, to the satisfaction of the Construction Manager.

14 GENERAL SITE WORK

14.1 General

The CQA Consultant will monitor the activities that are to be performed for various general site work items including, but not limited to all grading and civil/earthwork, installation of erosion and sediment control measures, roads, pavements, and guard rails, prefabricated elements, culverts and associated headwalls and culvert end retaining structures, prefabricated and cast- or constructed-in-place structures, outfall weirs, pipes, vegetative cover, topsoil, and vegetation for compliance with the Construction Documents.

In addition, the CQA Consultant will verify that materials used are in accordance with the Construction Documents and are installed in accordance with manufacturer's recommendations.

14.2 Conformance

Conformance of materials and construction techniques to verify compliance with the Construction Documents will be confirmed by the CQA Consultant. If non-conformances or other deficiencies are found by the CQA Consultant in the materials or completed work, they will be reported to the Contractor and Construction Manager. The CQA Consultant will observe the repairs or replacements of any non-conforming items. Repair of non-conformance items may require involvement and approval of the Design Engineer.

15 CQA RECORD DOCUMENTATION

15.1 Documentation

1. An effective CQA Plan depends largely on recognition of construction activities that should be monitored and on assigning responsibilities for the monitoring of each activity. This is most effectively accomplished and verified by the documentation of quality assurance activities. The CQA Consultant and CQA Consultant technicians or onsite field representatives will document that quality monitoring requirements have been addressed and satisfied, and the documentation is included in the project records.
2. The CQA Consultant will provide the Owner and Design Engineer with their daily field and weekly and monthly progress reports including signed descriptive remarks/sketches, datasheets, and logs and photographs to document that required CQA activities have been completed and any non-discrepancies properly documented and resolved. These reports will also identify potential quality assurance problems. The CQA Consultant will also maintain at the job site a complete file of project drawings including addendums, reports, material specifications and/or this CQA Plan, accepted shop drawings, this CQA Plan, checklists, test procedures, daily logs and photographs, and other pertinent documents.

15.2 Daily CQA Reports

1. The CQA Consultant 's reporting procedures will include preparations of a daily report by each CQA field representative which, at a minimum, will include the following information, where applicable:
 - a. A unique identifying sheet number for cross referencing and document control.
 - b. Date, project name, location, and other identification.
 - c. Data on weather conditions.
 - d. A reduced-scale site plan (taken from the project drawings) showing work areas and test locations.
 - e. Descriptions and locations of on-going construction.
 - f. Descriptions and specific locations of areas, or units, of work being tested and/or observed and documented.
 - g. Locations where tests and samples were taken.
 - h. A summary of test results.
 - i. Calibrations or recalibrations of test equipment, and actions taken as a result of recalibration.
 - j. Off-site materials received, including quality verification documentation.
 - k. Decisions made regarding acceptance of units of work, and/or corrective actions to be taken in instances of substandard quality.
 - l. Summaries of pertinent discussions with the Contractor and/or other parties involved.
 - m. Logged data and photographs, as applicable.
 - n. The CQA Consultant's signature.

2. The daily report must be completed at the end of each CQA Consultant field representative's shift, prior to leaving the site. This information will be submitted weekly to and reviewed by the Owner and Design Engineer.

15.3 CQA Progress Reports

1. The CQA Consultant will prepare a summary progress report at time intervals established at the pre-construction meeting (likely weekly and monthly). At a minimum, the progress reports will include the following information, where applicable:
 - a. A unique identifying sheet number for cross-referencing and document control.
 - b. The date, project name, location, and other information.
 - c. A summary of work activities during the progress reporting period.
 - d. A summary of construction situations, deficiencies, and/or defects occurring during the progress reporting period and resolutions to minor deficiencies.
 - e. Summary of test results, failures, and retests.
 - f. Signature of the CQA Consultant.
2. The CQA Consultant's progress reports must summarize the major events that occurred during the reporting period. Critical problems that occur shall be communicated verbally to the Design Engineer immediately as well as being included in the progress reports. The CQA Consultant's progress reports must be submitted to the Owner and Design Engineer at the time periods established at the pre-construction meeting, unless some other time schedule is directed by the Owner.

15.4 CQA Photographic Reporting

1. Photographs shall be taken by the CQA Consultant at regular intervals during the construction process and in areas deemed critical by the CQA Consultant or at the request of the Owner and/or Design Engineer.
2. These photographs will serve as a visual record of work progress, problems, and mitigation activities. These records will be provided to the Owner and Design Engineer as requested throughout construction, and the complete photographic records should be provided upon completion of the project.
3. As an alternative to still-photographic documentation, videotaping may be used to record work progress, problems, and mitigation activities. The Owner or DESIGN ENGINEER may require that a portion of the documentation be recorded by photographic means in conjunction with videotaping.

15.5 Deficiencies

The Owner and Design Engineer must be made aware of non-conformance with the requirements of this CQA Plan. The Design Engineer will then determine the cause of the non-conformance and recommend appropriate changes in procedures or specifications. When this type of evaluation is made, the results will be documented, and any revision to procedures or CQA Plan must be accepted by both the Owner and Design Engineer.

15.6 Design and/or Project Technical Specification Changes

Design and/or material specifications or CQA Plan changes may be required during construction. In such cases, the CQA Consultant will notify the Design Engineer. The Design Engineer will then determine the need for addenda or field clarification and notify the Owner, who then can notify the appropriate agency, if necessary.

15.7 Final Record Documentation Report

1. At the completion of construction, the CQA Consultant will provide documentation on required forms, observation logs, field and laboratory testing datasheets including sample location plans necessary for the CQA Consultant to assemble a final record documentation report which is to be sealed by Certifying Engineer who must be registered in the state of Georgia). This sealed record documentation report will document that the work has been performed as indicated or shown on the project drawings, and that the supporting documents provide the necessary information required by the Owner.
2. The CQA Consultant will also provide summaries of the data listed above for preparation of the report. The Record Drawings will include scale project drawings depicting the location of the construction and details pertaining to the extent of construction (e.g., depths, plan dimensions, elevations, soil component thicknesses, etc.).
3. All surveying and base maps required for development of the Record Drawings will be completed by the Contractor's construction surveyor. These documents will be required to be certified by the Contractor and delivered to the CQA Consultant and included as part of the final record documentation report.
4. At a minimum, all applicable testing items shown in the Appendices shall be included in the final record documentation report.

15.8 Record Documentation

The CQA Consultant will provide a final CQA Certification Report certifying that the Ash Pond 1, access roads, ditches, sediment basins, and other associated ancillary facilities for the project have been constructed as indicated or shown on the project drawings, specifications, and in accordance with this CQA Plan. The final construction certification report shall be completed in accordance with the approved CCR Closure Permit and the Rules. The certification shall have the CQA Consultant's seal as a professional engineer registered in the State of Georgia.

15.9 Storage of Records

Handwritten datasheet originals, especially those containing signatures, will be stored by the CQA Consultant in a safe repository onsite. Other reports may be stored by any standard method which will allow for easy access. All written documents will become property of the Owner at the completion of construction.

TABLE 15.9.1 - RECORD DOCUMENTATION REPORT GENERAL OUTLINE

- 1.0 Introduction
- 2.0 Project Description
- 3.0 CQA Program
 - 3.1 Scope of Services
 - 3.2 Personnel
 - 3.3 Summary of Deficiencies / Variances from Approved Plans and Specifications
- 4.0 Earthwork / Compacted Soil Barrier
- 5.0 Geosynthetic Barrier / Cap Geomembrane
- 7.0 Geocomposite Drainage Layer
- 8.0 Protective Cover Soil
- 9.0 Summary and Conclusions

APPENDIX A

MATERIAL PROPERTIES AND ACCEPTANCE CRITERIA FOR EARTHWORK

TABLE A.1: MATERIAL PROPERTIES AND ACCEPTANCE CRITERIA FOR SOIL FILL MATERIALS

SYSTEM COMPONENT	REQUIRED TEST / ACTIVITY	TEST METHOD	MINIMUM CQA FREQUENCY	ACCEPTANCE CRITERIA
Soil Fill Materials Conformance Testing¹	Visual Observation	Visual	As required (continuous during placement)	Substantially free of debris, large rocks, plant materials, or other deleterious material
	Particle Size Analysis	ASTM D 422	1 per source & 1 per 5,000 cubic yards	3.0 inch maximum particle size Analysis to include hydrometer
	Atterberg Limits	ASTM D 4318	1 per source & 1 per 5,000 cubic yards	Required to determine USCS soil classification
	Soil Classification	ASTM D 2487	1 per source & 1 per 5,000 cubic yards	SC, SP, SM, CL, CH, CL-ML, ML, GC, GP, or other Design Engineer approved classifications
	Moisture Content	ASTM D 2216	1 per source & 1 per 5,000 cubic yards	Determine if adequate moisture is present prior to compaction
	Standard Proctor	ASTM D 698	1 per source & 1 per 20,000 cubic yards	Determine optimum moisture and density requirements for each material. Verify material meets project minimum requirements for compaction
Soil Fill Materials Performance Testing²	Visual Observation	Visual	Continuous	Final surface is firm, smooth, and uniform No protrusions greater than 0.5 inch at final surfaces that will receive geomembrane or other geosynthetic materials (geotextile, geocomposite, etc.)
	Lift Depth Check	Manual	Each lift, as required	6 to 8-inches compacted lift (8 to 10 inches loose lift)
	Nuclear Densometer In-Place Density and Moisture Content	ASTM D 6938	1 per 10,000 square feet per lift, or 1 test per 200 feet per lift for linear features	≥95% Standard Proctor Maximum dry density and within specified (optimum) moisture content range
	Moisture Content	ASTM D 2216	1 per 25 nuclear densometer tests	Check nuclear densometer measurements to verify moisture correction
	Sand Cone Density or Drive Tube Sample	ASTM D 1556 ASTM D 2937	1 per 25 nuclear densometer tests	Check nuclear densometer measurements to verify moisture correction and density

Table Notes: (1) – Conformance testing is performed on borrow sources prior to placement of material to verify the minimum required values are met and the material remains consistent.
(2) – Performance testing is performed on materials after placement to complete to verify that the lift or layer meets design requirements.
(3) – The Contractor and the Contractor’s CQC Consultant may conduct conformance and performance tests to verify Technical Specifications are met. The CQA test results will govern whether or not materials are in compliance with the project documents.

TABLE A.2: MATERIAL PROPERTIES AND ACCEPTANCE CRITERIA FOR PROTECTIVE SOIL COMPONENT OF ALTERNATIVE FINAL SYSTEM

SYSTEM COMPONENT	REQUIRED TEST / ACTIVITY	TEST METHOD	MINIMUM CQA FREQUENCY	ACCEPTANCE CRITERIA
Protective Soil Layer Conformance Testing ¹	Visual Observation	Visual	As required (continuous during placement)	Substantially free of debris, large rocks, plant materials, or other deleterious material
	Particle Size Analysis	ASTM D 422	1 per source & 1 per 10,000 cubic yards	1.0 inch maximum particle size Analysis to include hydrometer
	Atterberg Limits	ASTM D 4318	1 per source & 1 per 10,000 cubic yards	Required to determine USCS soil classification
	Soil Classification	ASTM D 2487	1 per source & 1 per 10,000 cubic yards	CL, CH, CL-ML, ML,SC, SM, or other Design Engineer approved classifications
	Moisture Content	ASTM D 2216	1 per source & 1 per 10,000 cubic yards	Determine if adequate moisture is present prior to compaction
	Standard Proctor	ASTM D 698	1 per source & 1 per 20,000 cubic yards	Determine optimum moisture and density requirements for each material. Verify material meets project minimum requirements for compaction
Protective Soil Layer Performance Testing ²	Visual Observation	Visual	Continuous	Final surface is firm, smooth, and uniform
	Lift Depth Check	Manual	Each lift, as required	First lift is 12-inches Subsequent lifts at 6 to 8-inches compacted (8 to 10 inches loose lift)
	Nuclear Densometer In-Place Density and Moisture Content	ASTM D 6938	1 per 10,000 square feet per lift, or 1 test per 200 feet per lift for linear features	≥90% Standard Proctor Maximum dry density and within specified (optimum) moisture content range
	Moisture Content	ASTM D 2216	1 per 25 nuclear densometer tests	Check nuclear densometer measurements to verify moisture correction
	Sand Cone Density or Drive Tube Sample	ASTM D 1556 ASTM D 2937	1 per 25 nuclear densometer tests	Check nuclear densometer measurements to verify moisture correction and density

Table Notes:

- (1) – Conformance testing is performed on borrow sources prior to placement of material to verify the minimum required values are met and the material remains consistent.
- (2) – Performance testing is performed on materials after placement to complete to verify that the lift or layer meets design requirements.
- (3) – The Contractor and the Contractor’s CQC Consultant may conduct conformance and performance tests to verify Technical Specifications are met. The CQA test results will govern whether or not materials are in compliance with the project documents.

TABLE A.3: MATERIAL PROPERTIES AND ACCEPTANCE CRITERIA FOR VEGETATIVE COVER COMPONENT OF ALTERNATIVE FINAL SYSTEM

SYSTEM COMPONENT	REQUIRED TEST / ACTIVITY	TEST METHOD	MINIMUM CQA FREQUENCY	ACCEPTANCE CRITERIA
Vegetative Cover Layer Conformance Testing¹	Visual Observation	Visual	As required (continuous during placement)	Substantially free of debris, large rocks, plant materials, or other deleterious material
	Particle Size Analysis	ASTM D 422	1 per source & 1 per 10,000 cubic yards	3.0 inch maximum particle size Analysis to include hydrometer
	Atterberg Limits	ASTM D 4318	1 per source & 1 per 10,000 cubic yards	Required to determine USCS soil classification
	Soil Classification	ASTM D 2487	1 per source & 1 per 10,000 cubic yards	CL, CH, CL-ML, ML,SC, SM, or other Design Engineer approved classifications
	Moisture Content	ASTM D 2216	1 per source & 1 per 10,000 cubic yards	Determine if adequate moisture is present prior to compaction
	Standard Proctor	ASTM D 698	1 per source & 1 per 20,000 cubic yards	Determine optimum moisture and density requirements for each material. Verify material meets project minimum requirements for compaction
	Organic Content	ASTM D 2974	1 per source & 1 per 10,000 cubic yards	Determine organic content for each material. Verify material meets project minimum requirements to establish vegetation
Vegetative Cover Layer Performance Testing²	Visual Observation	Visual	Continuous	Substantially free of debris, large rocks, and deleterious materials. Shall not rut or pump excessively. Final surface is firm, smooth, and uniform.
	Lift Depth Check	Manual	Each lift, as required	6 inches
	Moisture Content	ASTM D 2216	1 per 25 nuclear densometer tests	Check nuclear densometer measurements to verify moisture correction

Table Notes:

- (1) – Conformance testing is performed on borrow sources prior to placement of material to verify the minimum required values are met and the material remains consistent.
- (2) – Performance testing is performed on materials after placement to complete to verify that the lift or layer meets design requirements.
- (3) – The Contractor and the Contractor’s CQC Consultant may conduct conformance and performance tests to verify Technical Specifications are met. The CQA test results will govern whether or not materials are in compliance with the project documents.

APPENDIX B

ACCEPTANCE CRITERIA FOR CCR REMOVAL AND PLACEMENT

TABLE B.1: ACCEPTANCE CRITERIA FOR CCR REMOVAL VIA EXCAVATION

ITEM	REQUIRED TEST / ACTIVITY	TEST METHOD	MINIMUM CQA FREQUENCY	ACCEPTANCE CRITERIA
CCR Removal	Verification/Documentation of excavation to bottom of CCR materials	Visual Topographic Survey	As required and continuous during CCR removal	When excavation of CCR materials is completed ¹
	Verification/documentation of excavation of 6-inch over-excavation beyond CCR Material bottom	Visual Topographic Survey	As required during excavation and once excavation is completed	When excavation is completed ^{1,2}

Table Notes: (1) – Documentation includes a photograph, a description of the material using the Unified Soil Classification System (ASTM D 2488) and a determination of the color of the material based on the Munsell Color Chart for every 100-foot by 100-foot project grid. .
 (2) – Documentation includes a verification that at least 6-inches of soils beneath the CCR materials have been removed by comparing data provided by the Surveyor for every 100-foot by 100-foot project grid.

TABLE B.2: MATERIAL ACCEPTANCE CRITERIA FOR CCR MATERIAL STACKING AND PLACEMENT

SYSTEM COMPONENT	REQUIRED TEST / ACTIVITY	TEST METHOD	MINIMUM CQA FREQUENCY	ACCEPTANCE CRITERIA
CCR Materials Conformance Testing ¹	Visual Observation	Visual	As required (continuous during placement)	Substantially free of debris, large rocks or cemented boulders, plant and organic materials (non-CCR or coal components), or other deleterious material
	Particle Size Analysis	ASTM D 422	1 per source & 1 per 50,000 cubic yards	3.0 inch maximum particle size Analysis to include hydrometer
	Moisture Content	ASTM D 2216	1 per source & 1 per 50,000 cubic yards	Determine if adequate moisture is present prior to compaction
	Standard Proctor	ASTM D 698	1 per source & 1 per 100,000 cubic yards	Determine optimum moisture and density requirements for each material. Verify material meets project minimum requirements for compaction
CCR Materials Performance Testing ²	Visual Observation	Visual	Continuous	Substantially free of debris, large rocks, and deleterious materials. Shall not rut or pump excessively. Final surface is firm, smooth, and uniform.
	Lift Depth Check	Manual	Each lift, as required	6 to 8-inches compacted lift (8 to 10 inches loose lift)
	Nuclear Densometer In-Place Density and Moisture Content	ASTM D 6938	1 per 40,000 square feet per lift	≥90% Standard Proctor Maximum dry density and within specified (optimum) moisture content range
	Moisture Content	ASTM D 2216	1 per 10 nuclear densometer tests	Check nuclear densometer measurements to verify moisture correction
	Sand Cone Density or Drive Tube Sample	ASTM D 1556 ASTM D 2937	1 per 10 nuclear densometer tests	Check nuclear densometer measurements to verify moisture correction and density

Table Notes:

- (1) – Conformance testing is performed on CCR borrow sources prior to placement of material to verify the minimum required values are met and the material remains consistent.
- (2) – Performance testing is performed on materials after placement to complete to verify that the lift or layer meets design requirements.
- (3) – The Contractor and the Contractor’s CQC Consultant may conduct conformance and performance tests to verify Technical Specifications are met. The CQA test results will govern whether or not materials are in compliance with the project documents.

APPENDIX C

MATERIAL PROPERTIES AND ACCEPTANCE CRITERIA FOR GEOMEMBRANES AND SEAMS

TABLE C.1: MATERIAL PHYSICAL PROPERTIES AND MANUFACTURER QUALITY CONTROL REQUIREMENTS FOR 40-MIL LLDPE TEXTURED GEOMEMBRANE

PROPERTIES	Subject	MQC Test Frequency	CQA Test Frequency	Units	Test Method	ACCEPTANCE CRITERIA
Physical Properties	Thickness	Every Roll	100,000 square feet	mils	ASTM D 5994	38 mils (min average) 36 mils (lowest individual reading for 8 out of 10) 34 mils (lowest individual reading for any of 10)
	Asperity Height	Every second roll	100,000 square feet	mils	ASTM D 7466	16 mils (min. average) on top and bottom
	Sheet Density and Resin Specific Gravity	1 per 200,000 lbs	100,000 square feet	g/cm ³	ASTM 1505 ASTM D792	0.939 (max.)
	Carbon Black Content	1 per 20,000 lbs	100,000 square feet	%	ASTM D 4218 ASTM D 1603	2.0 – 3.0 (range)
	Carbon Black Dispersion	1 per 45,000 lbs	100,000 square feet	None	ASTM D 5596	9 out of 10 in Category 1 or 2 ⁽²⁾
	Resin – Melt Flow Index	1 per 200,000 lbs	100,000 square feet	g/10 min.	ASTM D 1238	≤ 1.0

Table Notes: (1) – Definitions: % = percent ; g = grams; g/cm³ = grams per cubic centimeter; lb = pound; lb/in = pounds per inch; mils = millimeters
(2) – Carbon dispersion for 10 different views. One view allowed in Category 3.

TABLE C.2: MATERIAL TENSILE PROPERTIES AND MANUFACTURER QUALITY CONTROL REQUIREMENTS FOR 40-MIL LLDPE TEXTURED GEOMEMBRANE

PROPERTIES	Subject	MQC Test Frequency	CQA Test Frequency	Units	Test Method	ACCEPTANCE CRITERIA
Tensile Properties (each direction)	Tensile Strength at Break	1 per 20,000 lbs	100,000 square feet	lb/in	ASTM D 6693 Type IV	60 (minimum average)
	Elongation at Break	1 per 20,000 lbs	100,000 square feet	%	ASTM D 6693 Type IV	250 (minimum average)
	Tear Resistance	1 per 45,000 lbs	100,000 square feet	lb	ASTM D 1004	22 (minimum average)
	Puncture Resistance	1 per 45,000 lbs	100,000 square feet	lb	ASTM D 4833	44 (minimum average)
	Oxidative Induction Time (OIT) Standard OIT or High Pressure OIT	1 per 200,000 lbs	100,000 square feet	minutes	ASTM D 3895 ASTM D 5885	100 (minimum average) 400 (minimum average)
	2% Modulus	1 per Formulation	100,000 square feet	lb/in	ASTM D 5323	2,400 maximum
	Axi-symmetric Break Resistance Strain ⁽³⁾	1 per Formulation	--	%	ASTM D 5617	30 minimum
	Oven Aging at 85°C ⁽³⁾ Std. OIT – Retained after 90 days	1 per Formulation	--	%	ASTM D 5721 ASTM D 3895	35 (minimum average)
	High Pressure OIT – retained after 90 days			%	ASTM D 5885	60 (minimum average)
	UV Resistance ⁽³⁾⁽⁴⁾ High Pressure OIT	1 per Formulation	--	%	ASTM D 7238 ASTM D 5885	35 (minimum average)

Table Notes:

- (1) – Definitions: % = percent ; g = grams; g/cm³ = grams per cubic centimeter; lb = pound; lb/in = pounds per inch; mils = milli-inches
- (2) – Carbon dispersion for 10 different views. One view allowed in Category 3.
- (3) – For 2% modulus, axi-symmetric break resistance, oven aging, and UV resistance, Manufacturer’s certification may be accepted in lieu of actual test results.
- (4) – The condition of the test will be 20-hour UV cycle at 75°C followed by 4-hour condensation at 60°C.

TABLE C.3: SEAM PROPERTY AND INSTALLATION ACCEPTANCE CRITERIA FOR 40-MIL LLDPE TEXTURED GEOMEMBRANE

Subject	QC Test Frequency	CQA Test Frequency	Units	Test Method	ACCEPTANCE CRITERIA
Shear Strength Fusion & Extrusion ⁽¹⁾	--	1 test every 500 feet	lb/in	ASTM D 6392 Strain rate: 12 in/min on 1 inch strips	60 minimum
Peel Adhesion Fusion ⁽²⁾ Extrusion ⁽³⁾	--	1 test every 500 feet	lb/in lb/in	ASTM D 6392 Strain rate: 12 in/min on 1 inch strips	50 minimum 44 minimum
Vacuum Testing Welded Seams	100% of extrusion welds	Observation & Documentation of 100% of extrusion welds	--	--	--
Air Pressure Testing Welded Seams	100% of fusion welds	Observation & Documentation of 100% of extrusion welds	--	--	--

Table Notes: Definitions: in = inch; lb = pound; min. = minute; in/min = inch per minute

- (1) For Shear Testing of both fusion and extrusion welds, the strength of 4 out of 5 specimens must meet or exceed the given value. The 5th specimen must meet at least 80 percent of the specified value. Shear elongation at break must be at least 50 percent.
- (2) For Peel Testing of fusion welds, the strength of 4 out of 5 specimens must meet or exceed the specified value. The 5th specimen must achieve at least 80% of the specified value. All specimens shall fail due to film tear bond or with less than 25% incursion of the weld (peel).
- (3) For Peel Testing of extrusion welds, the strength of 4 out of 5 specimens must meet or exceed the specified value with less than 25% incursion at the weld. The 5th specimen must achieve at least 80% of the specified value. One specimen may exhibit greater than 25% incursion at the weld if the specified strength value is achieved.
- (4) For double fusion welded seams, both tracks will be tested for compliance with the specified minimum seam peel strengths.
- (5) Required laboratory seam testing will be performed by the Geosynthetics Laboratory at a frequency of one test per 500 linear feet of constructed seam for both extrusion and fusion welding equipment.
- (6) LLDPE field samples will be allowed to cool to a minimum of 75 degrees Fahrenheit prior to testing. Testing will be performed in a climate-controlled environment at the site such as an office or trailer.

APPENDIX D

MATERIAL PROPERTIES AND ACCEPTANCE CRITERIA FOR GEOTEXTILES

TABLE D.1: MATERIAL TENSILE PROPERTIES AND MANUFACTURER QUALITY CONTROL REQUIREMENTS FOR NON-WOVEN GEOTEXTILE SEPARATOR

Material Property	MQC Test Frequency	CQA Test Frequency	Units	Test Method	ACCEPTANCE CRITERIA
Polymer Composition	NA	--	%	Certification	95% polypropylene or polyester by weight
Mass per Unit Area	1 per 90,000 square feet	1 per 100,000 square feet	oz per square yard	ASTM D 5261	8 oz / square yard (minimum average)
Grab Tensile Strength	1 per	1 per 100,000 square feet	lbs	ASTM D 4632	220 (minimum average)
Grab Tensile Elongation	90,000 square feet	1 per 100,000 square feet	%	ASTM D 4632	50 minimum
CBR (Static) Puncture Strength	1 per 540,000 square feet	1 per 540,000 square feet	lbs	ASTM D 6241	575 (minimum average)
Trapezoidal Tear Strength	1 per 90,000 square feet	1 per 100,000 square feet	lbs	ASTM D 4533	90 (minimum average)
Ultraviolet Resistance	1 per formulation	--	%/hrs	ASTM D 4355	70 / 500 minimum

Table Notes: Definitions: hrs = hours; in = inch; lbs = pounds; oz = ounce

APPENDIX E

MATERIAL PROPERTIES AND ACCEPTANCE CRITERIA FOR GEOCOMPOSITES

TABLE E.1: Geonet Component MATERIAL PROPERTIES AND MANUFACTURER QUALITY CONTROL REQUIREMENTS FOR DOUBLE SIDED GEOCOMPOSITE

PROPERTIES	Subject	MQC Test Frequency	CQA Test Frequency	Units	Test Method	ACCEPTANCE CRITERIA
Geonet Component (HDPE, bi-planar, bi-axial)	Polymer Composition	Certify	--	%	Certification	95% polyethylene by weight
	Polymer Density	1 per 50,000 square feet	100,000 square feet	g/cm ³	ASTM D 792 (Method B) or ASTM D 1505	0.94 (minimum)
	Carbon Black Content	1 per 50,000 square feet	--	%	ASTM D 1603 ASTM D 4218	2 - 3 (range)
	Nominal Thickness	1 per 50,000 square feet	100,000 square feet	mil	ASTM D 5199	250 (minimum)
	Tensile Strength	1 per 50,000 square feet	--	lb/in	ASTM D 7179	75 (minimum)

Table Notes: Definitions: hrs = hours; in = inch; mm = millimeter; oz = ounce; lb = pound; lb/in = pounds per inch; cm = centimeter; m = meter; psi = pounds per square inch

- (1) All values represent minimum average roll values.
- (2) Minimum value measured in machine and cross-machine direction.

TABLE E.2: Component MATERIAL PROPERTIES AND MANUFACTURER QUALITY CONTROL REQUIREMENTS FOR DOUBLE SIDED GEOCOMPOSITE

PROPERTIES	Subject	MQC Test Frequency	CQA Test Frequency	Units	Test Method	ACCEPTANCE CRITERIA
Geotextile Component (non-woven needle punched polypropylene)	Polymer Composition	Certify	--	%	Certification	Min. 95% polyester or polyethylene by weight Needle punched, non-woven
	Mass per Unit	1 per 90,000 square feet	1 per 100,000 square feet	oz/yd ²	ASTM D 5261	8 oz/square yard (minimum)
	Apparent opening size	1 per 540,000 square feet	1 per 100,000 square feet	mm	ASTM D 4751	O ₉₅ ≤ 0.21 mm (minimum)
	Permittivity	1 per 540,000 square feet	1 per 100,000 square feet	sec ⁻¹	ASTM D 4491	1.3 (minimum)
	Grab Strength	1 per 90,000 square feet	1 per 100,000 square feet	lb	ASTM D 4632 ⁽²⁾	200 (minimum)
	Tear Strength	1 per 90,000 square feet	1 per 100,000 square feet	lb	ASTM D 4533 ⁽²⁾	75 (minimum)
	CBR puncture strength	1 per 540,000 square feet	1 per 100,000 square feet	psi	ASTM D 6241	500 (minimum)
	UV Resistance	1 per formulation	--	% / hrs	ASTM D 4355	70 / 500 (minimum)
Geocomposite (double sided with geotextile heat laminated on both sides of the geonet)	Transmissivity	1 per 540,000 square feet	1 per 100,000 square feet	m ² /s	ASTM D 4716	7.4 x 10 ⁻⁴ (minimum)
	Ply Adhesion	1 per 50,000 square feet	1 per 100,000 square feet	lb/in	ASTM D 7005	1.0 (minimum)

Table Notes: Definitions: hrs = hours; in = inch; mm = millimeter; oz = ounce; lb = pound; lb/in = pounds per inch; cm = centimeter; m = meter; psi = pounds per square inch

- (1) All values represent minimum average roll values.
- (2) Minimum value measured in machine and cross-machine direction.
- (3) Specified value must be met at the following conditions: For the alternative Final Cover System geocomposite, a gradient of 0.15, normal load of 250 psf, and water temperature at 70°F, between steel plates for 15 minutes.

APPENDIX F

ALTERNATIVE FINAL COVER SYSTEM INTERFACE SHEAR STRENGTH REQUIREMENTS

TABLE F.1: Alternative Final Cover System Interface Shear Strength Testing Requirements

System Components	Required Test	CQA Test Frequency	Test Method	ACCEPTANCE CRITERIA
Alternative Final Cover System Interfaces ⁽¹⁾	Interface Shear Strength	1 per 25 acres or change in product or material type/source	ASTM D 5321	As specified in the Construction Documents

Table Notes:

(1) In the soil-geosynthetic alternative final cover system option is selected for use, the alternative final cover system interface shear strength testing (for both peak and large displacement strengths) will be conducted for the following interfaces of that alternative final cover system:

- a. Geomembrane – CCR materials
- b. Geomembrane – Geocomposite drainage layer; and
- c. Geocomposite – Protective Soil Layer

APPENDIX G

MATERIAL PROPERTIES AND ACCEPTANCE CRITERIA FOR ENGINEERED TURF

TABLE G.1: MATERIAL PROPERTIES AND MANUFACTURER QUALITY CONTROL REQUIREMENTS FOR ENGINEERED TURF (CT32) AND BALLAST MATERIAL

PROPERTIES	Subject	MQC Test Frequency	CQA Test Frequency	Units	Test Method	ACCEPTANCE CRITERIA
Engineered Turf	CBR Puncture	1 per 300,000 square feet	1 per 400,000 square feet	lbs	ASTM D 6241	1,500 (minimum)
	Tensile Property	1 per 300,000 square feet	1 per 400,000 square feet	lbs	ASTM D 4595	2,100 (minimum)
	Yarn Weight (Total product Weight)	1 per 300,000 square feet	1 per 400,000 square feet	oz per square yard	ASTM D 5261	20 (minimum)
	Tensile Strength of Yarn	1 per 300,000 square feet	1 per 400,000 square feet	lbs	ASTM D 2256	15 (minimum)
Ballast Material	Sand Infill Gradation	Certify	1 per 250 cubic yards	in	ASTM C-33-03	Reference in Construction Documents
	Sand Infill Thickness	--	20 per acre	in	Manual Probe	Range: 0.5 to 0.75 inch thick
	Cementitious Binder – Thickness	--	20 per acre	in	Manual Probe	Range: 0.75 to 1 inch thick
	Cementitious Binder – Hydration	--	1 test per 100 square feet	n/a	Manual Probe	Check and verify
	Armored Fill Saturation	--	20 per acre	n/a	Manual Probe	Check and verify

Table Notes: Definitions: hrs = hours; in = inch; oz = ounce; lb = pound;

- (1) At least one test shall be performed for each lot. A lot shall be defined by ASTM D 4354.
- (2) If fusion seaming method is used, then trial seams shall be performed as stipulated in the Construction Documents