Construction Quality Assurance Manual

Halifax County Landfill Facility
Halifax County, North Carolina

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Halifax County Landfill Facility

Construction Quality Assurance Manual

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1.0 GENERAL

This Construction Quality Assurance (CQA) Manual has been prepared to provide the Owner, (Design) Engineer, and CQA Engineer the means to govern the construction quality and to satisfy landfill certification requirements under current solid waste management regulations.

More specifically, this CQA Manual addresses the soils and geosynthetics components of the landfill subgrade and final cover system for the construction and demolition debris (C&D) landfill units and the liner system, leachate management system, and the final cover system for the ash monofill.

The CQA Manual is divided into the following sections:

- Section 1.0 General
- Section 2.0 CQA Documentation
- Section 3.0 Earthwork CQA
- Section 4.0 Soil Liner CQA
- Section 5.0 Geomembrane CQA
- Section 6.0 Leachate Management System CQA
- Section 7.0 Geotextile CQA
- Section 8.0 Drainage Geocomposite CQA
- Section 9.0 Geosynthetic Clay Liner CQA
- Section 10.0 Final Cover System CQA

1.1 Definitions Relating to Construction Quality

1.1.1 Construction Quality Assurance (CQA)

In the context of this Manual, Construction Quality Assurance is defined as a planned and systematic program employed by the Owner to assure conformity of the subgrade, liner, leachate management, and final cover systems installation with the project drawings and the project specifications. CQA is provided by the CQA Engineer 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 and will perform satisfactorily in service.

1.1.2 Construction Quality Control (CQC)

Construction Quality Control refers to actions taken by manufacturers, fabricators, installers, and/or the Contractor to ensure that the materials and the workmanship meet the requirements of the project drawings and the project specifications. The manufacturer's specifications and quality control (QC) requirements are included in this CQA Manual by reference only. A complete

updated version of each geosynthetic component manufacturer's QC Plan shall be incorporated as part of the Contractor's CQC Plan.

1.1.3 CQA Certification Document

At the completion of construction, a certification document will be prepared by the CQA Engineer and submitted to State Solid Waste Regulators. The certification report will include documentation of all QC testing performed by the Geosynthetics Manufacturers, all CQC testing performed by the Geosynthetic Installers, and all CQA testing performed by the CQA Engineer.

1.1.4 Discrepancies Between Documents

The Contractor is instructed to bring discrepancies to the attention of the CQA Engineer who shall then notify the Engineer for resolution. The Engineer has the sole authority to determine resolution of discrepancies existing within the Contract Documents (this may also require the approval of State Solid Waste Regulators). Unless otherwise determined by the Engineer, the more stringent requirement shall be the controlling resolution.

1.2 Parties to Construction Quality Assurance

1.2.1 Description of the Parties

The parties to Construction Quality Assurance and Quality Control include the Owner, Engineer, Contractor, Geosynthetics Manufacturer, Geosynthetics Installer, CQA Engineer, Geosynthetics CQA Laboratory, and Soils CQA Laboratory.

1.2.1.1 Owner

The Owner is Halifax County, who owns and/or is responsible for the facility.

1.2.1.2 Engineer

The Engineer is responsible for the engineering design, drawings, and project specifications for the subgrade, liner, leachate management, and final cover systems. The Engineer is an official representative of the Owner. The Engineer serves as communications coordinator for the project, initiating the meetings outlined in **Section 1.6**. The Engineer will also be responsible for proper resolution of all quality issues that arise during construction. The Engineer is Smith Gardner, Inc.

1.2.1.3 Contractor

The Contractor is responsible for the construction of the subgrade, earthwork, and for placement of the liner, leachate management, and/or final cover systems. The Contractor is responsible for the overall CQC on each project and coordination of submittals to the CQA Engineer. Additional responsibilities of the Contractor are defined by the project specifications.

1.2.1.4 Geosynthetics Manufacturer

The Geosynthetics Manufacturer(s) is (are) responsible for the production of the geosynthetic components used in landfill construction. The Manufacturer(s) is (are) responsible for Quality Control (QC) during manufacture of the geosynthetic components, certification of the properties of the geosynthetic components, and field installation criteria.

1.2.1.5 Geosynthetics Installer

The Geosynthetics Installer(s) is (are) routinely a subcontractor of the Contractor and is (are) responsible for field handling, storing, placing, seaming, protection of (against wind, etc.), and other aspects of the geosynthetics installations. The Installer may also be responsible for transportation of these materials to the site, and for the preparation and completion of anchor trenches.

1.2.1.6 CQA Engineer

The CQA Engineer is a representative of the Owner, is independent from the Contractor, and is responsible for observing, testing, and documenting activities related to the CQA of the earthworks at the site, and the installation of the soil and geosynthetic components of the liner, leachate management, and final cover systems. The CQA Engineer may make field observations and review submittals for the Engineer and is responsible for notifying the Owner and Engineer of all quality issues that arise during construction. The CQA Engineer is also responsible for issuing a facility certification report, sealed by a Professional Engineer registered in The State of North Carolina.

1.2.1.7 Geosynthetics CQA Laboratory

The Geosynthetics CQA Laboratory is a party, independent from the Owner, that is responsible for conducting tests on conformance samples of geosynthetics used in the liner, leachate management, and final cover systems. The Geosynthetics CQA Laboratory service cannot be provided

by any party involved with the manufacture, fabrication, or installation of any of the geosynthetic components. The services of the Geosynthetics CQA Laboratory are coordinated by the CQA Engineer and are paid for by the Owner.

1.2.1.8 Soils CQA Laboratory

The Soils CQA Laboratory is a party, independent from the Owner, that is responsible for conducting geotechnical tests on conformance samples of soils and aggregates used in structural fills and the liner, leachate management, and final cover systems. The services of the Soils CQA Laboratory are coordinated by the CQA Engineer and are paid for by the Owner.

1.2.2 Qualifications of the Parties

The following qualifications are required of all parties involved with the manufacture, fabrication, installation, transportation, and CQA of all materials for the subgrade, liner, leachate management, and final cover systems. Where applicable, these qualifications must be submitted by the Contractor to the Owner and Engineer for review and approval.

1.2.2.1 Contractor

Qualifications of the Contractor are specific to the construction contract and independent of this CQA Manual.

1.2.2.2 Geosynthetics Manufacturers

Each Geosynthetics Manufacturer must satisfy the qualifications presented in the project specifications.

1.2.2.3 Geosynthetic Installer(s)

The Geosynthetic Installer(s) will be trained and qualified to install the geosynthetics components of the liner, leachate management, and final cover systems. Each Geosynthetics Installer must meet the requirements of the project specifications and be approved by the Engineer.

1.2.2.4 CQA Engineer

The CQA Engineer will act as the Owner's Quality Assurance Representative. The CQA Engineer will perform CQA testing to satisfy the

requirements of this CQA Manual and will prepare the CQA certification document. The CQA Engineer will have experience in the CQA aspects of the construction and testing of landfill liner, leachate management, and final cover systems, and be familiar with ASTM and other related industry standards. The activities of the CQA Engineer will be performed under the supervision of a Registered Professional Engineer.

1.2.2.5 Geosynthetics CQA Laboratory

The Geosynthetics CQA Laboratory should be certified by the Geosynthetics Accreditation Institute, will have experience in testing geosynthetics, and be familiar with ASTM, GRI, and other applicable test standards. The Geosynthetics CQA Laboratory will be capable of providing test results within 24 hours or a reasonable time after receipt of samples depending on the test(s) to be conducted, as agreed to at the outset of the project by affected parties, and will maintain that standard throughout the installation.

1.2.2.6 Soils CQA Laboratory

The Soils CQA Laboratory will have experience in testing structural fills, soil liners, and aggregates, and be familiar with ASTM and other applicable test standards. The Soils CQA Laboratory will be capable of providing test results within 24 hours or a reasonable time after receipt of samples depending on the test(s) to be conducted, as agreed to at the outset of the project by affected parties, and will maintain that standard throughout the installation.

1.3 Scope of Construction Quality Assurance Manual

The scope of this CQA Manual includes the CQA of the soils and geosynthetic components of the subgrade, liner, leachate management, and final cover systems for the subject facility. The CQA for the selection, evaluation, and placement of the soils is included in the scope.

1.4 Units

In this CQA Manual, all properties and dimensions are expressed in U.S. units.

1.5 References

The CQA Manual includes references to the most recent version of the test procedures of the American Society of Testing and Materials (ASTM) and/or the Geosynthetic Research Institute (GRI). **Appendix A** contains a list of these procedures.

1.6 CQA Meetings

To facilitate the specified degree of quality during installation, clear, open channels of communication are essential. To that end, meetings are critical.

1.6.1 Soil Liner CQA Meeting (Where Applicable)

Prior to the start of soil liner system construction a CQA Meeting will be held. This meeting will include all parties then involved, including the Engineer, the CQA Engineer, and the Contractor.

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 Manual to all of the parties involved. It is very important that the rules regarding testing, repair, etc., be known and accepted by all.

This meeting should include all of the activities referenced in the project specifications.

The meeting will be documented by the Engineer and minutes will be transmitted to all parties. The Soil Liner CQA Meeting and the Geosynthetics CQA Meeting may be held as one meeting or separate meetings, depending on the direction of the Engineer.

1.6.2 Geosynthetics CQA Meeting (Where Applicable)

A CQA Meeting will be held at the site prior to placement of the geosynthetics. At a minimum, the meeting will be attended by the Engineer, the CQA Engineer, the Contractor, and the Geosynthetic Installation Superintendent(s).

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 Manual to all of the parties involved. It is very important that the rules regarding testing, repair, etc., be known and accepted by all.

This meeting should include all of the activities referenced in the project specifications.

The meeting will be documented by the Engineer and minutes will be transmitted to all parties. The Soil Liner CQA Meeting and the Geosynthetics CQA Meeting may be held as one meeting or separate meetings, depending on the direction of the Engineer.

1.6.3 CQA Progress Meetings

Progress meetings will be held between the Engineer, the CQA Engineer, the Contractor, the Geosynthetic Installation Superintendent(s), and representatives from any other involved parties at the frequency dictated in the project specifications or, at a minimum, once per month during active construction. These meetings will discuss current progress, planned activities for the next week, and any new business or revisions to the work. The CQA Engineer will log any problems, decisions, or questions arising at this meeting in his daily or periodic reports. Any matter requiring action which is raised in this meeting will be reported to the appropriate parties. These meetings will be documented by the Engineer and minutes will be transmitted to affected parties.

1.6.4 Problem or Work Deficiency Meetings

A special meeting will be held when and if a problem or deficiency is present or likely to occur. At a minimum, the meeting will be attended by the Engineer, the CQA Engineer, the Contractor, and representatives from any other involved parties. The purpose of the meeting is to define and resolve the problem or work deficiency as follows:

- define and discuss the problem or deficiency;
- review alternative solutions; and
- implement an action plan to resolve the problem or deficiency.

The meeting will be documented by the Engineer and minutes will be transmitted to affected parties.

1.7 Control Versus Record Testing

1.7.1 Control Testing

In the context of this CQA Manual, Control Tests are those tests performed on a material prior to its actual use in construction to demonstrate that it can meet the requirements of the project plans and specifications. Control Test data may be used by the Engineer as the basis for approving alternative material sources.

1.7.2 Record Testing

Record Tests are those tests performed during the actual placement of a material to demonstrate that its in-place properties meet or exceed the requirements of the project drawings and specifications.

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2.0 CQA DOCUMENTATION

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 Engineer will document that quality assurance requirements have been addressed and satisfied.

The CQA Engineer will provide the Owner and Engineer with his daily and progress reports including signed descriptive remarks, data sheets, and logs to verify that required CQA activities have been carried out. These reports will also identify potential quality assurance problems. The CQA Engineer will also maintain at the job site a complete file of project drawings, reports, project specifications, a CQA Manual, checklists, test procedures, daily logs, and other pertinent documents.

2.1 Daily CQA Report

The CQA Engineer's reporting procedures will include preparation of a daily report which, at a minimum, will include the following information, where applicable:

- a unique identifying sheet number for cross referencing and document control;
- date, project name, location, and other identification;
- data on weather conditions;
- a reduced scale Site Plan showing all proposed work areas and test locations;
- descriptions and location of ongoing construction;
- descriptions and specific locations of areas, or units, of work being tested and/or observed and documented;
- locations where tests and samples were taken;
- a summary of test results;
- calibrations or recalibrations of test equipment, and actions taken as a result of recalibration;
- off-site materials received, including quality verification documentation;
- decisions made regarding acceptance of units of work, and/or corrective actions to be taken in instances of substandard quality;

- summaries of pertinent discussions with the Contractor and/or Geosynthetic Installers; and

- the CQA Engineer's signature.

The daily report must be completed at the end of each day. This information will be submitted to the Engineer for review on a routine basis and to the Owner upon request.

2.2 CQA Progress Reports

The CQA Engineer will prepare summary progress reports at time intervals as requested by the Engineer or Owner or upon a total project shutdown. As a minimum, this report will include the following information for the reporting period, where applicable:

- a summary of work activities performed;

- a summary of construction situations, deficiencies, and/or defects;

- a summary of all test results, failures, and retests;

- a compilation of daily CQA reports; and

- the CQA Engineer's signature.

Critical problems that occur will be communicated verbally to the Engineer immediately as well as being included in the progress reports.

2.3 CQA Photographic Reporting

Photographs will be taken by the CQA Engineer at regular intervals during the construction process and in all areas deemed critical by the CQA Engineer. These photographs will serve as a pictorial record of work progress, problems, and mitigation activities. Videotaping may be used to supplement photographs in the documentation of work progress, problems, and/or mitigation activities. These records will be presented to the Engineer upon completion of the project.

2.4 Deficiencies

The Owner and Engineer will be made aware of any significant recurring non-conformance with the project specifications. The Engineer will then determine the cause of the non-conformance and recommend appropriate changes in procedures or specification. When this type of evaluation is made, the results will be documented, and any revision to procedures or project specifications will be approved by the Owner and Engineer.

2.5 Design and/or Project Technical Specification Changes

Design and/or project specification changes may be required during construction. In such cases, the CQA Engineer will notify the Engineer. The Engineer will then notify the appropriate agency, if necessary.

Design and/or project specification changes will be made only with the written agreement of the Engineer, and will take the form of an addendum to the project specifications. All design changes will include a detail (if necessary) and state which detail it replaces in the plans.

2.6 Final CQA Report

At the completion of each major construction activity at the landfill unit, the CQA Engineer will certify all required forms, observation logs, field and laboratory testing data sheets including sample location plans, etc. The CQA Engineer will also provide a final report which will certify that the work has been performed in compliance with the plans and project technical specifications, and that the supporting documents provide the necessary information.

The CQA Engineer will also provide summaries of all the data listed above with the report. The Record Drawings will include scale 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.). All surveying and base maps required for development of the Record Drawings will be done by the Contractor's Construction Surveyor. These documents will be certified by the Contractor and delivered to the CQA Engineer and included as part of the final CQA (Certification) report.

It may be necessary to prepare interim certifications, as allowed by the regulatory agency, to expedite completion and review.

At a minimum, the items shown in **Table 2.1** will be included in the Final CQA Report. Note that some items may not be applicable to all projects.

2.7 Storage of Records

All handwritten data sheet originals, especially those containing signatures, will be stored by the CQA Engineer in a safe repository on site. Other reports may be stored by any standard method which will allow for easy access. All written documents will become property of the Owner.

Table 2.1A Final CQA Report General Outline (Liner System)

1. Introduction
2. Project Description
3. CQA Program
    a. Scope of Services
    b. Personnel
4. Earthwork CQA
5. Soil Liner CQA
6. GCL CQA
7. Geomembrane CQA
8. Leachate Management System CQA
9. Geotextile CQA
10. Drainage Geocomposite CQA
11. Summary and Conclusions
12. Project Certification

Appendices

- Appendix A Design Clarifications and Modifications
- Appendix B Piezometer Abandonment (if applicable)
- Appendix C Geophysical Investigation (if applicable)
- Appendix D Rock Blasting (if applicable)
    - D1. Approved Rock Blasting Plan
    - D2. Results of Rock Blasting
- Appendix E Photographic Documentation
- Appendix F CQA Reporting
    - F1. CQA Reports
    - F2. CQA Meeting Minutes
- Appendix G Earthwork CQA Data
    - G1. CQA Test Results - Control Tests
    - G2. CQA Test Results - Record Tests
- Appendix H Soil Liner CQA Data
    - H1. CQA Test Results - Control Tests
    - H2. CQA Test Results - Record Tests
- Appendix I Interface Shear Strength Test Data
- Appendix J GCL CQA Data
    - J1. Manufacturer's Product Data Submittals and Quality Control Certificates
    - J2. Geosynthetics Inventory - GCL
    - J3. CQA Test Results - Material Control Tests
    - J4. GCL Installation Certification
- Appendix K Geomembrane CQA Data
    - K1. Manufacturer's Product Data Submittals and Quality Control Certificates
    - K2. Geosynthetics Inventory - Geomembrane(s)
    - K3. CQA Test Results - Material Control Tests
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O2.	Soil Liner As-Built
O3.	Geomembrane As-Built(s)
O4.	Leachate Collection Media As-Built
O5.	HDPE Pipe As-Built
O6.	Protective Cover As-Built

Table 2.1B Final CQA Report General Outline (Final Cover System)

1. Introduction
2. Project Description
3. CQA Program
    a. Scope of Services
    b. Personnel
4. Earthwork CQA
5. Final Cover System CQA
6. Geomembrane CQA
7. Geotextile CQA
8. Drainage Geocomposite CQA
9. Summary and Conclusions
10. Project Certification

Appendices

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- Appendix B Photographic Documentation
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- Appendix D Earthwork CQA Data
    - D1. CQA Test Results - Control Tests
    - D2. CQA Test Results - Record Tests
- Appendix E Final Cover System CQA Data
    - E1. Manufacturer's Product Data Submittals and Quality Control Certificates
    - E2. CQA Test Results - Drainage Aggregate
    - E3. CQA Test Results - Vegetative Soil Layer
    - E4. CQC Test Results - Pressure Testing of HDPE Piping
- Appendix F Interface Shear Strength Test Data
- Appendix G Geomembrane CQA Data
    - G1. Manufacturer's Product Data Submittals and Quality Control Certificates
    - G2. Geosynthetics Inventory - Geomembrane
    - G3. CQA Test Results - Material Control Tests
    - G4. Subgrade Acceptance Certificates
    - G5. Trial Seam Logs
    - G6. Panel Placement Logs
    - G7. Panel Seaming Logs
    - G8. CQC Test Results - Nondestructive Seam Testing Report Forms
    - G9. CQC Test Results - Destructive Seam Testing Report Forms (Field)
    - G10. CQA Test Results - Destructive Seam Testing Report Forms (Laboratory)
    - G11. Repair Logs
    - G12. Geomembrane Installation Certification

Table 2.1B (Continued):

Appendix H	Geotextile CQA Data
H1.	Manufacturer's Product Data Submittals and Quality Control Certificates
H2.	Geosynthetics Inventory - Geotextiles
H3.	CQA Test Results - Material Control Tests
Appendix I	Drainage Geocomposite CQA Data
I1.	Manufacturer's Product Data Submittals and Quality Control Certificates
I2.	Geosynthetics Inventory - Drainage Geocomposite
I3.	CQA Test Results - Material Control Tests
Appendix J	Record Drawings
J1.	Geomembrane As-Built
J2.	HDPE Pipe As-Built
J3.	Vegetative Soil Layer As-Built

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3.0 EARTHWORK CQA

This section of the CQA Manual addresses earthwork (excavation and embankment) and outlines the soils CQA program to be implemented with regard to material approval, subgrade approval, field control and record tests, and resolution of problems.

3.1 Embankment Material Approval

All material to be used as compacted embankment shall be approved in advance by the CQA Engineer. Approval is based upon successful completion of CQA control testing outlined below. Such testing can be performed either during excavation and stockpiling or from existing stockpiles prior to use.

3.1.1 Control Tests

The procedure for CQA testing during excavation and stockpiling (including existing stockpiles) is outlined below.

Each load of soil will be examined either at the borrow source or the stockpile area. Any unsuitable material will be rejected or routed to separate stockpiles consistent with its end use. Appropriate entries will be made in the daily log.

During stockpiling operations, control tests, as shown on **Table 3.1**, will be performed by the CQA Engineer prior to placement of any compacted embankment.

3.2 Subgrade Approval

The CQA Engineer will verify that the compacted embankment subgrade is constructed in accordance with the project specifications.

3.3 Earthwork Construction

3.3.1 Construction Monitoring

A. Earthwork shall be performed as described in the project specifications.

B. Only soil previously approved by the CQA Engineer (see **Section 3.2**) shall be used in construction of the compacted embankment. Unsuitable material will be removed prior to acceptance by the CQA Engineer.

C. All required field density and moisture content tests shall be completed before the overlying lift of soil is placed. The surface preparation (e.g.

wetting, drying, scarification, etc.) shall be completed before the CQA Engineer will allow placement of subsequent lifts.

D. The CQA Engineer will monitor protection of the earthwork during and after construction.

3.3.2 Control Tests

The control tests, as shown on **Table 3.2**, will be performed by the CQA Engineer prior to placement of compacted embankment.

3.3.3 Record Tests

The record tests, as shown on **Table 3.2**, will be performed by the CQA Engineer during placement of compacted embankment.

3.3.3.1 Record Test Failure

Recompaction of the failed area shall be performed and retested until the area meets or exceeds requirements outlined in the specifications.

3.3.4 Judgmental Testing

During construction, the frequency of control and/or record testing may be increased at the discretion of the CQA Engineer when visual observations of construction performance indicate a potential problem. Additional testing for suspected areas will be considered when:

- the rollers slip during rolling operation;
- the lift thickness is greater than specified;
- the fill material is at an improper moisture content;
- fewer than the specified number of roller passes are made;
- dirt-clogged rollers are used to compact the material;
- the rollers may not have used optimum ballast;
- the fill materials differ substantially from those specified; or
- the degree of compaction is doubtful.

3.4 Deficiencies

The CQA Engineer will immediately determine the extent and nature of all defects and deficiencies and report them to the Owner and Engineer. All defects and deficiencies will be documented by the CQA Engineer. The Contractor shall correct defects and deficiencies to the satisfaction of the CQA Engineer. The CQA Engineer will observe all retests on repaired defects.

Table 3.1 CQA Testing Program for Embankment Material Approval

Property	Test Method	Minimum Test Frequency
Control Tests:		
Visual Classification	ASTM D 2488	Each Soil
Moisture-Density Relationship	ASTM D 698	5,000 CY per Each Soil

Table 3.2 CQA Testing Program for Compacted Embankment

Property	Test Method	Minimum Test Frequency
Control Tests: (See **Table 3.1**)		
Record Tests:		
Lift Thickness	-----	Each Lift
In-Place Density	ASTM D 6938[1]	20,000 ft^2 per lift & 1 per 500 LF/lift of Berms (< 200 ft. base width)
Moisture Content	ASTM D 6938[2]	20,000 ft^2 per lift & 1 per 500 LF/lift of Berms (< 200 ft. base width)
Area 2 C&DLF Unit Only: Verification of Subgrade Soil Type (Soil within 2 Vertical Feet of Finished Subgrade Elevations) (See Note 3)		
Visual Classification:	ASTM D 2488	10,000 ft^2
Atterberg Limits:	ASTM D 4318	40,000 ft^2
Grain Size Analysis:	ASTM D422[2]	40,000 ft^2

Notes:

1. Optionally use ASTM D 1556, ASTM D 2167, or ASTM D 2937. For every 10 nuclear density tests perform at least 1 density test by ASTM D 1556, ASTM D 2167, or ASTM D 2937 as a verification of the accuracy of the nuclear testing device.

2. Optionally use ASTM D 2216, ASTM D 4643, or ASTM D 4959. For every 10 nuclear moisture tests perform at least 1 moisture test by ASTM D 2216, ASTM D 4643, or ASTM D 4959 as a verification of the accuracy of the nuclear testing device.
3. Conduct subgrade verification using hand augered boring or test pit.

4.0 SOIL LINER CQA

This section of the CQA Manual addresses the soil liner component of the final cover system for the Area 2 C&D landfill unit and outlines the soils CQA program to be implemented with regard to material approval, subgrade approval, test fill construction, field and laboratory control and record tests, and resolution of problems.

4.1 Soil Liner Material Approval

All material to be used as soil liner shall be approved in advance by the CQA Engineer. Approval is based upon successful completion of CQA control testing outlined below. Such testing can be performed either during excavation and stockpiling or from existing stockpiles prior to use.

4.1.1 Control Tests

The procedure for CQA testing during excavation and stockpiling (including existing stockpiles) is outlined below.

Each load of soil will be examined either at the borrow source or the stockpile area. Any unsuitable material will be rejected or routed to separate stockpiles consistent with its end use. Appropriate entries will be made in the daily log.

During stockpiling operations, control tests, as shown on **Table 4.1**, will be performed by the CQA Engineer prior to placement of any soil liner material.

4.2 Subgrade Approval

The CQA Engineer will verify that the soil liner subgrade is constructed in accordance with the project specifications.

4.3 Test Fill Construction

A test fill meeting the requirements of the project specifications will be constructed using the same construction methods, equipment, and material to be used for the soil liner component. The test fill construction will be conducted prior to or coincide with the beginning of construction of the soil liner component.

Construction equipment and methods will be reviewed by the CQA Engineer prior to test fill placement.

4.3.1 Control Tests

The control tests, as shown on **Table 4.2**, will be performed by the CQA Engineer prior to placement of soil liner material in the test fill.

4.3.2 Record Tests

The record tests, as shown on **Table 4.2**, will be performed by the CQA Engineer during placement of soil liner material in the test fill.

4.3.3 Test Fill Completion

The test fill program is completed when the Contractor has shown that the soil liner constructed using the same construction methods, equipment, and material to be used in construction of the soil liner will satisfy project specifications. No soil liner can be placed until the test fill program is completed.

4.4 Soil Liner Construction

4.4.1 Construction Monitoring

A. Soil liner shall be placed as described in the applicable section(s) of the project specifications using the construction methods, equipment, and material demonstrated in the test fill construction.

B. Only soil previously approved by the CQA Engineer (see **Section 4.1**) shall be used in construction of the soil liner. Unsuitable material will be removed prior to acceptance by the CQA Engineer.

C. All required field density and moisture content tests shall be completed before the overlying lift of soil is placed. The surface preparation (e.g. wetting, drying, scarification, etc.) shall be completed before the CQA Engineer will allow placement of subsequent lifts.

D. The CQA Engineer will monitor protection of the soil liner during and after construction.

E. The liner surface shall be sprinkled with water as needed to prevent desiccation. Should desiccation occur, the last lift shall be reconstructed in accordance with the project specifications. Standing water should not be present on the soil liner.

F. Frost heave or other damage due to freezing shall require lift reconstruction in accordance with the project specifications.

G. The CQA Engineer will inspect the soil liner and certify that it is in accordance with the project specifications and approved plans prior to the Contractor beginning installation of overlying geosynthetics.

H. The finished soil liner shall be free of all rock protrusions. All cracks and voids shall be filled and the surface made uniform. This shall be accomplished by final dressing of the soil liner with smooth-drum rollers and hand raking. No rubber tired vehicles are permitted on the final dressed surface unless authorized by the CQA Engineer.

I. The surface on which the overlying geosynthetics are to be placed shall be maintained in a firm, clean, and smooth condition and shall be within the acceptable moisture range before and during the geosynthetics installation.

4.4.2 Control Tests

The control tests, as shown on **Table 4.3**, will be performed by the CQA Engineer prior to placement of soil liner material.

4.4.3 Record Tests

The record tests, as shown on **Table 4.3** and as described below, will be performed by the CQA Engineer during placement of soil liner material.

A. Each lift will be checked visually for soil clods, rocks, debris, plant materials and other foreign material. Any such material which does not meet specified requirements shall be identified and removed prior to and during the compaction process.

B. The thickness of the loose lift will be measured at random locations after spreading and leveling is completed. Loose lift thickness should not exceed the depth of penetration of the compaction feet.

C. Moisture content will be monitored by the CQA Engineer prior to compaction. If the soil is drier than the specified minimum moisture content, water will be added and the lift will be disced to distribute the moisture evenly.

Results of testing will be certified within 7 days of soil liner placement.

4.4.3.1 Record Test Failure

The following procedures shall be used in the event of density or hydraulic conductivity test failure:

A. Failed Density Test: Recompaction of the failed area shall be performed and retested until the area meets or exceeds requirements outlined in the specifications.

B. Failed Hydraulic Conductivity Test: The area of failure shall be localized and reconstructed in accordance with the project specifications. This area will be retested as outlined within the plan by the CQA Engineer. Optionally, at least five replicate samples shall be obtained and tested by the Contractor in the immediate vicinity of the failed test. If all five samples pass, then the initial failing test will be discounted. However, should the replicate samples confirm the failure of the soil liner to meet specifications, the area of failure shall be localized, reconstructed, and retested as described above.

4.4.4 Judgmental Testing

During construction, the frequency of control and/or record testing may be increased at the discretion of the CQA Engineer when visual observations of construction performance indicate a potential problem. Additional testing for suspected areas will be considered when:

- the rollers slip during rolling operation;
- the lift thickness is greater than specified;
- the fill material is at an improper moisture content;
- fewer than the specified number of roller passes are made;
- dirt-clogged rollers are used to compact the material;
- the rollers may not have used optimum ballast;
- the fill materials differ substantially from those specified; or
- the degree of compaction is doubtful.

4.4.5 Perforations In Soil Liner

All holes shall be patched with compacted soil liner (if allowed by the project specifications) or sodium bentonite compacted and hydrated in the holes.

4.5 Deficiencies

The CQA Engineer will immediately determine the extent and nature of all defects and deficiencies and report them to the Owner and Engineer. All defects and deficiencies will be documented by the CQA Engineer. The Contractor shall correct defects and deficiencies to the satisfaction of the CQA Engineer. The CQA Engineer will observe all retests on repaired defects.

Table 4.1 CQA Testing Program for Soil Liner Material Approval

Property	Test Method	Minimum Test Frequency
Control Tests:		
Visual Classification	ASTM D 2488	Each Soil
Moisture Content	ASTM D 2216	2,000 CY per Each Soil
Grain Size Analysis	ASTM D 422	2,000 CY per Each Soil
Atterberg Limits	ASTM D 4318	2,000 CY per Each Soil
Moisture-Density Relationship	ASTM D 698	5,000 CY per Each Soil
Hydraulic Conductivity - Lab Remolded	ASTM D 5084[3]	10,000 CY per Each Soil

Table 4.2 CQA Testing Program for Soil Liner Test Fill

Property	Test Method	Minimum Test Frequency
Control Tests: (See **Table 4.1**)		
Moisture-Density Relationship	ASTM D 698[4]	1 per lift
Hydraulic Conductivity - Lab Remolded	ASTM D 5084[3,4]	1 per lift
Record Tests:		
Lift Thickness	-----	Each Lift
Atterberg Limits	ASTM D 4318	1 per lift
Grain Size Analysis	ASTM D 422	1 per lift
In-Place Density	ASTM D 2922[1]	3 per lift
Moisture Content	ASTM D 6938[2]	3 per lift
Hydraulic Conductivity - Undisturbed (Shelby Tube)	ASTM D 5084[3]	1 per lift

Table 4.3 CQA Testing Program for Soil Liner

Property	Test Method	Minimum Test Frequency
Control Tests: (See **Table 4.1**)		
Record Tests:		
Lift Thickness	-----	Each Lift
In-Place Density	ASTM D 6938[1]	10,000 ft^2 per lift
Moisture Content	ASTM D 6938[2]	10,000 ft^2 per lift
Hydraulic Conductivity - Undisturbed (Shelby Tube)	ASTM D 5084[3]	40,000 ft^2 per lift

Notes:

1. Optionally use ASTM D 1556, ASTM D 2167, or ASTM D 2937. For every 10 nuclear density tests perform at least 1 density test by ASTM D 1556, ASTM D 2167, or ASTM D 2937 as a verification of the accuracy of the nuclear testing device.

2. Optionally use ASTM D 2216, ASTM D 4643, or ASTM D 4959. For every 10 nuclear moisture tests perform at least 1 moisture test by ASTM D 2216, ASTM D 4643, or ASTM D 4959 as a verification of the accuracy of the nuclear testing device.

3. Maximum effective confining pressure and hydraulic gradient as required by the project specifications. Backpressure as recommended by ASTM D 5084.

4. These tests performed on the test fill may count toward the minimum frequencies established in **Table 4.1**.

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5.0 GEOMEMBRANE CQA

This section of the CQA Manual addresses the geomembrane components of the ash monofill liner and final cover systems and the geomembrane component of the Area 1 C&D landfill unit final cover system and outlines the CQA program to be implemented with regard to manufacturer and installer approval, material approval, subgrade approval, field and laboratory control and record tests, repairs, and resolution of problems.

5.1 Geomembrane Manufacturer and Installer Approval

The Contractor shall submit the qualifications of the Geomembrane Manufacturer and the Geomembrane Installer, as described in the specifications, to the CQA Engineer for approval.

5.2 Geomembrane Material Approval

5.2.1 Geomembrane Product Data

The CQA Engineer will review the Contractor's submittals for conformance with the project specifications.

5.2.2 Shipment And Storage

During shipment and storage, all geomembrane will be protected as required by the project specifications. The CQA Engineer will observe rolls upon delivery at the site.

5.2.3 Quality Control Certificates

Upon delivery, the CQA Engineer will:

- verify 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 verify that the certified properties meet the project technical specifications

5.2.4 Material Control Tests

Samples for material control tests, as shown on **Table 5.1**, will be obtained by the CQA Engineer at the indicated frequencies upon delivery of the geomembrane. Alternatively, samples may be randomly obtained at the

manufacturing site by the CQA Engineer or representatives of the Geosynthetics CQA Laboratory.
Unless otherwise specified, samples will be 3 feet long by the roll or sheet width. The CQA Engineer will mark the machine direction on the samples with an arrow.

All material control tests will be performed by the Geosynthetics CQA Laboratory.

All control test results must be available at the site prior to the deployment of all geomembrane. The CQA Engineer will examine all results from laboratory conformance testing.

5.2.4.1 Material Control Test Failure

The following procedure will apply whenever a sample fails a material control test:

A. The Geomembrane Installer will replace the roll or sheet of geomembrane that is in nonconformance with the project specifications with a roll or sheet that meets project specifications.

B. The Geomembrane Installer will remove conformance samples for testing by the Geosynthetics CQA Laboratory from the closest numerical roll or sheet on both sides of the failed roll or sheet. These two samples must both conform to project specifications. If either of these samples fails, 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 fails, the Engineer will dictate the frequency of additional testing.

The CQA Engineer will document actions taken in conjunction with material control test failures.

5.3 Geomembrane Installation

5.3.1 Handling

The Geosynthetic Installer will handle all geomembrane in such a manner as required by the project specifications.

5.3.2 Earthwork

5.3.2.1 Surface Preparation

The Geomembrane Installer will certify in writing that the surface on which the geomembrane will be installed meets line and grade, and the surface preparation requirements of the project specifications. The certificate of acceptance will be given to the CQA Engineer prior to commencement of geomembrane installation in the area under consideration. The CQA Engineer will give a copy of this certificate to the Engineer.

To ensure a timely covering of the subgrade surface, the Engineer may allow subgrade acceptance in areas as small as one acre. After the supporting soil has been accepted by the Geomembrane Installer, it will be the Geomembrane Installer's responsibility to indicate to the Engineer and CQA Engineer any change in the supporting soil condition that may require repair work. If the CQA Engineer concurs with the Geomembrane Installer, then the Engineer will ensure that the supporting soil is repaired.

5.3.2.2 Anchorage System

The CQA Engineer will verify that anchor trenches have been constructed and backfilled according to project specifications and design drawings.

5.3.3 Geomembrane Placement

5.3.3.1 Field Panel Identification

The CQA Engineer will document that the Geomembrane Installer labels each field panel with an "identification code" (number or letter-number consistent with the layout plan) agreed upon by the Geomembrane Installer and CQA Engineer at the Geosynthetics CQA Meeting (see **Section 1.6.2**).

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 Engineer weekly for review and verification. The field panel identification code will be used for all quality control and quality assurance records.

5.3.3.2 Field Panel Placement

Location: The CQA Engineer will verify that field panels are installed at the location indicated in the Geomembrane Installer's layout plan, as approved or modified in **Section 5.3.3.1**.

Installation Schedule: The CQA Engineer will evaluate every change in the schedule proposed by the Geomembrane Installer and advise the Engineer on the acceptability of that change.

The CQA Engineer will record the identification code, location, and date of installation of each field panel.

Placement of Geomembrane: The CQA Engineer will verify that project specification related restrictions on placement of geomembrane are fulfilled. Additionally, the CQA Engineer will verify that the supporting soil has not been damaged by weather conditions.

Damage: The CQA Engineer will visually observe each panel, after placement and prior to seaming, for damage. The CQA Engineer will advise the Engineer which panels, or portion 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 Engineer. Repairs will be made according to procedures described in this section.

As a minimum, the CQA Engineer will document that:

- the panel is placed in such a manner that it is unlikely to be damaged; and
- any tears, punctures, holes, thin spots, etc. are either marked by the Geomembrane Installer for repair or the panel is rejected.

5.3.4 Field Seaming

5.3.4.1 Seam Layout

The Geomembrane Installer will provide the CQA Engineer with a seam layout drawing, i.e., a drawing of the area to be lined showing all expected seams. The CQA Engineer and Engineer will review the seam layout drawing and verify that it is consistent with the accepted state of practice and this CQA Manual.

A seam numbering system compatible with the panel numbering system will be agreed upon at the Geosynthetics CQA Meeting (see **Section 1.6.2**). An on-going written record of the seams and repair areas shall be maintained by the Geomembrane Installer with weekly review by the CQA Engineer.

5.3.4.2 Requirements of Personnel

The Geomembrane Installer will provide the CQA Engineer with a list of proposed seaming personnel and their experience records. This document will be reviewed by the CQA Engineer for compliance with project specifications.

5.3.4.3 Seaming Equipment and Products

Field seaming processes must comply with project specifications. Proposed alternate processes will be documented and submitted to the Engineer and CQA Engineer for their approval. Only seaming apparatus which have been specifically approved by make and model will be used. The CQA Engineer will submit all documentation to the Engineer for his concurrence.

5.3.5 Field Seam Control Tests

5.3.5.1 Trial Seams

A. Prior to production seaming, after four (4) hours of continuous seaming, and/or when significant changes in geomembrane or ambient temperature occurs, the Geomembrane Installer shall perform trial seams to verify that seaming conditions and procedures are adequate. Trial seams shall be performed by each operator of extrusion welders and by the primary operator of each wedge welder using seaming equipment to be used in production seaming.

B. Trial seams shall be made on appropriate sized pieces of identical or equivalent geomembrane material.

C. Hot wedge trial seams shall be approximately 72" x 12" with the seam centered lengthwise. Extrusion fillet trial seams shall be approximately 36" x 12" with the seam centered lengthwise. A minimum of four coupons shall be tested in peel and shear (two each) (ASTM D 6392) by the Geomembrane Installer using a field tensiometer. All coupons shall meet the minimum seam strength requirements as shown in the project specifications.

D. Each trial seam shall be assigned a number and the test results recorded in the appropriate log by the Geomembrane Installer. The CQA Engineer will observe all trial seams and compile all trial seam logs.

5.3.6 Field Seam Record Tests

5.3.6.1 Nondestructive Seam Continuity Testing

The Geomembrane Installer shall test and document all seams continuously over their full length using one of the following nondestructive seam tests. This testing shall be performed simultaneously with geomembrane deployment as the work progresses and not at the completion of all field seaming.

A. Vacuum Testing shall conform to ASTM D 5641 requirements.

B. Air Pressure Testing (for double seam with an enclosed space) shall conform to ASTM D 5820 requirements and the requirements listed in **Table 5.2**.

The CQA Engineer will observe the nondestructive testing on a full time basis to ensure conformance with this CQA Manual and the project specifications.

5.3.6.2 Field Destructive Seam Testing

A. The Geomembrane Installer shall obtain 12" x 30" (or longer as needed) samples of field seams with the seam centered lengthwise, suitable for testing, at an average frequency of one sample per 500 linear feet of seam. The sample shall be cut into two equal-length pieces, one for field destructive seam testing by the Geosynthetics Installer and one given to the CQA Engineer as an archive sample. The date, time, equipment, seam number, and seaming parameters will be marked on each sample and recorded by the CQA Engineer.

B. The Geomembrane Installer shall perform and document field destructive seam testing using a field tensiometer which has been calibrated within the prior 6 months (calibration information shall be provided to the CQA Engineer). A minimum of three (3) coupons each will be tested in peel and shear (ASTM D 6392). Coupons shall meet the minimum seam strength requirements as shown in the project specifications.

C. The CQA Engineer or the Owner may require additional random samples to be taken for testing in areas which visually appear defective and not in accordance with the project requirements.

D. All holes in the geomembrane resulting from destructive seam sampling shall be immediately repaired in accordance with repair procedures described in this manual.

5.3.6.3 Geosynthetics CQA Laboratory Destructive Testing

A. The Geomembrane Installer shall obtain 12" x 30" (or longer as needed) samples of field seams with the seam centered lengthwise, suitable for testing, at an average frequency of one sample per day to confirm field destructive seam tests. The sample shall be cut into two equal-length pieces, both to be given to the CQA Engineer for laboratory destructive seam testing and as an archive sample. The date, time, equipment, seam number, and seaming parameters will be marked on each sample and recorded by the CQA Engineer.

B. Laboratory destructive test samples will be packaged and shipped to the Geosynthetics CQA Laboratory by the CQA Engineer in a manner that will not damage the test sample.

C. A minimum of five (5) coupons each will be tested in peel and shear (ASTM D 6392) by the Geosynthetics CQA Laboratory. Coupons shall meet the minimum seam strength requirements as shown in the project specifications.

D. All geomembrane destructive test samples that fail to meet project specifications will be saved and sent to the CQA Engineer for observation.

E. The CQA Engineer will review laboratory test results as soon as they become available.

5.3.6.4 Field Seam Record Test Failure

For noncomplying tests, the CQA Engineer will:

- observe continuity testing of the repaired areas performed by the Geomembrane Installer;

- confirm the record location, date, test unit number, name of tester, and compile the record of testing provided by the Geomembrane Installer;

- provide a walk-through inspection of all impacted seam areas and verify that the areas have been tested in accordance with the CQA Manual and project specifications; and

- verify that the Geomembrane Installer has marked repair areas with the appropriate color-coded marking pencil.

5.3.6.5 Defining Extent of Field Seam Record Test Failure

All defective seam test failures must be bounded by acceptable destructive tests. The CQA Engineer will document repair actions taken in conjunction with all seam test failures.

5.3.7 Repairs & Verification

5.3.7.1 Repair Procedures

A. All repair procedures shall be in accordance with the project specifications. The CQA Engineer will observe all repair procedures.

B. All surfaces shall be clean and dry at the time of the repair.

C. After an extrusion seam is made, no more than ¼ inch of abrasion shall be visible beyond the weld.

5.3.7.2 Repair Verification

A. Each repair shall be numbered and logged by the Geomembrane Installer.

B. Each repair shall be non-destructively tested by the Geomembrane Installer using the methods described above. Repairs which pass non-destructive testing shall be taken as an indication of an adequate repair.

C. Repairs more than 150 feet long may be of sufficient length to require destructive test sampling, at the discretion of the CQA Engineer. A failed test indicates that the repair shall be redone and retested until passing test results are achieved.

5.4 Liner System Acceptance

The geomembrane component of the liner system will be accepted by the Owner when:

- the installation is finished;

- verification of the adequacy of all seams and repairs, including associated testing, is complete;

- CQA Engineer provides the Engineer with a final copy of the nondestructive test documentation, repair information, and as-built drawings, as submitted by the Geomembrane Installer;

- CQA Engineer provides the Engineer with a certification, 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 project specifications; and

- all documentation of the installation is completed including the CQA Engineer's final report.

5.5 Materials in Contact with Geomembranes

The quality assurance procedures indicated in this subsection are only intended to assure that the installation of these materials does not damage the geomembrane. All reasonable measures to protect the geomembrane and provide additional quality assurance procedures are necessary to assure that systems built with these materials will be constructed to ensure proper performance.

5.5.1 Soils

Prior to placement, the CQA Engineer will visually confirm that all soil materials to be placed against the geomembrane comply with project specifications. The Geomembrane Installer will provide the CQA Engineer a written surface acceptance certificate in accordance with **Section 5.3.2**. All soil materials shall be placed and compacted in accordance with project specifications.

5.5.2 Sumps and Appurtenances

The CQA Engineer will verify that:

- installation of the geomembrane in appurtenance areas, and connection of the geomembrane to appurtenances have been made according to the project specifications;

- extreme care is taken while seaming around appurtenances since neither nondestructive nor destructive testing may be feasible in these areas; and

- the geomembrane or appurtenances have not been visibly damaged while making connections to appurtenances.

5.6 Deficiencies

The CQA Engineer will immediately determine the extent and nature of all defects and deficiencies and report them to the Owner and Engineer. All defects and deficiencies will be documented by the CQA Engineer. The Contractor shall correct defects and deficiencies to the satisfaction of the CQA Engineer. The CQA Engineer will observe all retests on repaired defects.

Table 5.1 CQA Testing Program for Geomembrane Material Approval

Property	Test Method	Test Frequency
Thickness	ASTM D 5199/D 5994	100,000 ft^2 or 1 per Lot[1]
Density	ASTM D 1505/D 792	100,000 ft^2 or 1 per Lot[1]
Carbon Black Content	ASTM D 1603	100,000 ft^2 or 1 per Lot[1]
Carbon Black Dispersion	ASTM D 5596	100,000 ft^2 or 1 per Lot[1]
Tensile Properties:	ASTM D 6693 (Type IV)	
Tensile Strength at Yield		100,000 ft^2 or 1 per Lot[1]
Tensile Strength at Break		100,000 ft^2 or 1 per Lot[1]
Elongation at Yield		100,000 ft^2 or 1 per Lot[1]
Elongation at Break		100,000 ft^2 or 1 per Lot[1]
Tear Resistance	ASTM D 1004	100,000 ft^2 or 1 per Lot[1]

Notes:

1. Whichever provides the larger number of tests.

Table 5.2 Air Pressure Test Requirements

Material	Minimum Pressure (PSI)	Maximum Pressure Drop (PSI) After 5 Minutes
30 Mil LLDPE 40 Mil LLDPE ≥ 60 Mil HDPE	25	3

6.0 LEACHATE MANAGEMENT SYSTEM CQA

This section of the CQA Manual addresses the components of the ash monofill leachate management system including components of the leachate collection system (LCS) (drainage aggregate, collection pipe, etc.) and the leachate transmission and storage system (sumps, transmission piping, manholes, valves, and storage pond). By reference to **Sections 7.0 and 8.0** of this CQA Manual, this section also addresses the geotextiles and drainage geocomposite that are components of the LCS. This section outlines the CQA program to be implemented with regard to material approval, construction monitoring, and resolution of problems.

6.1 Leachate Management System Material Approval

The CQA Engineer will verify that the following are provided and installed in accordance with the project drawings, specifications, and this CQA Manual.

6.1.1 Coarse Aggregate (Drainage Aggregate)

A. Receipt of Contractor's submittals on coarse aggregate.

B. Review of submittals for coarse aggregate for conformity to the project specifications.

C. Verify that coarse aggregate in stockpiles or at borrow sources conforms to the project specifications.

D. Conduct material control tests in accordance with **Table 6.1**.

6.1.2 High Density Polyethylene (HDPE) Pipe

A. Receipt of Contractor's submittals on HDPE pipe.

B. Review of submittals for HDPE pipe for conformity to the project specifications.

6.1.3 Geotextiles (Verify for each type of Geotextile)

The CQA program for geotextiles is presented in **Section 7.0** of this CQA Manual.

6.1.4 Drainage Geocomposite

The CQA program for drainage geocomposite is presented in **Section 8.0** of this CQA Manual.

6.1.5 Sumps/Manholes

A. Receipt of Contractor's submittals on sumps/manholes.

B. Review of submittals for sumps/manholes for conformity to the project specifications.

6.1.6 Valves

A. Receipt of Contractor's submittals on valves.

B. Review of submittals for valves for conformity to the project specifications.

6.2 Leachate Management System Installation

6.2.1 Leachate Collection System (LCS)

The CQA Engineer will allow installation of the LCS to proceed only after he has been provided certification of the installed HDPE geomembrane.

The CQA Engineer will monitor and document the construction of all LCS components for compliance with the project specifications. Monitoring the construction work includes the following:

- monitoring the minimum vertical buffer maintained between field equipment and the geomembrane;
- monitoring that the placement of the LCS components does not fold or damage the geomembrane or other underlying layers; and
- witness and verify the installation of collection piping and gravel columns.

6.2.2 Leachate Transmission and Storage System

The CQA Engineer will monitor and document the construction of all leachate transmission and storage system components for compliance with the project specifications. Monitoring the construction work includes the following:

- witness and verify the installation of transmission piping;
- witness and verify the leak testing of transmission piping.

6.3 Deficiencies

The CQA Engineer will immediately determine the extent and nature of all defects and deficiencies and report them to the Owner and Engineer. All defects and deficiencies will be documented by the CQA Engineer. The Contractor shall correct defects and deficiencies to the satisfaction of the CQA Engineer. The CQA Engineer will observe all retests on repaired defects.

Table 6.1 CQA Testing Program for Leachate Management System

Component	Property	Test Method	Minimum Test Frequency
Control Tests:			
Coarse Aggregate:	Gradation	ASTM C 136	5,000 CY
	Carbonate Content	ASTM D 3042	1 per source

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7.0 GEOTEXTILE CQA

This section of the CQA Manual addresses geotextiles and outlines the CQA program to be implemented with regard to material approval, material control tests, repairs, and resolution of problems.

7.1 Geotextile Material Approval

7.1.1 Geotextile Product Data

For each type of geotextile to be used, the CQA Engineer will review the Contractor's submittals for conformance with the project specifications.

7.1.2 Shipment And Storage

During shipment and storage, all geotextiles will be protected as required by the project specifications. The CQA Engineer will observe rolls upon delivery at the site.

7.1.3 Quality Control Certificates

Upon delivery, the CQA Engineer will:

- verify that the Manufacturer's quality control certificates have been provided at the specified frequency and that each certificate identified the rolls related to it; and

- review the Manufacturer's quality control certificates and verify that the certified properties meet the project technical specifications.

7.1.4 Geotextile Material Control Tests

Samples for material control tests, as shown on **Table 7.1**, will be obtained by the CQA Engineer at the indicated frequencies upon delivery of the geotextiles. Alternatively, samples may be randomly obtained at the manufacturing site by the CQA Engineer or representatives of the Geosynthetics CQA Laboratory.

Unless otherwise specified, samples will be 3 feet long by the roll width. The CQA Engineer will mark the machine direction on the samples with an arrow.

All material control tests will be performed by the Geosynthetics CQA Laboratory.

All test results must be available at the site prior to the deployment of all geotextiles. The CQA Engineer will examine all results from laboratory testing.

7.1.4.1 Material Control Test Failure

The following procedure will apply whenever a sample fails a material control test:

A. The Geosynthetic Installer will replace the roll of geotextile that is in nonconformance with the project specifications with a roll that meets project specifications.

B. The Geosynthetic Installer will remove samples for testing by the Geosynthetics CQA Laboratory from the closest numerical roll on both sides of the failed roll. These two samples must both conform to project specifications. If either of these samples fails, 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 fails, the Engineer will dictate the frequency of additional testing.

The CQA Engineer will document actions taken in conjunction with material control test failures.

7.2 Geotextile Installation

7.2.1 Handling And Placement

The Geosynthetic Installer will handle and place all geotextiles in such a manner as required by the project specifications.

7.2.2 Seams And Overlaps

All geotextiles will be seamed or overlapped in accordance with project specifications or as approved by the CQA Engineer and Engineer.

7.2.3 Repairs

Any holes or tears in the geotextile will be repaired in accordance with the project specifications. The CQA Engineer will observe any repair.

7.2.4 Placement Of Overlying Materials

All soil materials located on top of a geotextile shall be placed in accordance with the project specifications.

7.3 Deficiencies

The CQA Engineer will immediately determine the extent and nature of all defects and deficiencies and report them to the Owner and Engineer. All defects and deficiencies will be documented by the CQA Engineer. The Contractor shall correct defects and deficiencies to the satisfaction of the CQA Engineer. The CQA Engineer will observe all retests on repaired defects.

Table 7.1 CQA Testing Program for Geotextile Material Approval

Property	Test Method	Test Frequency
Control Tests:		
Tensile Properties	ASTM D 4632	100,000 ft^2 or 1 per Lot[1]
Puncture Resistance	ASTM D 6241	100,000 ft^2 or 1 per Lot[1]
Trapezoidal Tear Strength	ASTM D 4533	100,000 ft^2 or 1 per Lot[1]
Mass Per Unit Area (Type GT- C Geotextile Only)	ASTM D 5261	100,000 ft^2 or 1 per Lot[1]
Apparent Opening Size (AOS) (Type GT-S Geotextile Only)	ASTM D 4751	100,000 ft^2 or 1 per Lot[1]

Notes:

1. Whichever provides the larger number of tests.

2. CQA testing is not required for geotextiles placed outside of the containment area.

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8.0 DRAINAGE GEOCOMPOSITE CQA

This section of the CQA Manual addresses drainage geocomposite (DGC) and outlines the CQA program to be implemented with regard to material approval, material control tests, repairs, and resolution of problems.

8.1 DGC Material Approval

8.1.1 DGC Product Data

The CQA Engineer will review the Contractor's submittals for conformance with the project specifications.

8.1.2 Shipment And Storage

During shipment and storage, all DGC will be protected as required by the project specifications. The CQA Engineer will observe rolls upon delivery at the site.

8.1.3 Quality Control Certificates

Upon delivery, the CQA Engineer will:

- verify that the Manufacturer's quality control certificates have been provided at the specified frequency and that each certificate identified the rolls related to it; and

- review the Manufacturer's quality control certificates and verify that the certified properties meet the project technical specifications.

8.1.4 DGC Material Control Tests

Samples for material control tests, as shown on **Table 8.1**, will be obtained by the CQA Engineer at the indicated frequencies upon delivery of the DGC. Alternatively, samples may be randomly obtained at the manufacturing site by the CQA Engineer or representatives of the Geosynthetics CQA Laboratory.

Unless otherwise specified, samples will be 3 feet long by the roll width. The CQA Engineer will mark the machine direction on the samples with an arrow.

All material control tests will be performed by the Geosynthetics CQA Laboratory.

All test results must be available at the site prior to the deployment of all DGC. The CQA Engineer will examine all results from laboratory testing.

8.1.4.1 Material Control Test Failure

The following procedure will apply whenever a sample fails a material control test:

A. The Geosynthetic Installer will replace the roll of DGC that is in nonconformance with the project specifications with a roll that meets project specifications.

B. The Geosynthetic Installer will remove samples for testing by the Geosynthetics CQA Laboratory from the closest numerical roll on both sides of the failed roll. These two samples must both conform to project specifications. If either of these samples fails, 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 fails, the Engineer will dictate the frequency of additional testing.

The CQA Engineer will document actions taken in conjunction with material control test failures.

8.2 DGC Installation

8.2.1 Handling And Placement

The Geosynthetic Installer will handle and place all DGC in such a manner as required by the project specifications.

8.2.2 Stacking And Joining

When several layers of DGC are stacked, care should be taken to ensure that stacked DGC are placed in the same direction. Stacked DGC will never be laid in perpendicular directions to the underlying DGC (unless otherwise specified by the Engineer). The CQA Engineer will observe the stacking of DGC.

Adjacent rolls of DGC will be joined according to construction drawings and project specifications.

8.2.3 Repairs

Any holes or tears in the DGC will be repaired in accordance with the project specifications. The CQA Engineer will observe any repair.

8.2.4 Placement Of Overlying Materials

All soil materials located on top of DGC shall be placed in accordance with the project specifications.

8.3 Deficiencies

The CQA Engineer will immediately determine the extent and nature of all defects and deficiencies and report them to the Owner and Engineer. All defects and deficiencies will be documented by the CQA Engineer. The Contractor shall correct defects and deficiencies to the satisfaction of the CQA Engineer. The CQA Engineer will observe all retests on repaired defects.

Table 8.1 CQA Testing Program for Drainage Geocomposite Material Approval

Property	Test Method	Test Frequency
Control Tests:		
Thickness (geonet only)	ASTM D 5199	100,000 ft^2 or 1 per Lot[1]
Density (geonet only)	ASTM D 1505	100,000 ft^2 or 1 per Lot[1]
Ply Adhesion	ASTM D 7005	100,000 ft^2 or 1 per Lot[1]
Transmissivity	ASTM D 4716[2]	1 per Resin Lot

Notes:

1. Whichever provides the larger number of tests.

2. Conduct tests for transmissivity in accordance with the conditions given in the project specifications.

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9.0 GEOSYNTHETIC CLAY LINER (GCL) CQA

This section of the CQA Manual addresses geosynthetic clay liner (GCL) and outlines the CQA program to be implemented with regard to material approval, material control tests, repairs, and resolution of problems.

9.1 GCL Manufacturer and Installer Approval

The Contractor shall submit the qualifications of the GCL Manufacturer and the GCL Installer, as described in the specifications, to the CQA Engineer for approval.

9.2 GCL Material Approval

9.2.1 GCL Product Data

The CQA Engineer will review the Contractor's submittals for conformance with the project specifications.

9.2.2 Shipment And Storage

During shipment and storage, GCL will be protected as required by the project specifications. The CQA Engineer will observe rolls upon delivery at the site.

9.2.3 Quality Control Certificates

Upon delivery, the CQA Engineer will:

- verify that the Manufacturer's quality control certificates have been provided at the specified frequency and that each certificate identified the rolls related to it; and

- review the Manufacturer's quality control certificates and verify that the certified properties meet the project technical specifications.

9.2.4 GCL Material Control Tests

Samples for material control tests, as shown on **Table 9.1**, will be obtained by the CQA Engineer at the indicated frequencies upon delivery of the GCL. Alternatively, samples may be randomly obtained at the manufacturing site by the CQA Engineer or representatives of the Geosynthetics CQA Laboratory.

Unless otherwise specified, samples will be 3 feet long by the roll width. The CQA Engineer will mark the machine direction on the samples with an arrow.

All material control tests will be performed by the Geosynthetics CQA Laboratory.

All test results must be available at the site prior to the deployment of all GCL. The CQA Engineer will examine all results from laboratory testing.

9.2.4.1 Material Control Test Failure

The following procedure will apply whenever a sample fails a material control test:

A. The Geosynthetic Installer will replace the roll of GCL that is in nonconformance with the project specifications with a roll that meets project specifications.

B. The Geosynthetic Installer will remove samples for testing by the Geosynthetics CQA Laboratory from the closest numerical roll on both sides of the failed roll. These two samples must both conform to project specifications. If either of these samples fails, 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 fails, the Engineer will dictate the frequency of additional testing.

The CQA Engineer will document actions taken in conjunction with material control test failures.

9.3 GCL Installation

9.3.1 Handling And Placement

The Geosynthetic Installer will handle and place all GCL in such a manner as required by the project specifications.

9.3.2 Seams And Overlaps

All GCL will be seamed or overlapped in accordance with project specifications or as approved by the CQA Engineer and Engineer.

9.3.3 Repairs

Any holes or tears in the GCL will be repaired in accordance with the project specifications. The CQA Engineer will observe any repair.

9.3.4 Placement Of Overlying Materials

All soil materials located on top of the GCL shall be placed in accordance with the project specifications.

9.4 Deficiencies

The CQA Engineer will immediately determine the extent and nature of all defects and deficiencies and report them to the Owner and Engineer. All defects and deficiencies will be documented by the CQA Engineer. The Contractor shall correct defects and deficiencies to the satisfaction of the CQA Engineer. The CQA Engineer will observe all retests on repaired defects.

Table 9.1 CQA Testing Program for GCL Material Approval

Property	Test Method	Test Frequency
Control Tests:		
Hydraulic Conductivity	ASTM D 5084/D 5887	100,000 ft^2 or 1 per Lot[1]
Bentonite Content	ASTM D 5993 (@ 0% moisture)	100,000 ft^2 or 1 per Lot[1]
Peel Strength	ASTM D 6496	100,000 ft^2 or 1 per Lot[1]

Notes:

1. Whichever provides the larger number of tests.

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10.0 FINAL COVER SYSTEM CQA

This section of the CQA Manual addresses the landfill gas (LFG) system (C&D landfill units), drainage aggregate and piping, and the vegetative soil layer of the final cover system. By reference to **Sections 4.0, 5.0, 7.0, and 8.0** of this CQA Manual, this section also addresses the soil liner, geomembrane, geotextiles, and drainage geocomposite that are included in the final cover systems for the C&D landfill units and/or ash monofill. This section outlines the CQA program to be implemented with regard to material approval, construction monitoring, and resolution of problems.

10.1 Final Cover System Material Approval

The CQA Engineer shall verify that the following are provided and installed in accordance with the project drawings, specifications, and this CQA Manual.

10.1.1 High Density Polyethylene (HDPE) Pipe

A. Receipt of Contractor's submittals on HDPE pipe.

B. Review of submittals for HDPE pipe for conformity to the project specifications.

10.1.2 Polyvinyl Chloride (PVC) Pipe

A. Receipt of Contractor's submittals on PVC pipe.

B. Review of submittals for PVC pipe for conformity to the project specifications.

10.1.3 Corrugated Polyethylene (CPE) Pipe

A. Receipt of Contractor's submittals on CPE pipe.

B. Review of submittals for CPE pipe for conformity to the project specifications.

10.1.4 LFG System Components

A. Receipt of Contractor's submittals on LFG system components.

B. Review of submittals for LFG system components for conformity to the project specifications.

10.1.5 Aggregates (Verify for each type of aggregate)

A. Receipt of Contractor's submittals on aggregates.

B. Review of submittals for aggregates for conformity to the project specifications.

C. Verify that aggregates in stockpiles or at borrow sources conform to the project specifications.

D. Conduct material control tests in accordance with **Table 10.1**.

10.1.6 Soil Liner

The CQA program for soil liner is presented in **Section 4.0** of this CQA Manual.

10.1.7 Geomembrane

The CQA program for geomembranes is presented in **Section 5.0** of this CQA Manual.

10.1.8 Geotextiles

The CQA program for geotextiles is presented in **Section 7.0** of this CQA Manual.

10.1.9 Drainage Geocomposite

The CQA program for drainage geocomposite is presented in **Section 8.0** of this CQA Manual.

10.1.10 Vegetative Soil Layer

A. Review the proposed source of vegetative soil layer for conformance with the project specifications.

B. Conduct material control tests in accordance with **Table 10.1**.

10.2 Final Cover System Installation

The CQA Engineer will monitor and document the construction of all final cover system components for compliance with the project specifications. Monitoring the construction work for the components of the final cover system includes the following:

- verify location and depth of LFG wells;
- verify location of all piping;

- monitoring the minimum vertical buffer maintained between field equipment and geosynthetics/piping; and

- monitoring that the placement of the final cover system components does not fold or damage the geosynthetics or other underlying layers.

10.3 Deficiencies

The CQA Engineer will immediately determine the extent and nature of all defects and deficiencies and report them to the Owner and Engineer. All defects and deficiencies will be documented by the CQA Engineer. The Contractor shall correct defects and deficiencies to the satisfaction of the CQA Engineer. The CQA Engineer will observe all retests on repaired defects.

Table 10.1 CQA Testing Program for Final Cover System

Component	Property	Test Method	Minimum Test Frequency
Control Tests:			
Coarse Aggregate:	Gradation	ASTM C 136	5,000 CY
Vegetative Soil Layer:	Visual Classification	ASTM D 2488	Each Load
	Grain Size Analysis	ASTM D 422	5,000 CY
	Atterberg Limits	ASTM D 4318	5,000 CY

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Appendix A

Reference List of Test Methods

Construction Quality Assurance Manual
Halifax County Landfill Facility
Halifax County, North Carolina

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Construction Quality Assurance Manual
Appendix A: Reference List of Test Methods

American Society American Society of Testing and Materials (ASTM):

ASTM C 136	Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
ASTM D 422	Standard Test Method for Particle Size Analysis of Soils.
ASTM D 698	Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3).
ASTM D 792	Standard Test Method for Density and Specific Gravity (Relative Density) of Plastics by Displacement.
ASTM D 1004	Standard Test Method for Initial Tear Resistance of Plastic Film and Sheeting.
ASTM D 1505	Standard Test Method for Density of Plastics by the Density-Gradient Technique.
ASTM D 1556	Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
ASTM D 1603	Standard Test Method for Carbon Black in Olefin Plastics.
ASTM D 2167	Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method.
ASTM D 2216	Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.
ASTM D 2434	Standard Test Method for Permeability of Granular Soils (Constant Head).
ASTM D 2488	Standard Practice for Description and Identification of Soils (Visual-Manual Procedure).
ASTM D 2937	Standard Test Method for Density of Soil in Place by the Drive Cylinder Method.

ASTM D 3042	Standard Test Method for Insoluble Residue in Carbonate Aggregates.
ASTM D 4318	Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
ASTM D 4533	Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
ASTM D 4632	Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
ASTM D 4643	Standard Test Method for Determination of Water (Moisture) Content of Soil by the Microwave Oven Method.
ASTM D 4716	Standard Test Method for Constant Head Hydraulic Transmissivity (In-Plane Flow) of Geotextiles and Geotextile Related Products.
ASTM D 4751	Standard Test Method for Determining Apparent Opening Size of a Geotextile.
ASTM D 4959	Standard Test Method for Determination of Water (Moisture) Content of Soil by Direct Heating Method.
ASTM D 5084	Standard Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter.
ASTM D 5199	Standard Test Method for Measuring Nominal Thickness of Geotextiles and Geomembranes.
ASTM D 5261	Standard Test Method for Measuring Mass per Unit Area of Geotextiles.
ASTM D 5596	Standard Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics.
ASTM D 5641	Standard Practice for Geomembrane Seam Evaluation by Vacuum Chamber.
ASTM D 5820	Standard Practice for Pressurized Air Channel Evaluation of Dual Seamed Geomembranes.

ASTM D 5887	Standard Test Method for Measurement of Index Flux Through Saturated Geosynthetic Clay Liner Specimens Using a Flexible Wall Permeameter.
ASTM D 5993	Standard Test Method for Measuring Mass per Unit of Geosynthetic Clay Liners.
ASTM D 5994	Standard Test Method for Measuring Core Thickness of Textured Geomembrane.
ASTM D 6241	Standard Test Method for the Static Puncture Strength of Geotextiles and Geotextile Related Products Using a 50 mm Probe.
ASTM D 6392	Standard Test Method for Determining the Integrity of Nonreinforced Geomembrane Seams Produced Using Thermo-Fusion Methods.
ASTM D 6496	Standard Test Method for Determining Average Bonding Peel Strength Between the Top and Bottom Layers of Needle-Punched Geosynthetic Clay Liners.
ASTM D 6693	Standard Test Method for Determining Tensile Properties of Nonreinforced Flexible Polyethylene and Nonreinforced Polypropylene Geomembranes.
ASTM D 6938	Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
ASTM D 7005	Standard Test Method for Determining the Bond Strength (Ply Adhesion) of Geocomposites.

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