

Attachment VI-2

Appendix A

CONSTRUCTION QUALITY ASSURANCE PLAN

FOR LANDFILL

CONSTRUCTION AND CLOSURE

CONSTRUCTION QUALITY ASSURANCE PLAN
FOR LANDFILL CONSTRUCTION AND CLOSURE

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1.0 INTRODUCTION

Clean Harbors Grassy Mountain, LLC, (Clean Harbors) has developed this Construction Quality Assurance (CQA) Plan to ensure that construction activities comply with the applicable state and federal regulations, approved design criteria, engineering plans and specifications, and good engineering practice. The attached table of CQA activities provides the Engineering Specifications, Quality Control (QC), and Quality Assurance (QA) inspections, sampling, testing, survey controls, and records required to demonstrate that these requirements have been met. This CQA Plan is contained in the State-issued Part B Permit as Attachment VI-2. This CQA Plan has been prepared by a professional civil engineer licensed in the State of Utah.

The CQA Plan governs compliance in construction of each new phase landfill cell, including foundations, compacted clay liners, geosynthetics, leachate collection and removal systems, leak detections systems, and each phase of final closure.

Clean Harbors is both the owner and operator of the Grassy Mountain Facility located in Grassy Mountain, Utah. Responsibility for the design, construction, operation, and closure of the facility rests with Clean Harbors alone.

1.1 Definitions Relating to Construction Quality Assurance

This CQA Plan is devoted to Construction Quality Assurance. In the context of this document, Construction Quality Assurance and Construction Quality Control are defined as follows:

Construction Quality Assurance (CQA) - A planned and systematic pattern of means and actions designed to assure adequate confidence that materials and/or services meet contractual and regulatory requirements.

Construction Quality Control (CQC) - Those actions which provide a means to measure and regulate the characteristics of an item or service in relation to contractual and regulatory requirements.

In the context of this document:

- CQA refers to means and actions employed by the CQA Consultant to assure conformity of the Project “Work” with this CQA Plan, the Construction Drawings and Project Specifications; and
- CQC refers to those actions taken by the Contractor, Manufacturer, or Geosynthetic Installer to verify that the materials and the workmanship meet the requirements of this CQA Plan, the Construction Drawings, and the Project Specifications. In the case of soil components, CQC is combined with CQA and is provided by the CQA Consultant. In the case of the geosynthetic components and piping of the Work, CQC is provided by the

Manufacturer and Geosynthetic Installer and the Contractor. CQA testing of soil, pipe, concrete, and geosynthetic components is provided by the CQA Consultant.

1.2 Specifications

Should a disparity be documented between a requirement or specification in the CQA Plan, and any other documentation associated with construction or closure of a landfill, the more stringent requirement or specification shall apply.

2.0 PARTIES INVOLVED WITH CONSTRUCTION QUALITY ASSURANCE

This section defines the personnel involved with the development and implementation of the CQA Plan, as well as their qualifications. Figure 1 shows the organizational structure of the project, including lines of communication and authority. Names and contact information of selected personnel will be provided at the pre-construction meeting (Section 4.1.1). The Construction Manager (or his delegate) shall be responsible for coordination with the Director. The responsibilities and qualifications of parties are described below.

2.1 Design Engineer

Responsibilities

The Design Engineer is responsible for the design, Construction Drawings, and Project Specifications for the Project Work. The Design Engineer is responsible for reviewing and approving design changes to the landfill (including final closure) to meet the operational requirements of Clean Harbors and the permitting requirements of the agencies. The Design Engineer will also approve corrective measures to be implemented where deviation occurs during construction of the design.

Qualifications

The Design Engineer (Engineer of Record) shall be a qualified engineer, registered as required by Utah state regulations. The Design Engineer should have expertise that demonstrates significant familiarity with piping, geosynthetics and soils, as appropriate, including design and construction experience related to landfill liner systems. The Design Engineer shall have a minimum of three years experience in the waste industry.

2.2 Construction Manager

Responsibilities

The Construction Manager is responsible for implementing the construction, and overseeing contractors. The Construction Manager may be a Clean Harbors employee or an employee of a different consultant.

Qualifications

The Construction Manager shall have experience with landfill construction projects and have familiarity with earthwork construction and installation of geosynthetic materials.

2.3 Earthworks Contractor

Responsibilities

In this CQA Plan, the Contractor refers to a third party and/or Clean Harbors construction personnel, performing the Work in general accordance with this CQA Plan, the Construction Drawings, and the Project Specifications. The Earthworks Contractor will be responsible for the installation of the soils and appurtenant components of the liner and final cover systems in accordance with contract documents. This work may include excavation, placement and compaction of engineered fill and prepared subgrade, placement of drainage aggregate and operations layer material, installation of piping, installation of temporary erosion control features, and coordination of work with the Geosynthetic Installer and other contractors and subcontractors.

Qualifications

Qualifications of the Earthworks Contractor are specific to the construction contract and Project Specifications. The Earthworks Contractor should have a demonstrated history of successful earthwork construction and maintain current state and federal licenses as appropriate.

2.4 Resin Supplier

Responsibilities

The Resin Supplier produces and delivers the resin to the Geosynthetics Manufacturer.

Qualifications

Qualifications of the Resin Supplier are specific to the Manufacturer's requirements. The Resin Supplier will have a demonstrated history of providing resin with consistent properties and meeting the requirements outlined in the Project Specifications.

2.5 Geosynthetics Manufacturer

Responsibilities

The Manufacturer is responsible for the production of finished material (geomembrane, geotextile, geosynthetic clay liner, geocomposite, pipe, and other specified material, as

appropriate) from appropriate raw materials.

Qualifications

The Manufacturer(s) will be able to provide sufficient production capacity and qualified personnel to meet the demands of the project.

2.6 Geosynthetic Installer

Responsibilities

The Geosynthetic Installer is responsible for field handling, storage, placement, seaming, loading or anchoring against wind uplift, developing the layout plan and other aspects of the geosynthetic material installation. The Geosynthetic Installer may also be responsible for specialized construction tasks.

Qualifications

The Geosynthetic Installer will be trained and qualified to install the geosynthetic materials of the type specified for this project. The Geosynthetic Installer shall meet the qualification requirements identified in the Project Specifications. The Lead Geosynthetic Installer shall have, at a minimum, 10 million square feet of installation experience. The Field Supervisors working for the Geosynthetic Installer shall have, at a minimum, 2 million square feet of installation experience,

2.7 CQA Consultant

Responsibilities

The CQA Consultant is a party, independent from the Contractor, Manufacturer, and Geosynthetic Installer, who is responsible for observing, testing, and documenting activities related to the CQC and CQA of the earthwork, piping, and the geosynthetic components used in the construction of the Project. The CQA Consultant will also be responsible for issuing certification in accordance with Utah Admin. Code R315-8.2.10(d) and a CQA report at the completion of the Project construction, which details the earthworks, piping, and geosynthetic installation activities and associated CQA activities. The certification and CQA report will be signed and sealed by the CQA Officer who will be a Professional Engineer registered in the State of Utah.

The CQA Consultant will be responsible for obtaining and testing representative samples of components used in construction of the Project as required by this CQA Plan and the Project Specifications. Tests will be conducted in accordance with ASTM or other applicable state or federal standards. The CQA Consultant will be responsible for inspecting earthwork, piping, geosynthetic, and cast-in-place concrete construction associated with the Project to verify that

the components are installed in accordance with this CQA Plan, Construction Drawings, and Project Specifications.

Qualifications

The CQA Consultant is a well established firm specializing in geotechnical and geosynthetic engineering and possesses the equipment, personnel, and licenses necessary to conduct the geotechnical and geosynthetic tests required by the project plans and Project Specifications. The CQA Consultant will provide qualified staff for the project, as necessary, and will include a CQA Officer, and a CQA Site Manager. The CQA Officer will be a professionally licensed engineer as required by Utah State regulations and have a minimum of three years of experience in the waste industry.

The CQA Consultant will be experienced with earthwork construction, the installation of geosynthetic materials, and cast-in-place concrete installation, as similar to those materials that may be used in construction of the Project. The CQA Consultant will be experienced in the preparation of CQA documentation including CQA Plans, field documentation, field testing procedures, laboratory testing procedures, construction specifications, construction drawings, and CQA reports.

The CQA Site Manager will be specifically familiar with the construction of earthworks, piping, and the installation of geosynthetic materials and will be trained by the CQA Consultant in the duties of a CQA Site Manager.

2.8 Surveyor

Responsibilities

The Surveyor is a party that is responsible for surveying, documenting, and verifying the location of all significant components of the Work. The Surveyor is responsible for issuing record drawings of the construction.

Qualifications

The Surveyor will be a well established surveying company with experience in the profession of surveying services in the State of Utah. The Surveyor will be a licensed professional as required by the State of Utah regulations.

2.9 CQA Laboratory

Responsibilities

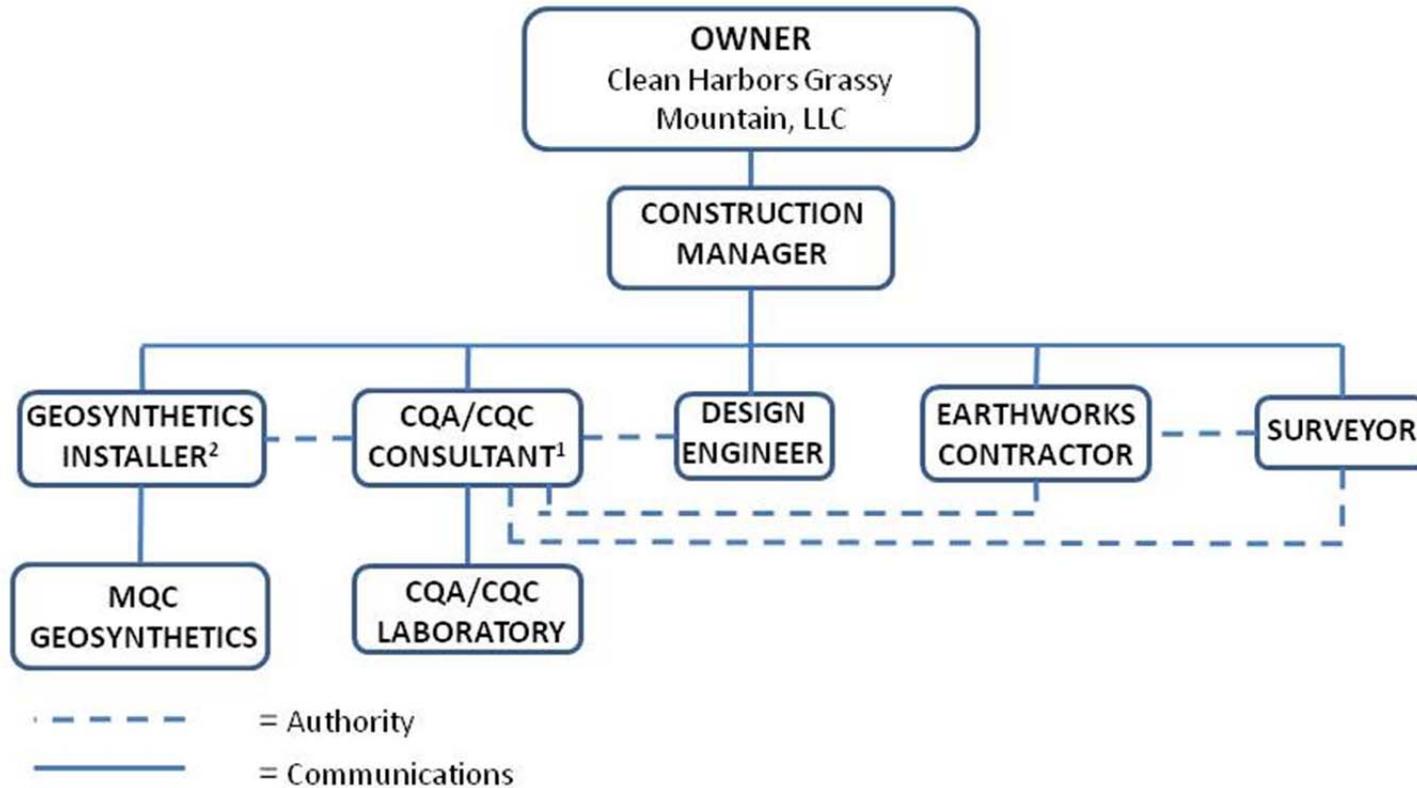
The CQA Laboratory is a party, independent from the Contractor, Manufacturer, and Geosynthetic Installer, that is responsible for conducting tests in accordance with ASTM and

other applicable test standards on samples of geosynthetic materials and soil, in either an on-site or off-site laboratory.

Qualifications

The CQA Laboratory will have experience in testing soils and geosynthetic materials and will be familiar with ASTM and other applicable test standards.

**FIGURE 1
 ORGANIZATION STRUCTURE
 CONSTRUCTION QUALITY CONTROL/QUALITY ASSURANCE**



Notes:

- 1.) The CQA Consultant shall conduct CQC testing on Earthwork materials and installation. The CQA Consultant will not be responsible for providing control for lines and grades of earthwork, this will be the responsibility of the Earthworks Contractor.
- 2.) The Manufacturers Quality Control (MQC) testing and CQC testing of geosynthetic materials and installation will be performed by the Geosynthetics Installer or Supplier and submitted to the CQA Consultant for review.

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3.0 CQA CONSULTANT'S PERSONNEL ORGANIZATION AND DUTIES

3.1 Overview

The CQA Consultant will provide monitoring and testing, as appropriate, of construction activities associated with the project which may include the following:

- excavation and screening of materials;
- placement and compaction of compacted soil, prepared subgrade, compacted clay liner, protective soil cover, and other soil components of the liner and final cover systems;
- installation of geotextile;
- installation of geosynthetic clay liner (GCL);
- installation of high density polyethylene (HDPE) liner (geomembrane);
- installation of drainage aggregate;
- installation of drainage net (geocomposite);
- installation of geotextile;
- placement of gravel armor plating;
- installation of concrete; and
- installation of piping.

The duties of the CQA personnel are provided in Table 1 and are generally discussed in the remainder of this section.

3.2 CQA Personnel

For construction of the Project, the CQA Consultant's personnel will include:

- the CQA Officer, who operates from the office of the CQA Consultant and who conducts periodic visits to the site as required; and
- the CQA Site Manager, who is located at the site.

The duties of the CQA Personnel are discussed in the following subsections.

3.2.1 CQA Officer

The CQA Officer shall supervise and be responsible for monitoring and CQA activities relating to the construction of the earthworks, piping, installation of the geosynthetic materials, and cast-in-place concrete of the Project. Specifically, the CQA Officer will:

- coordinate design issues with the Design Engineer;
- review this CQA Plan, Construction Drawings, and Project Specifications;
- review weekly reports
- review other site-specific documentation; unless otherwise agreed, such reviews are for familiarization and for evaluation of constructability only, and hence the CQA Officer and the CQA Consultant assume no responsibility for design;
- attend progress, pre-construction, and work deficiency meetings, as needed;
- administer the CQA program (i.e., provide supervision of and manage on-site CQA personnel, review field reports, and provide engineering review of CQA related activities);
- provide quality control of CQA documentation and conducts site visits;
- review the record (as-builts) drawings;
- be a licensed engineer in the State of Utah and shall stamp the final CQA report; and
- prepare the CQA report documenting that the project was constructed in accordance with the Construction Documents.

3.2.2 CQA Site Manager

The CQA Site Manager will:

- act as the on-site representative of the CQA Consultant;
- attend CQA-related meetings (e.g., pre-construction, progress, work deficiency (or designates a representative to attend the meeting));

- prepare or oversee the ongoing preparation of the record (as-built) drawings;
- review test results provided by Contractor;
- assign locations for testing and sampling;
- oversee the collection and shipping of laboratory test samples;
- confirm regular calibration of testing equipment is properly conducted and reported;
- review results of laboratory testing and make appropriate recommendations;
- review the calibration and condition of on-site CQA equipment (calibration should be performed in accordance with manufacturer recommendations);
- prepare a daily summary report for the project;
- Prepare a Weekly Report for the project for submittal to the Director (see Section 6.3);
- review the Manufacturer's QC documentation;
- review the Geosynthetic Installer's personnel qualifications for conformance with those pre-approved for work on site;
- note in the daily construction report and report to the CQA Officer and Construction Manager on-site activities that could result in damage to the geosynthetic materials or other completed work;
- document or cause to be documented on a daily basis non-conforming or suspected non-conforming work with the construction, design engineering, and project specifications as defined in the CQA Plan;
- document on a weekly basis a summary of all non-conforming or suspected non-conforming work for the week through establishing the following:
 - remedial action(s) taken or resolution;
 - time-frame/schedule associated with the remedial action or resolution;

- final compliance and the measure of compliance with the remedial action or resolution; and
- description of corrective action shall be taken to prevent future occurrences.
- assist with the preparation of the CQA report.

4.0 PROJECT MEETINGS

4.1 Project Coordination Meetings

Meetings of key project personnel are necessary to assure a high degree of quality during installation, and promote clear, open channels of communication. Therefore, Project Coordination Meetings are an essential element in the success of the project. Several types of Project Coordination Meetings are described below, including: (i) pre-construction meetings; (ii) progress meetings; and (iii) problem or work deficiency meetings. Meetings will be scheduled by the Construction Manager (or his delegate). The Director's field representative will be adequately notified by the Construction Manager (or his delegate) of all meetings identified in this Plan and other meetings as determined necessary.

4.1.1 Pre-Construction Meeting

A Pre-Construction Meeting will be held at the site prior to beginning construction of the Project. As a minimum, the Pre-Construction Meeting will be attended by the Contractor, the Geosynthetic Installer, the CQA Consultant, the Design Engineer, and the Construction Manager. The Director's field representative will be notified by the Construction Manager of the Pre-Construction Meeting at least ten days prior to the proposed pre-construction meeting date.

Specific items for discussion at the pre-construction meeting include the following:

- appropriate modifications or clarifications to the CQA Plan;
- the Construction Drawings and Project Specifications;
- the responsibilities of each party;
- lines of authority and communication;
- names and contact information for involved parties (e.g., Earthworks Contractor; CQA Consultant, etc.);

- methods for documenting and reporting, and for distributing documents and reports;
- acceptance and rejection criteria;
- protocols for testing and observation;
- protocols for handling deficiencies, repairs, and re-testing;
- identifying work areas and equipment and materials storage areas;
- identifying required submittal for the project;
- the time schedule for all operations;
- procedures for packaging and storing archive samples;
- panel layout and numbering systems for panels and seams;
- seaming procedures and seam acceptance and rejection criteria;
- repair procedures.

The Construction Manager will conduct a site tour to observe the current site conditions and to review construction material and equipment storage locations. A person in attendance at the meeting will be appointed by the Construction Manager to record the discussions and decisions of the meeting in the form of meeting minutes. Copies of the meeting minutes will be distributed to all attendees and to the Director's field representative, irrespective of attendance.

4.1.2 Progress Meetings

Regular progress meetings will be held between the CQA Site Manager, the Contractor, Construction Manager, and other concerned parties participating in the construction of the project. DSHW representatives shall be notified of the progress meetings and will have the option to attend the meetings. These meetings will include discussions on the current progress of the project, planned activities for the next week, and revisions to the work plan and/or schedule. The meeting will be documented in meeting minutes prepared by a person designated by the CQA Site Manager at the beginning of the meeting.

A weekly report will be provided to the Director, as specified in Section 6 below.

4.1.3 Problem or Work Deficiency Meeting

A special meeting will be held when and if a significant problem or deficiency is present or likely to occur. The meeting will be scheduled by the Construction Manager or his delegate. The meeting will be attended by the Contractor, the Construction Manager, the CQA Site Manager, DSHW representative(s) and other parties as appropriate. If the problem requires a design modification, the Design Engineer should either be present at, consulted prior to, or notified immediately upon conclusion of this meeting. The purpose of the work deficiency meeting is to define and resolve the problem or work deficiency as follows:

- define and discuss the problem or deficiency;
- review alternative solutions;
- select a suitable solution agreeable to all parties; and
- implement an action plan to resolve the problem or deficiency.

When correcting construction deficiencies, the Director, or his representative, will be provided notification so that they can be onsite to observe the implementation of the solution. The meeting record and schedule will be documented in the form of meeting minutes and copies will be distributed to all affected parties. A copy of the minutes will be retained in facility records.

5.0 CHANGE CONTROL PROCEDURES

The need may arise for a design, engineering, or construction change to the project. Therefore, change control procedures have been established to ensure the design analysis remains valid upon incorporation of the change. Where a design change is necessary because of an incorrect or faulty design, the design process and verification procedures themselves should be reviewed and modified, as necessary.

Construction activities, drawings and prints which are approved for a particular construction phase shall be stamped by a Utah Registered Professional Engineer.

The general change control procedure is as follows:

- A. A change request may be initiated by, including but not limited to, the Contractor, CQA Officer, Construction Manager, or Design Engineer.
- B. All proposed design, engineering, or construction changes shall be reviewed for applicability by the Design Engineer. After consulting the Construction Manager and others (CQA, contractor, etc.), and if determined to be justified by the Design Engineer, the scope of the change shall be subject to the same design control measures as those applied to the original design.
- C. The Design Engineer shall submit the change for approval to the Owner. The Owner will determine if the change is a minor change which does not require formal approval from UDSHW; or, is major change which requires formal

approval from the UDSHW. If the permittee is unsure whether or not the Division might consider any proposed modification to plans, specifications, or QA/QC documents to be minor, it is permittee's responsibility to communicate the proposed minor modifications to the Division for an opinion. The Division shall issue this opinion in a letter of acceptance or denial. Minor and major changes are described as follows:

C1) Minor changes are defined as all changes that will in no way affect the performance standard or the original intent of the plans and specification approved by UDSHW. The minor changes will in no way reduce the effectiveness of the QA/QC effort used to ensure the quality and consistency of the materials and workmanship used to meet the performance standards in the plans and specifications approved by UDSHW. Examples of minor changes include, but are not limited to, changes in testing procedures (ASTM updates), material property changes, grade changes that do not impact overall surface water flow patterns, use of pre-cast concrete elements in lieu of cast in place concrete elements, etc. Minor changes shall conform to the original design intent. All minor changes to the plans, specifications, and QA/QC documents will be clearly identified, described and justified in the construction certification report. Minor changes may be implemented immediately and shall be documented as outlined in items D, E, and F in this section. The UDSHW (Division) will allow the permittee to make minor modifications to design plans, specifications, and quality assurance/quality control (QA/QC) procedures without prior approval by the Division, provided that the requirements above are met.

C2) Major changes are defined as changes which require a permit modification pursuant to 40 CFR §270.42, Appendix I. Major changes shall be reviewed by the Owner, the CQA Officer, and the Design Engineer. Clean Harbors shall receive Director approval prior to implementation of major changes.

- D. Upon approval, the Construction Manager shall communicate the change to all affected construction, and CQA personnel. The Construction Manager may issue an amendment to the applicable documents and submit the amendment to the CQA Officer (or designee) for distribution to critical personnel. The Construction Manager may also communicate the change via a Field Directive distributed to critical personnel.
- E. Documentation of changes shall be included in the Construction Certification Report.
- F. As-built drawings of the project shall reflect changes made to the Permit Drawings.

6.0 DOCUMENTATION

6.1 Overview

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

The CQA Site Manager will provide the Construction Manager with signed descriptive remarks, data sheets, and logs to verify that monitoring activities have been carried out. Sample forms are provided in Appendix A. The CQA Site Manager will also maintain, at the job site, a complete file of Construction Drawings, CQA Plan, checklists, test procedures, daily logs, and other pertinent documents.

6.2 Daily Recordkeeping

Preparation of daily CQA documentation will consist of daily construction reports prepared by the CQA Site Manager which may include CQA monitoring logs, and testing data sheets. This information may be regularly submitted to and reviewed by the Construction Manager.

The CQA Site Manager will prepare daily construction reports that document the activities observed during each day of activity. At a minimum, these logs and data sheets will include the following information:

- the date, project name, location, and other identification;
- a summary of the weather conditions;
- a summary of locations where construction is occurring;
- equipment and personnel on the project;
- a summary of meetings held and attendees;
- a description of materials used and references of results of testing and documentation;
- identification of deficient work and materials;
- results of re-testing corrected “deficient work;”
- an identifying sheet number for cross referencing and document control;

- descriptions and locations of construction monitored;
- type of construction and inspection performed;
- description of construction procedures and procedures used to evaluate construction;
- a summary of test data and results;
- calibrations or re-calibrations of test equipment and actions taken as a result of re-calibration;
- decisions made regarding acceptance of units of work and/or corrective actions to be taken in instances of substandard testing results;
- a discussion of agreements made between the interested parties which may affect the work; and
- signature of the respective CQA Site Manager.

6.3 Weekly Report

A Weekly Report will be provided to the Director that will consist of, at a minimum, a summary of the items found in Section 6.1 of this plan, as applicable, documented during the weekly interval. The reporting period is from Sunday through Saturday. The report will be provided by the second Monday following the close of the reporting week. Weekly Reports will be required to be submitted commencing at the Pre-Construction meeting and until the construction of the caps has been completed.

6.4 Construction Problems and Resolution Data Sheets

Construction Problems and Resolution Data Sheets, to be submitted with the daily construction reports prepared by the CQA Site Manager, describing the issue(s) and respective resolution will be cross-referenced with daily reports, specific observation logs, and testing data sheets and will include the following information, where available:

- an identifying sheet number for cross-referencing and document control;
- a detailed description of the situation or deficiency;
- the location and probable cause of the situation or deficiency;

- how and when the situation or deficiency was found or located;
- documentation of the response to the situation or deficiency;
- final results of responses;
- measures taken to prevent a similar situation from occurring in the future; and
- signature of the CQA Site Manager and a signature indicating concurrence by the Construction Manager.

The Construction Manager will be made aware of significant recurring nonconformance with the Construction Drawings, Project Specifications, or CQA Plan. The cause of the nonconformance will be determined and appropriate changes in procedures or specifications will be recommended. These changes will be submitted to the Design Engineer for approval in accordance with the requirements presented in Section 5.0.

A summary of supporting data sheets, along with final testing results and the CQA Site Manager's approval of the work, will be required upon completion of construction.

6.5 Photographic Documentation

Photographs will be taken and documented in order to serve as a pictorial record of work progress, problems, and mitigation activities. Photographic reporting data sheets, where used, will be cross-referenced with observation and testing data sheet(s), and/or construction problem and solution data sheet(s). Photographs used for documentation will be identified with the date, time, and location of the photograph.

6.6 Design and/or Specification Changes

Design changes will be documented as described in Section 5.0.

6.7 CQA Report

At the completion of the Project, the CQA Consultant will submit to the Owner the CQA report signed and sealed by a Professional Engineer licensed in the State of Utah. The CQA report will acknowledge: (i) that the work has been performed in substantial compliance with the CQA Plan and applicable State and Federal regulations; (ii) physical sampling and testing has been conducted at the appropriate frequencies; and (iii) that the summary document provides the necessary supporting information. At a minimum, this report will include, as applicable:

- Manufacturers' quality control documentation;

- a summary report describing the CQA activities and indicating compliance with the Construction Drawings, Project Specifications, and CQA Plan which is signed and sealed by the CQA Officer;
- a summary of CQA/CQC testing, including failures, corrective measures, and retest results;
- contractor personnel resumes and qualifications, as required in the Project Specifications;
- documentation that the geomembrane trial seams were performed in general accordance with the CQA Plan and Project Specifications;
- documentation that field seams were non-destructively tested using a method in general accordance with the applicable test standards;
- documentation that nondestructive testing was monitored by the CQA Consultant, that the CQA Consultant informed the Geosynthetic Installer of required repairs, and that the CQA Consultant monitored the seaming and patching operations for uniformity and completeness;
- records of sample locations, the name of the individual conducting the tests, and the results of tests;
- record drawings (as-built drawings) as provided by the Surveyor; and
- daily construction reports.

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). Base maps required for development of the record drawings and the record drawings will be prepared by a qualified Professional Land Surveyor registered in the State of Utah. These documents will be reviewed by the CQA Consultant and included as part of the CQA Report which will be submitted to the appropriate regulatory agencies within sixty (60) days of completion of the project.

**TABLE 1
LANDFILL CELL CONSTRUCTION AND CLOSURE – CQC/CQA ACTIVITIES**

SPECIFICATION	CONSTRUCTION QUALITY CONTROL	CONSTRUCTION QUALITY ASSURANCE
GENERAL		
1) All measurement and survey equipment shall be calibrated or verified annually or at the frequency recommended by the manufacturer. Submit calibration certification or laboratory verification procedures of applicable equipment to the CQA Consultant for approval prior to construction. Appendix C provides guidelines for verification/calibration requirements.	No action required.	Review and approve calibration certificates from Surveyor, Contractor, Geosynthetics Installer, CQA Laboratory, as appropriate. Confirm and document that equipment meets the calibration requirements. CQA Consultant will document activities on forms similar to those provided in Appendix A as well as photographic documentation. Reports and records shall become part of the permanent record for the cell/closure construction project involved.
2) Contractor shall provide access to all work to the CQC/CQA Consultant(s) to perform required testing and any additional testing recommended by CQC/CQA Consultant(s) or Owner.	All tests shall be assigned a unique identification label. For example, each compaction/moisture content test shall be labeled with a unique numerical identification (ID may include soil type label); all retests shall be labeled with a alphanumeric modifier (e.g., if compaction test 'Fill-05' fails, then retests would be identified as 'Fill05A' and 'Fill05B').	Confirm that a uniform test identification system is implemented and used to track minimum testing frequencies.
SURVEY CONTROL		
3) All survey measurements (Using Total Station or other method approved by CQA Consultant) shall be performed by a licensed surveyor. Survey points shall be on at least a 60 foot grid and at all control points, unless otherwise documented in	Provide survey control measurements to CQA Consultant for review in accordance with specification.	Review as-built survey for conformance to required grades. Notify Construction Manager and Contractor of deficiencies and observe and document corrective actions.

**TABLE 1
LANDFILL CELL CONSTRUCTION AND CLOSURE – CQC/CQA ACTIVITIES**

SPECIFICATION	CONSTRUCTION QUALITY CONTROL	CONSTRUCTION QUALITY ASSURANCE
these specifications. Surveyor shall indicate where the embankment meets the design line and grade.		
CLEARING AND GRUBBING		
4) Remove vegetation, debris, organic, or deleterious material from below areas to receive stockpile or embankment material and borrow areas.	Observe and photograph the clearing and grubbing operation. Notify CQA Consultant and Contractor of deficiencies.	Observe the area of clearing and grubbing upon completion. Document that clearing and grubbing is complete and that vegetation, roots, and highly organic soil within appropriate areas is removed.
CELL FOUNDATION PREPARATION		
5) Where the CQA Officer deems subgrade material to be unsatisfactory, excavation below grade shall be required to such depths as necessary to remove unsatisfactory material. Excavated areas shall be replaced with engineered fill. Material removed shall be disposed of as directed by the CQA Consultant.	<p>Observe and photograph subgrade preparation activities and any corrective actions. Perform compaction testing on recompacted subgrade material in accordance with frequencies provided in Table 2 and listed below:</p> <ul style="list-style-type: none"> • Standard Proctor (ASTM D698) – 1 per material type • Nuclear Density/Moisture (ASTM D6938) – 1 per 1,000 cy. A minimum of 2 passing retests for each area shall be required where a failing test is documented. For test areas that represent less than 500 cy, one passing retest shall be required. <p>Report observations and test results to</p>	Identify soft and yielding areas of subgrade and report to Construction Manager and Contractor for over excavation and removal. Observe and document that required activities are performed. Review results of compaction testing. Report any deficiencies to the Construction Manager and Contractor and confirm that deficient areas are reworked and retested in accordance with requirements of Table 2 and meet the specification. Obtain signature and approval of geosynthetic subgrade acceptance from Geosynthetic Installer, as appropriate.

**TABLE 1
LANDFILL CELL CONSTRUCTION AND CLOSURE – CQC/CQA ACTIVITIES**

SPECIFICATION	CONSTRUCTION QUALITY CONTROL	CONSTRUCTION QUALITY ASSURANCE
<p>6) Scarify & Recompact: Foundation areas shall be scarified to a minimum depth of 4 inches and recompact to a minimum of 95% of the maximum dry density (ASTM D698). Areas with soft or yielding spots shall be corrected by drying, wetting, or removal, as appropriate, and recompacting to a minimum of 95% of the maximum dry density.</p>	<p>CQA Consultant. Observe and photograph scarification and recompaction activities and any corrective actions. Notify CQA Consultant and Contractor of deficiencies, including unsuitable material. Perform compaction testing in accordance with frequencies provided in Table 2 (and listed above in Item#5) Report observations and test results to CQA Consultant.</p>	<p>Observe and document that required activities are performed. Report any deficiencies to the Construction Manager and Contractor and confirm that deficient areas are reworked and meet the specification. Obtain signature and approval of geosynthetic subgrade acceptance from Geosynthetic Installer, as appropriate.</p>
CLAY LINER/CAP SUBGRADE PREPARATION		
<p>7) In place waste materials that form the subgrade for the compacted clay liner/cap shall be graded to the designed elevations and typical sections. Acceptable tolerances for finished subgrade shall be at or up to 1 foot below grade; no areas of ponding shall be allowed. Survey shall be performed on completed subgrade prior to placement of subsequent clay cap.</p>	<p>Observe, photograph and document subgrade preparation activities. Notify Contractor and CQA Consultant of any deficiencies. Survey measurement shall be performed by licensed surveyor. Survey points will be on at least a 60-foot grid and at all control points. Corrective grading, if necessary, will be re-surveyed. Final as-built survey data will be prepared and submitted to the CQA Consultant for review.</p>	<p>Observe the area of subgrade preparation upon completion. Observe and document that required activities are performed. Review as-built survey for conformance to required grades. Notify Construction Manager and Contractor of deficiencies and observe and document corrective grading activities. Obtain signature and approval of geosynthetic subgrade acceptance from Geosynthetic Installer, as appropriate.</p>
<p>8) Areas to receive geosynthetics shall be free from ponded water and shall be smooth, free from sharp objects, deleterious material that might damage the overlying geosynthetics, holes or depressions more than ½-inch deep and protrusions extending above the surface more than ½-inch. The finished surface</p>		

**TABLE 1
LANDFILL CELL CONSTRUCTION AND CLOSURE – CQC/CQA ACTIVITIES**

SPECIFICATION	CONSTRUCTION QUALITY CONTROL	CONSTRUCTION QUALITY ASSURANCE
shall be proof-rolled with a steel drum roller or rubber-tired roller to eliminate tire or roller marks and provide a smooth, dense surface.		
9) Subgrade shall be maintained in the finished condition until the first succeeding material is placed.	Observe that the finished condition of the subgrade is maintained after placement and prior to placing succeeding material.	Observe condition of subgrade after finishing and prior to placement of succeeding material. Notify Construction Manager and Contractor of deficiencies and observe and document corrective grading activities.
ENGINEERED FILL		
10) Provide samples to CQA Site Manager at required intervals (see Table 2). Embankment material, fill for roadways and ramps shall be constructed with engineered fill. Engineered fill shall be classified, in accordance with the Unified Soil Classification System (USCS) as CL, ML, SM, SC, or combinations of these materials and shall have a maximum particle size equal to half of the lift height, so long as oversized particles are not nested. Materials that classify as SP, SW, GM, GC, GP, and GW (or combinations of these materials) may be used as long as they are mixed in with finer grained soils.	Collect samples of proposed fill/engineered fill soil and test at the required intervals (see Table 2 and provided below: <ul style="list-style-type: none"> • Standard Proctor (ASTM D698) – 1 per 10,000 cy (min 1 per material type) • Atterberg Limits (ASTM D4318) – 1 per 10,000 cy (min 1 per material type) • #200 Wash (ASTM D1140) – 1 per 10,000 cy (min 1 per material type) • Visual Classification (ASTM D2488) – 1 per 5,000 cy (min 1 per material type) 	Review results of testing for conformance with specifications. Document any deficiencies and notify Construction Manager and Contractor of unacceptable material and observe and document that this material is not utilized. Observe sampling locations and confirm that samples are representative of source material.

**TABLE 1
LANDFILL CELL CONSTRUCTION AND CLOSURE – CQC/CQA ACTIVITIES**

SPECIFICATION	CONSTRUCTION QUALITY CONTROL	CONSTRUCTION QUALITY ASSURANCE
	<ul style="list-style-type: none"> • Visually verify that particles greater than 2 inches are not nested. 	
<p>11) Engineered fill and backfill shall be placed in uniform loose lifts not to exceed 12 inches for material compacted by heavy compaction equipment and 4 inches for material compacted by hand operated tampers. In anchor trenches, the first lift shall have a maximum uncompacted height of 12 inches and subsequent lifts shall have a maximum uncompacted height of 4 inches.</p>	<p>Observe, photograph and document that soil placement operations meet the specifications and notify the Contractor and CQA Consultant of any deficiencies.</p>	<p>Review CQC documentation for conformance to the specifications and report any deficiencies to the Contractor and Construction Manager (as appropriate) and confirm that all deficient areas are reworked and meet the specification.</p>
<p>12) Place and compact engineered fill and backfill to a minimum 95% relative compaction per ASTM D698 and at a moisture content ± 5 percent of optimum moisture content (per ASTM D698).</p>	<p>Conduct in-place density tests in accordance with ASTM D6938 and the frequencies in Table 2 (min 1 per 1,000 cy with minimum 1 per lift). Notify the Contractor and CQA Consultant of any failing tests. Observe reworking of failing areas and retest in-situ density until the areas meet the specification. A minimum of 2 passing retests for each area shall be required where a failing test is documented. For test areas that represent less than 500 cy, one passing retest shall be required.</p>	<p>Review in-situ testing results. Testing shall be in accordance with frequencies in Table 2. Review in-situ density testing for conformance with the requirements.</p>
<p>13) Where backfill is placed around pipes, the first lift shall be placed to a depth slightly higher than the spring line of the pipe, to</p>	<p>Observe that the first lift of backfill placed around pipes is placed to a depth slightly above the spring line. Notify the</p>	<p>Observe and document soil placement operations around pipes. Confirm that all deficient areas are reworked and meet the</p>

**TABLE 1
LANDFILL CELL CONSTRUCTION AND CLOSURE – CQC/CQA ACTIVITIES**

SPECIFICATION	CONSTRUCTION QUALITY CONTROL	CONSTRUCTION QUALITY ASSURANCE
prevent displacement of the pipe.	Contractor and CQA Consultant of any deficiencies.	specification.
14) Engineered fill and backfill shall be graded to the design elevations and typical sections. Acceptable grading tolerances for finished embankment surfaces shall be: a) interior embankment slopes and the cell floor: at or below grade; b) all other embankment slopes: ± 0.2 feet. Repair any noted damage and fill low spots to meet the design height.	Conduct survey measurement at completion by licensed surveyor (Surveyor). Survey points will be on at least a 60-foot grid and at all control points. Corrective grading, if necessary, will be re-surveyed. Final as-built survey data will be prepared and submitted to the CQA Consultant for review.	Review and approve survey data. Notify Construction Manager and Contractor of areas not meeting design specifications and requirements.
15) Fill material shall not be placed in areas covered with snow or over frozen soil. Snow and frozen soil shall be removed prior to fill placement.	Observe and document site conditions and notify CQA Consultant and Contractor of any deficiencies. Observe that snow is removed in work areas. Document and observe that any required corrective actions are made.	Review documentation and notify Contractor and Construction Manager of deficiencies. Confirm corrective actions have been taken as appropriate.
COMPACTED CLAY LINER/CLAY CAP		
16) Provide representative, composite samples to CQC Monitor at required intervals (see Table 2).	Collect composite samples of proposed clay soil. Samples shall be a minimum of 5 gallons each (unless otherwise required by the CQA Consultant). Each sample shall consist of clay soil collected at three locations of similar clay soil. Test compacted clay liner/cap material in accordance with minimum frequencies listed in Table 2, and listed below: <ul style="list-style-type: none"> • Standard Proctor (ASTM D698) – 1 per 10,000 cy (min 1 per 	Review test results on composite soil samples for conformance with specifications. Document any deficiencies and notify Contractor and Construction Manager of unacceptable material and observe and document that this material is not utilized. Observe sampling locations and confirm that samples are representative of source material.

**TABLE 1
LANDFILL CELL CONSTRUCTION AND CLOSURE – CQC/CQA ACTIVITIES**

SPECIFICATION	CONSTRUCTION QUALITY CONTROL	CONSTRUCTION QUALITY ASSURANCE
	material type) • Sieve Analyses (ASTM D422) - 1 per 3,000 cy (min 1 per material type) • Atterberg Limits (ASTM D4318) – 1 per 3,000 cy (min 1 per material type) • Visual Classification (ASTM D2488) – 1 per 3,000 cy (min 1 per material type) Observe sampling locations and confirm that samples are representative of source material.	
17) Place unsuitable material in a separate stockpile on site.	Observe and document that unsuitable materials are stockpiled separately on site or away from the work area.	Confirm unsuitable materials are stockpiled in areas away from clay liner/clay cap stockpiles.
18) Compacted clay liner/clay cap material shall have fines greater than 85% passing #200 sieve and be classified as CL, CH, CL-ML, ML or MH in accordance USCS with a maximum particle size of 1 inch and maximum hydraulic conductivity of 1×10^{-7} cm/sec.	Perform visual classification (ASTM D2488) in accordance with the applicable methods listed in Appendix B. Notify the Contractor and CQA Consultant of unacceptable material and observe that this material is not utilized.	Review results of visual and laboratory classifications for conformance with project specifications. Notify the Construction Manager and Contractor of unacceptable material and confirm that this material is not utilized
19) The Contractor shall perform the following procedures to provide suitable material for construction of the clay liner soil: A) Mine satisfactory material	Perform observation and testing as indicated above and advise the Construction Manager and CQA Consultant of unsuitable material.	Review documentation and test results. Report any deficiencies to the Construction Manager and Contractor and confirm that all deficient areas/soil are reworked and meet the specification.

TABLE 1
LANDFILL CELL CONSTRUCTION AND CLOSURE – CQC/CQA ACTIVITIES

SPECIFICATION	CONSTRUCTION QUALITY CONTROL	CONSTRUCTION QUALITY ASSURANCE
<p>from the borrow.</p> <p>B) Moisture condition the mined clay to a moisture content of minus (-) 2% to plus (+) 4% of the optimum moisture content.</p> <p>C) Equally apply deflocculant to the clay soil at a rate of at least 3.5 pounds per 50 cubic feet of loose clay soil, or at a lesser rate if approved by the Design Engineer, Construction Manager, and CQA Officer. The design engineer may waive the requirement if not required.</p> <p>D) Mix (using a disk or soil pulverizer)-the deflocculant thoroughly into the clay soil.</p> <p>E) Add moisture to the clay soil to near optimum moisture content.</p> <p>F) Mix and break up the material to maintain dry clod sizes smaller than 1 inch. Continue to mix and break up the material to produce a homogeneous material.</p>	<p>Observe, photograph and document that the processing operations are performed in accordance with the specifications. Perform moisture content testing and notify Contractor and CQA Consultant of any deficiencies. Deficient areas/soil shall be reworked and retested until the requirements of the specification are met.</p>	
<p>20) Test Fill: A test fill shall be performed only if there is a change in material, source or construction methodology, or if owner desires to implement new construction procedures (i.e. loose lift thickness, number of passes with the</p>	<p>Observe, document and test the construction of the clay liner test fills. Testing frequencies shall meet the minimum requirements in Table 2 for the Test Fill, and provided below:</p>	<p>Notify Director prior to initiation of test fill construction. Review construction procedures and documentation for the construction of the clay liner test fill. Review the testing documentation for conformance with the requirements of the</p>

**TABLE 1
LANDFILL CELL CONSTRUCTION AND CLOSURE – CQC/CQA ACTIVITIES**

SPECIFICATION	CONSTRUCTION QUALITY CONTROL	CONSTRUCTION QUALITY ASSURANCE
<p>compactor, etc). Test fill will not be re-performed if the proposed borrow source was determined suitable and previously approved for clay liner construction and a similar construction methodology is followed. An approximately 60 by 75 foot large test fill shall be constructed to establish the procedure for compaction of the clay liner. An approximately 5 by 5 foot small test fill shall also be constructed to establish the procedures for compaction of the clay liner in small areas using hand compactors, if manually operated compaction equipment is proposed for construction). The test fill shall be constructed and tested in accordance with the following:</p> <p>A) Place the clay in at least three lifts with a loose material thickness not exceeding 12 inches for the first lift and not exceeding 9 inches for each subsequent lift (maximum loose lift height for the small test pad shall be 4 inches).</p> <p>B) The clay is to be compacted by equipment proposed for use during construction of the clay liner. In the large test fill, a minimum of one pass of the sheepsfoot compactor will be required over the uncompacted</p>	<ul style="list-style-type: none"> • Nuclear Density/Moisture (ASTM D6938) 1 per 100 cy or 3 per lift, whichever is greater (a minimum of two passing tests shall be required for each area where a failing test has been documented) • Standard Proctor (ASTM D698) - min 3 or per material type, whichever is greater • Visual Classification (ASTM D2488) – min 3 or per material type, whichever is greater • Sieve Analyses (ASTM D422) - min 3 or per material type, whichever is greater • Atterberg Limits (ASTM D4318) – min 3 or per material type, whichever is greater • Field Hydraulic Conductivity (ASTM 5126) – min 1 per test fill (min 1 for small test pad) • Laboratory Hydraulic Conductivity (ASTM D5084) - min 1 per lift (min 1 for small test pad) <p>Notify Contractor and CQA Consultant of unacceptable material and observe and</p>	<p>specifications. Notify the Construction Manager and Contractor of any deficiencies. Verify that the design engineer has approved the test fill compaction procedures.</p>

**TABLE 1
LANDFILL CELL CONSTRUCTION AND CLOSURE – CQC/CQA ACTIVITIES**

SPECIFICATION	CONSTRUCTION QUALITY CONTROL	CONSTRUCTION QUALITY ASSURANCE
<p>material for each lift. Compaction of the large test fill is to be accomplished by at least four passes of suitable compaction equipment.</p> <p>C) The clay shall be compacted to at least 95% of the maximum dry density (ASTM D698) at a moisture content of minus -2% to plus (+) 4% of the optimum moisture content.</p> <p>D) The clay shall be compacted to provide a permeability of no greater than 1×10^{-7} cm/sec.</p> <p>E) Assist CQA/CQC Consultant in set-up of in-situ hydraulic conductivity testing equipment. If field permeability testing does not indicate passing results, additional large test pad shall be constructed and tested per specifications until passing results are obtained.</p> <p>F) Assist CQA/CQC Consultant with collection of three thin walled samples from the large test fill and one from the small test fill.</p> <p>G) Test fill procedures shall be reviewed and approved by the Design Engineer prior to placement of clay liner soil in the landfill.</p>	<p>document that this material is not utilized. Report any deficiencies to the Contractor and CQA Consultant and confirm that all deficient areas/soil are reworked and meet the specification. Perform in-situ hydraulic conductivity test, in accordance with ASTM D 5126 (e.g. Guelph permeameter, single ring infiltrometer, Boutwell, etc.), or large diameter block sample test in accordance with requirements in Appendix B. Approval of clay test pad shall require three passing field permeability test results. Collect three thin wall samples for the large test fill (one for small test fill) with assistance from Contractor and perform hydraulic conductivity testing (ASTM D5084) in accordance with requirements in Table 2 (and summarized above) for use in correlation of field and laboratory testing. Prepare memorandum summarizing test fill construction procedures and test results. Submit copy of memorandum to Department of Environmental Quality, Division of Solid and Hazardous Waste, and the USEPA.</p>	
<p>21) Clay Liner Placement: Clay liner</p>	<ul style="list-style-type: none"> • Observe, photograph, and 	<p>Review testing documentation and confirm</p>

**TABLE 1
LANDFILL CELL CONSTRUCTION AND CLOSURE – CQC/CQA ACTIVITIES**

SPECIFICATION	CONSTRUCTION QUALITY CONTROL	CONSTRUCTION QUALITY ASSURANCE
<p>material shall be prepared, placed and compacted specifically in the same manner with the same type of equipment that were used in the approved test pad construction. The clay shall be compacted to at least 95% of the maximum dry density (ASTM D698) at a moisture content of minus (-) 2% to plus (+) 4% of the optimum moisture content. Based on test fill construction using the on-site clay source, place the clay in at least three lifts with a loose material thickness not exceeding 12 inches for the first lift and not exceeding 5 inches for each subsequent lift (maximum loose lift height for the areas to be compacted with hand compactors shall be 4 inches). Clay liner shall be compacted with a minimum of 4 passes of a Cat D825 sheepsfoot compactor (or equivalent). A Cat CP-433E sheepsfoot compactor may be used with an initial 12-inch loose lift and subsequent lifts not exceeding 4 inches. A minimum of 4 passes shall be used with the Cat 433E. If a more recent test fill has been constructed, utilize lift thickness, equipment, and number of passes consistent with the test fill construction resulting in appropriate hydraulic conductivity results.</p>	<p>document clay liner during placement and compaction operations. Notify Contractor and CQA Consultant of deficiencies (including material type, lift thickness, compaction, moisture content, etc.) Conduct in-place density tests in accordance with the applicable methods indicated in Appendix B and the frequencies in Table 2 and listed below:</p> <ul style="list-style-type: none"> • Nuclear Density/Moisture (ASTM D6938) 1 per 500 cy (min 1 per lift). A minimum of two passing tests should be performed for each area where a failing test has been recorded. During compaction of the first 5,000 cy of clay, frequency shall be 1 per 250 cy. If a new test fill is prepared, the frequency of ASTM D6938 may be modified to the specification demonstrated. • Sand Cone/Drive Cylinder and Moisture Content (ASTM D1556/2216 or D2937/D2216) – 1 per 40 nuclear density/moisture tests 	<p>that placement and compaction operations meet the specifications. Report any deficiencies to the Construction Manager and Contractor and confirm that all deficient areas/soil are reworked, retested, and meet the specification.</p>

TABLE 1
LANDFILL CELL CONSTRUCTION AND CLOSURE – CQC/CQA ACTIVITIES

SPECIFICATION	CONSTRUCTION QUALITY CONTROL	CONSTRUCTION QUALITY ASSURANCE
	<p>The test locations shall be random or in areas of suspected non-conformance. Additional testing may be performed beyond the requirements of Table 2. Observe reworking of failing areas and retest in-situ density until the areas meet the specification.</p>	
<p>22) Compacted clay liner material shall have an in-place permeability of no greater than 1×10^{-7} cm/sec. If an individual test fails, the Contractor, CQA Officer, and Design engineer shall determine which of the following three procedures should be followed to bring the defective area into compliance and notify the Director prior to initiating the procedure.</p> <p>A) Remove, replace and work the soil included within the representative area (lot). One test, randomly selected in the lot will be conducted to determine if the lot is acceptable. A lot is defined as the volume representative of the CQC testing required, and shall represent a volume of soil no greater than 1,000 cy.</p> <p>B) The lot will be reworked. After reworking the lot, the original test site and one other selected site within the lot shall be tested. The original</p>	<p>Perform and document permeability tests in accordance with minimum frequencies in Table 2 and listed below:</p> <ul style="list-style-type: none"> • Hydraulic Conductivity (ASTM D5084) – 1 per 1,000 cy (min 1 per material type), tested on Shelby tube samples <p>See specification for methodology to address failing tests.</p>	<p>Observe permeability testing and review results for conformance with the frequencies in Table 2 and the requirements of the specifications.</p>

**TABLE 1
LANDFILL CELL CONSTRUCTION AND CLOSURE – CQC/CQA ACTIVITIES**

SPECIFICATION	CONSTRUCTION QUALITY CONTROL	CONSTRUCTION QUALITY ASSURANCE
<p>permeability test results shall not be included as final test results. If the lot still does not meet the required permeability, the process of reworking and retesting the clay may be repeated, as required.</p> <p>C) Divide the defective lot and each adjacent lot into at least 2 sub-lots. One field permeability test, randomly located in each sub-lot, immediately adjacent to the defective sub-lot, would be conducted. Each defective sub-lot can then be reworked and retested or replaced and retested.</p>		
<p>23) Probe holes in the clay liner created by the nuclear density gauge shall be filled with dry granular bentonite or with clay liner material and compacted in approximately 3-inch loose lifts.</p>	<p>Confirm and document that probe holes are infilled with bentonite of clay liner material.</p>	<p>No action required.</p>
<p>24) Water shall be sprayed on clay surface as necessary to prevent desiccation prior to placement of overlying layers.</p>	<p>Observe the condition of the clay liner for drying and notify the Contractor and CQA Consultant of deficiencies. Observe and document that corrective actions are completed.</p>	<p>Observe surface of clay liner for drying and notify Construction Manager and Contractor of deficiencies and confirm that all deficient areas/soil are reworked and meet the specification.</p>
<p>25) Clay liner soil shall not be placed in areas covered with snow or on frozen ground. Snow and frozen soil shall be removed</p>	<p>Observe and document site conditions and notify the Contractor and CQA Consultant of any deficiencies. Confirm</p>	<p>Observe and document site conditions. Confirm that all deficient areas/soil are removed and replaced or reworked to meet</p>

**TABLE 1
LANDFILL CELL CONSTRUCTION AND CLOSURE – CQC/CQA ACTIVITIES**

SPECIFICATION	CONSTRUCTION QUALITY CONTROL	CONSTRUCTION QUALITY ASSURANCE
prior to fill placement. No frozen material may be incorporated into the fill.	and document that snow is removed from work areas.	the specification.
26) Clay liner soil shall not become contaminated with other soil or debris.	Observe clay liner soil during excavation, hauling, storing, mixing, and placing. Confirm that the clay liner soil is not contaminated with other soil or debris. Notify the Contractor and CQA Consultant of unacceptable material and confirm that the material is removed and not utilized.	Review site conditions during excavation, hauling, storing, mixing, and placing. Notify Construction Manager and Contractor of unacceptable material and confirm that this material is removed and not utilized.
27) Final grading of the clay liner/clay cap shall be from zero (0) to plus two tenths of a foot (0.2 ft).	Conduct survey measurement at completion by licensed surveyor (Surveyor). Survey points will be on at least a 60-foot grid and at all control points. Corrective grading, if necessary, will be re-surveyed. Final as-built survey data will be prepared and submitted to the CQA Consultant for review.	Review and approve survey data. Notify Contractor and Construction Manager of areas not meeting design specifications and requirements.
28) Final grading and finishing efforts on the surface of the clay liner/clay cap shall leave the surface free of sharp objects and deleterious material that might damage the overlying geosynthetics. Areas to receive geosynthetics shall be free from ponded water and shall be smooth, free from sharp objects, deleterious material that might cause damage to overlying geosynthetics, holes or depressions more than ½-inch deep and protrusions extending above the surface more than ½-	Observe, photograph and document that the finished surface of the clay liner/clay cap meets the specifications. Observe that desiccation cracks more than ¼-inch are filled with dry powdered bentonite. Observe and document any rework for compliance with specifications. Conduct survey measurement at completion by licensed surveyor (Surveyor). Survey points will be on at least a 60-foot grid and at all control points. Corrective grading, if necessary, will be re-surveyed.	Observe, approve and document final grading and finishing efforts for compliance with specification. Report any deficiencies to the Contractor and Construction Manager and confirm that all deficient areas are reworked and meet the specification.

**TABLE 1
LANDFILL CELL CONSTRUCTION AND CLOSURE – CQC/CQA ACTIVITIES**

SPECIFICATION	CONSTRUCTION QUALITY CONTROL	CONSTRUCTION QUALITY ASSURANCE
inch. Desiccation cracks larger than ¼-inch wide and one inch deep shall be filled with dry powdered bentonite.	Final as-built survey data will be prepared and submitted to the CQA Consultant for review.	
SAND LAYER		
29) Prior to placement of the GCL, a minimum six (6) inch layer of sand shall be placed above the graded waste to provide a layer between the GCL and the waste. This material shall be free of organics, waste or other deleterious material and shall have a maximum particle size of one inch and a maximum of 50 percent (by weight) passing the No. 200 sieve. The sand layer shall have a surface with protrusions or ruts no greater than ½-inch. The Contractor shall identify potential material source and submit samples for approval to the CQA Officer.	Collect one representative sample of proposed source material. Test source in accordance with requirements of Table 2 and listed below: <ul style="list-style-type: none"> • Grain size analyses (ASTM D422) – 1 per 5,000 cy (min 1 per material type) 	Review test results for compliance with specifications and approve material for use, as appropriate. Notify Contractor and Construction Manager of areas or materials not meeting design specifications and requirements.
30) Placement of the sand layer shall be performed in a manner so as not to incorporate the underlying waste into the sand material.	Observe and document placement of the sand layer is placed in a manner as not to incorporate the underlying waste.	Review documentation for compliance with specifications. Notify the Construction Manager and Contractor of deficiencies and confirm corrective actions are made.
31) Surface of sand layer shall be proof rolled prior to placement of the GCL.	Observe proof rolling of sand layer. Notify the Contractor and CQA Consultant of any deficiencies.	
32) The sand layer shall not be saturated or have areas of ponded water immediately	Confirm and document that the sand layer is not saturated and contains no areas of	

**TABLE 1
LANDFILL CELL CONSTRUCTION AND CLOSURE – CQC/CQA ACTIVITIES**

SPECIFICATION	CONSTRUCTION QUALITY CONTROL	CONSTRUCTION QUALITY ASSURANCE
prior to placement of the GCL.	ponding water immediately prior to placement of the GCL. Notify the Contractor and CQA Consultant of any deficiencies.	
33) The depth of the sand layer should be verified by survey (Total Station) on a grid no greater than 60 feet by 60 feet by a registered surveyor or alternative method approved by the CQA Consultant.	Verify depth of sand layer through direct measurement or alternative methods approved by CQA Consultant in accordance with the specifications. Document results of measurement and notify the CQA Consultant and Contractor of deficiencies and confirm corrective actions are made.	Review measurement of sand layer thickness, notify Construction Manager and Contractor of deficiencies and confirm that all deficient areas are reworked and meet the specification. Prepare sand layer acceptance form.
GEOSYNTHETIC CLAY LINER (GCL)		
34) Geosynthetic Installer or Geosynthetics Supplier shall submit conformance testing results in accordance with requirements of Table 5. Materials shall meet minimum requirements in Table 5. GCL shall not be deployed until CQA Consultant approves material.	Collect samples of GCL for quality control certifications in accordance with the requirements of Table 5. Conformance testing results shall be submitted to the CQA Consultant for review and acceptance.	Test representative samples for CQA testing in accordance with Table 5. Review CQA testing results and manufacturer conformance testing frequencies and results in accordance with Table 5. Reject rolls not meeting the minimum specifications. Confirm that rejected rolls are removed from the project area and are unused.
35) GCL rolls shall be identified, handled and stored in accordance with ASTM D5888. Each roll shall be identified and labeled with a unique identification number.	Confirm and document that the GCL rolls are identified, handled, and stored in accordance with ASTM D5888. Notify the Contractor (Geosynthetic Installer) and CQA Consultant of deficiencies and confirm corrective actions are made.	Notify Construction Manager and Contractor (Geosynthetic Installer) of deficiencies and confirm that all deficiencies are addressed.

**TABLE 1
LANDFILL CELL CONSTRUCTION AND CLOSURE – CQC/CQA ACTIVITIES**

SPECIFICATION	CONSTRUCTION QUALITY CONTROL	CONSTRUCTION QUALITY ASSURANCE
36) Geosynthetic Installer shall submit a GCL panel layout plan for approval to the CQA Consultant prior to placement.	Observe panel installation for conformance with approved panel layout plan.	Review, comment and approve GCL panel layout as appropriate. Observe panel installation for conformance with panel layout plan.
37) Review subgrade condition for conformance with specifications prior to placement of GCL. Subgrade shall be firm and shall not have areas of saturated soil or ponded water.	Confirm the subgrade condition conforms to the requirements of the technical specifications prior to placement of GCL. Notify CQA Consultant and Contractor of deficiencies and observe and document that all deficient areas are reworked and meet the specification.	Review subgrade conditions prior to placement of GCL panels for compliance with specification. Notify Construction Manager of deficiencies and confirm that all deficient areas are reworked and meet the specification. Obtain signature and approval of GCL subgrade acceptance from Geosynthetic Installer, as appropriate
38) GCL panels shall be placed as closely as practical to the GCL panel placement plan approved by the CQA Consultant. Minor alterations will not be considered a field design, engineering or construction change, as determined by the CQA Consultant.	Observe and document that panels are placed in general accordance with the specifications and GCL placement plan approved by the Geosynthetics Installer and the CQA Consultant. Together with the CQA Consultant, approve any minor alterations to the placement plan prior to the change being made. Maintain an as-built drawing showing the general placement of the panels. Document all corrective actions.	Observe and document that panels are placed in general accordance with the approved GCL placement plan and specifications. Review and approve any minor alterations to the placement plan prior to the change being made. Notify Construction Manager and Contractor of deficiencies and confirm that all deficient areas are reworked and meet the specification. Document all corrective actions.
39) Horizontal seams shall not be allowed for slopes greater than 5%.		
40) GCL shall be placed in accordance with ASTM D 6102. No equipment shall be allowed on the surface of the GCL that will cause damage. Equipment directly on the GCL shall be limited to low ground		

**TABLE 1
LANDFILL CELL CONSTRUCTION AND CLOSURE – CQC/CQA ACTIVITIES**

SPECIFICATION	CONSTRUCTION QUALITY CONTROL	CONSTRUCTION QUALITY ASSURANCE
<p>pressure all-terrain vehicles (ATVs) provided that no sudden stops, starts or turns are made. Additional equipment may be allowed if approved by the CQA Officer.</p>		
<p>41) The installer shall mark the roll number and the panel conspicuously on the panel.</p>		
<p>42) The GCL shall be installed so as to provide a surface with minimal creases or irregularities.</p>		
<p>43) Rolls shall be inspected during placement for equipment damage, holes, thin spots, areas where bentonite does not adhere to the support fabric, or the support fabric has become separated, signs of contamination by foreign material, or areas where the GCL has become hydrated.</p>	<p>Observe the rolls as they are unwound. Identify defective or damaged areas and confirm that unsuitable material is rejected and removed from the project area. Notify the Contractor and CQA Consultant of damaged materials.</p>	<p>Confirm that damaged or defective material is removed from the project area. Notify Construction Manager and Contractor of deficiencies and rejected materials.</p>
<p>44) Defective areas shall be repaired with an additional piece of GCL placed over the areas with a minimum overlap of 12 inches. The placement of additional bentonite in the seams of the repair shall be performed in accordance with the manufacturer recommendations.</p>	<p>Verify and document that defective areas are repaired in accordance with the specification. Notify CQA Consultant and Contractor of deficiencies and observe and document that all deficient areas are reworked and meet the specification.</p>	<p>Verify that repairs are performed in accordance with the specifications. Notify Construction Manager and Contractor of deficiencies and verify corrective actions have been taken where required.</p>

**TABLE 1
LANDFILL CELL CONSTRUCTION AND CLOSURE – CQC/CQA ACTIVITIES**

SPECIFICATION	CONSTRUCTION QUALITY CONTROL	CONSTRUCTION QUALITY ASSURANCE
45) GCL seams shall maintain a minimum of six (6) inches of overlap along the edges and twelve (12) inches at the end joints, at all times regardless of shrinkage. Seams shall be free of foreign material. Seams shall run parallel with the greatest slope with the uphill panel overlapping the downhill panel. GCL shall not be used on slope greater than seven (7) percent.	Observe and documents seams to verify adequate overlap has been provided and is maintained. Overlap will be verified by visual observation of the manufacturer’s lap lines, if available, or direct measurement.	Verify and document that adequate overlap has been provided and maintained. Verify that corrective actions have been taken where required.
46) GCL shall not be installed during periods of rain, in areas of standing water, over areas which have been softened by precipitation (unconfined compressive strength less than 1.0 tons/sq. ft) or over areas of ice or frozen subgrade.	Observe weather conditions and GCL surface condition. Verify that deficiencies are noted and corrected actions required by the CQA personnel are accomplished. Confirm that damaged material is rejected and removed from the project area.	Observe and document weather conditions during GCL deployment. Notify Construction Manager and Contractor of deficiencies and confirm that all deficient areas are reworked and meet the specification. Document all corrective actions.
47) HDPE geomembrane liner shall be deployed as soon as practical over the placement of the GCL. It is the Geosynthetic Installer’s responsibility to protect the GCL during installation process.	Observe and document GCL conditions prior to deployment of geomembrane. Observe and document that deficiencies are noted and corrected actions required by the CQA personnel are accomplished.	Notify Construction Manager and Contractor of damaged or hydrated areas. Confirm that all deficient areas are replaced/repared and meet the specification. Document all corrective actions.
48) Cover all exposed edges of the GCL with protective tarps and sandbag in place at the end of each working day.	Observe and document that all exposed edges are covered and sandbags are in place at the end of each day.	Notify Construction Manager and Contractor of deficiencies and confirm that all deficient areas are reworked and meet the specification.
FLEXIBLE GEOMEMBRANE LINERS/GEOMEMBRANES		
49) Geosynthetic Installer or Geosynthetics	No action required.	Review manufacturer conformance testing

**TABLE 1
LANDFILL CELL CONSTRUCTION AND CLOSURE – CQC/CQA ACTIVITIES**

SPECIFICATION	CONSTRUCTION QUALITY CONTROL	CONSTRUCTION QUALITY ASSURANCE
<p>Supplier shall submit manufacturer’s conformance testing results in accordance with requirements of Table 3. Materials shall meet minimum requirements in Table 3. Rolls that do not meet project requirements shall be marked conspicuously and removed from the construction area. Manufacturer shall submit a statement that the following is true for the geomembrane to be used for this project: No post-consumer resin is used. The addition of reworked polymer (from the manufacturing process) to resin shall be permitted if it does not exceed 2% by weight, contains no encapsulated scrim, and is performed with appropriate cleanliness. Rolls shall not be deployed until approval from the CQA Consultant has been received.</p>		<p>frequencies and results in accordance with Table 3. Representative samples shall be shipped to CQA laboratory for conformance testing in accordance with Table 3. Review results of CQA and MQC tests for compliance with minimum specifications. Reject rolls not meeting the minimum specifications. Confirm that rejected rolls are removed from the project area and are unused.</p>
<p>50) Geomembrane rolls shall be identified, handled and stored in accordance with ASTM D4873. Each roll shall be identified and labeled with a unique identification number.</p>	<p>Observe and document that the HDPE liner rolls are identified, handled, and stored in accordance with ASTM D4873. Observe and document that deficiencies are corrected.</p>	<p>Review material handling procedures and equipment. Notify Construction Manager and Contractor (Geosynthetic Installer) of deficiencies. Confirm that deficiencies are corrected.</p>
<p>51) The liner manufacturer shall supply certification that the resin meets the density specification defined in Table 3.</p>	<p>Confirm and document that rejected material is tagged and removed from the project area.</p>	<p>Document, review and approve required documentation for compliance with specification. Reject material not meeting the minimum specifications.</p>

**TABLE 1
LANDFILL CELL CONSTRUCTION AND CLOSURE – CQC/CQA ACTIVITIES**

SPECIFICATION	CONSTRUCTION QUALITY CONTROL	CONSTRUCTION QUALITY ASSURANCE
<p>52) Geosynthetic Installer shall submit a geomembrane panel layout plan for approval to the CQA Consultant prior to placement. The drawing shall be in sufficient detail to provide an accurate representation of the field seaming and anchor trench details that will be performed. All overlaps shall be in the downslope direction. Panel layout shall be established such that the total length of seam shall be minimized and to minimize the number of seams which run parallel to the toe of the slope with a distance of five (5) feet from the toe.</p>	<p>Observe panel installation for conformance with panel layout plan. Document any deficiencies and report to CQA Consultant and Contractor (Geosynthetic Installer).</p>	<p>Review, comment and approve geomembrane panel layout as appropriate.</p>
<p>53) Welding rod manufacturer shall provide certification that the rod is of the same polymer as the geomembrane sheets and shall specify the polymer used.</p>	<p>Review submittals for compliance; Welding technicians shall not be allowed to weld until approval has been received from the CQA Consultant.</p>	<p>Review submittals for conformance with specification. Reject any submittals that do not comply with specifications.</p>
<p>54) The Installer must demonstrate a minimum of 10 million sq. ft. of HDPE geomembrane installed. Installer shall submit resume of Installation Superintendent(s), who shall have prior experience supervising installation of a minimum of 2 million sq. ft of liner.</p>		
<p>55) Installer shall submit resume of Welding Technician Supervisors, who shall have</p>		

**TABLE 1
LANDFILL CELL CONSTRUCTION AND CLOSURE – CQC/CQA ACTIVITIES**

SPECIFICATION	CONSTRUCTION QUALITY CONTROL	CONSTRUCTION QUALITY ASSURANCE
<p>prior experience welding a minimum of 1 million sq. ft of liner. At least one Welding Technician Supervisor shall be assigned to each welding crew. Welding technicians shall not be allowed to weld until approval has been received from the CQA Consultant indicating that the welding technicians have been approved based on the required submittals.</p>		
<p>56) Liner Surface Preparation: Areas to receive geomembrane shall be free from ponded water and shall be smooth, free from sharp objects, holes or depressions, and deleterious material that might damage the overlying geomembrane. The surface of the completed clay liner/clay cap or protective soil cover shall be uniformly graded. The surface shall provide a firm foundation. Desiccation cracks larger than ¼-inch wide and one inch deep shall be filled with dry powdered bentonite.</p>	<p>Observe, photograph and document that the subgrade condition conforms to the requirements of the technical specifications prior to placement of HDPE liner.</p>	<p>Observe the subgrade for the HDPE liner. Notify Construction Manager and Contractor of any deficiencies and confirm corrective actions have been taken. Record findings of observations, review and actions taken.</p>
<p>57) Geomembrane panels shall be placed as closely as practical to the geomembrane panel placement plan approved by the CQA Consultant. Minor alterations will not be considered a field design, engineering or construction change, as</p>	<p>Observe that panels are placed in general accordance with the HDPE liner panel placement plan approved by the Geosynthetics Installer and the CQA Consultant. Together with the CQA Consultant, approve any minor alterations</p>	<p>Observe that the liner is placed in accordance with the approved liner placement plan. Review and approve any modifications to the proposed placement plan during construction. If rejected, an alternative plan must be proposed and</p>

**TABLE 1
LANDFILL CELL CONSTRUCTION AND CLOSURE – CQC/CQA ACTIVITIES**

SPECIFICATION	CONSTRUCTION QUALITY CONTROL	CONSTRUCTION QUALITY ASSURANCE
<p>determined by the CQA Consultant. Advise the CQA Consultant of the reasons for the proposed modifications.</p>	<p>to the placement plan prior to the change being made. Maintain an as-built drawing showing the general placement of the panels</p>	<p>accepted or the previously approved plan must be followed.</p>
<p>58) The geomembrane liner shall be installed in such a manner to prevent damage or contamination to the underlying surface. Damage is defined as any tearing, gouging, ripping, wrinkling, folding, etc. of the underlying materials such that its integrity or functionality is diminished. Mark roll number conspicuously on the panel.</p>	<p>Observe the rolls as they are unwound. Identify defective or damaged areas and confirm that unsuitable material is rejected and removed from the project area. Notify the Contractor and CQA Consultant of damaged materials.</p>	<p>Confirm that damaged or defective material is removed from the project area. Notify Construction Manager and Contractor of deficiencies and rejected materials.</p>
<p>59) Rolls shall be inspected during placement for equipment damage, holes, blisters, thin spots, undispersed raw materials, or any signs of contamination by foreign material. In most instances, visual defects (such as blisters) are small enough that the repair of a visual defect may consist of placing a bead of extrudate from the extrusion welding gun over the visual defect. Welding beads placed to repair such visual defects are not considered extrusion welding and therefore do not require vacuum testing. Any form of hole in or penetration through the liner must be patched with a cap which must be vacuum tested.</p>	<p>Visually inspect the HDPE liner during placement for any deficiencies. Observe and document that deficiencies are noted and corrected actions required by the CQA personnel are accomplished.</p>	<p>Review field documentation and notify Construction Manager and Contractor of deficiencies. Verify that corrective actions are performed.</p>

**TABLE 1
LANDFILL CELL CONSTRUCTION AND CLOSURE – CQC/CQA ACTIVITIES**

SPECIFICATION	CONSTRUCTION QUALITY CONTROL	CONSTRUCTION QUALITY ASSURANCE
<p>60) Panel deployment shall utilize a spreader bar or similar equipment to prevent slings from damaging the roll edges. Small floatation tired ATV's are also acceptable. No tracked vehicles shall be allowed on the geosynthetics. Low ground pressure (LGP) equipment (average ground pressure < 4 psi), with rubber tracks or tires shall be used for geomembrane deployment over the GCL.</p>	<p>Observe, photograph and document panel deployment, including equipment used and material placed. Observe and document that deficiencies are noted and corrected actions required by the CQA personnel are accomplished.</p>	<p>Observe and document panel deployment. Notify Construction Manager and Contractor of any deficiencies and observe and document corrective actions.</p>
<p>61) Direct equipment contact with components of the geosynthetic cover system shall be minimized. The geomembrane shall be protected by geotextile “rub sheets”, scrap geomembranes, or other suitable materials, in trafficked areas or other areas requiring geomembrane protection.</p>		
<p>62) Method used to place panels shall minimize wrinkles (especially differential wrinkles between panels). The geomembrane shall be securely anchored and then rolled in such a matter as to continually keep the geomembrane in tension to preclude folding.</p>		
<p>63) The geomembrane shall be weighted with</p>	<p>Verify the HDPE liner is appropriately</p>	<p>Observe panel condition and notify</p>

**TABLE 1
LANDFILL CELL CONSTRUCTION AND CLOSURE – CQC/CQA ACTIVITIES**

SPECIFICATION	CONSTRUCTION QUALITY CONTROL	CONSTRUCTION QUALITY ASSURANCE
<p>sandbags or equivalent ballast materials, to prevent movement by wind. Such sandbags shall be installed during placement and shall remain until replaced with subsequent liner system materials and cover soils and/or other materials capable of providing sufficient ballast against wind uplift. In case of high winds, continuous loading is recommended along edges of panels to minimize risk of wind uplift of panels.</p>	<p>weighted with sandbags or equivalent ballast materials. Verify that deficiencies are noted and corrected actions required by the CQA personnel are accomplished.</p>	<p>Construction Manager and Contractor of any deficiencies and observe and document corrective actions.</p>
<p>64) Do not place panels at ambient temperature below or above the manufacturer’s suggested ambient temperature range for installation. Do not place during precipitation, in presence of excessive moisture (e.g. fog or dew), in areas of ponded water, or during excessive winds, as determined by the Owner or Owner’s representative.</p>	<p>Observe weather conditions during panel deployment. Notify the Contractor and CQA Consultant of deficiencies. Observe and document that deficiencies are noted and corrected actions required by the CQA personnel are accomplished.</p>	<p>Record site conditions during panel deployment. Notify Construction Manager and Contractor of any deficiencies and verify corrective actions are performed.</p>
<p>65) Overlap panels a minimum of 3 inches unless otherwise recommended by the geomembrane manufacturer.</p>	<p>Observe seams to verify adequate overlap has been provided and is maintained.</p>	<p>Measure and observe panel overlaps meet specifications.</p>
<p>66) Prior to seaming, seam shall be clean and free of moisture, dust, dirt, debris of any kind, and foreign material. If seam grinding is required, process shall be</p>	<p>Observe the full length of the seam for excessive grinding and compliance with the specifications. Confirm that corrective actions required by CQA</p>	<p>Observe the full length of the seam (welded by extrusion welding technique) for excessive grinding. Report deficiencies to Construction Manager and Contractor</p>

**TABLE 1
LANDFILL CELL CONSTRUCTION AND CLOSURE – CQC/CQA ACTIVITIES**

SPECIFICATION	CONSTRUCTION QUALITY CONTROL	CONSTRUCTION QUALITY ASSURANCE
<p>completed according to Manufacturer’s instructions and in a way not damaging to geomembrane A copy of the Manufacturer’s instructions shall be submitted to the CQA Consultant upon request. In the event that excessive grinding does take place, then the seam in that area will be considered defective, and a cap seam shall be placed over the entire seam where the excessive grinding is observed. A cap seam is defined as an additional welding bead (or beads) parallel to the seam weld, as long as the additional welding bead(s) covers the area of excessive grinding. A maximum of two welding beads may be allowed to cover areas of excessive grinding. If the additional welding bead(s) does not cover the area of excessive grinding, then a liner cap shall be placed over that portion of the seam where the welding bead(s) does not cover the area of excessive grinding.</p>	<p>personnel are accomplished.</p>	<p>and observe and document corrective actions. A copy of the Manufacturer’s instructions (provided by the Contractor) shall be submitted to the Director upon request.</p>
<p>67) Align seams with least possible number of wrinkles and “fish mouths”.</p>	<p>Observe that seams are aligned in a manner to reduce wrinkles and “fish mouths.”</p>	<p>Observe the condition of the seam for conformance with specifications and report deficiencies to Construction Manager and Contractor and observe and document corrective actions.</p>
<p>68) Welding shall be accomplished by either the fusion method or the extrusion</p>	<p>Document the type of weld, date welded, and the welding technician for each seam</p>	<p>Review welding documentation for compliance with specifications. Notify</p>

**TABLE 1
LANDFILL CELL CONSTRUCTION AND CLOSURE – CQC/CQA ACTIVITIES**

SPECIFICATION	CONSTRUCTION QUALITY CONTROL	CONSTRUCTION QUALITY ASSURANCE
welding method. Extrusion welding shall be restricted to repairs and welding applications not possible by the fusion process.	on the applicable form contained in Appendix A or similar forms.	Contractor and Construction Manager of deficiencies. Verify that deficiencies are addressed and corrective actions are performed as necessary.
69) Prior to any welding (using either welding method), at the beginning of the construction shift and after the lunch break, a pre-weld test will be run for each technician/equipment combination. After cooling, coupons will be taken and tested for peel and shear. If any pre-weld test does not meet the seaming requirements in Table 3, than an additional pre-weld sample will be made and tested. After any second pre-weld test failure, two consecutive pre-weld samples must be made, tested and have passing results before that particular technician/machine combination can be put into production welding.	Observe pre-weld testing and record results on the applicable forms contained in Appendix A, or similar forms. Notify Contractor and CQA Consultant of failing tests/deficiencies and observe and document that corrective actions are taken to correct problems identified during pre-weld testing.	Observe, document and review test welds. Approve test weld results and report deficiencies to Construction Manager and Contractor and verify corrective actions are performed.
70) Geosynthetic Installer shall perform non-destructive testing on all production fusion welds in accordance with ASTM D5820 and on all extrusion welds in accordance with ASTM D5641.	Perform non-destructive testing (to be performed by Geosynthetic Installer). Record and document results of the non-destructive seam tests on the applicable form in Appendix A, or a similar form.	Observe and document all non-destructive testing. Where defective results are obtained, require and verify that the seams are repaired in accordance with specifications for repair and/or patching.
71) Geosynthetic Installer shall perform destructive testing at a minimum	Obtain samples for destructive testing at the intervals indicated. Record sample	Identify destructive sampling locations. Record locations on liner placement plan.

**TABLE 1
LANDFILL CELL CONSTRUCTION AND CLOSURE – CQC/CQA ACTIVITIES**

SPECIFICATION	CONSTRUCTION QUALITY CONTROL	CONSTRUCTION QUALITY ASSURANCE
<p>frequency of every 500 lf. Locations shall be selected by CQA Consultant and shall be at non-critical locations such as anchor trench locations or leachate collection sumps whenever possible. Sample shall be a minimum of 26 inches by 12 inches. Samples shall be numbered consecutively. Remove two coupons of one-inch in width from the sample for field testing in the peel and shear modes. Field test the strips for peel and shear with a digital field tensiometer capable of quantitatively measuring shear and peel strengths. If one or more field tests fail in either peel or shear, implement procedures in Item 72. If the samples pass the field test, divide the sample into two approximately 12 inch x 12 inch samples (one portion for the Owner’s independent laboratory for testing; and one portion to the Owner for archiving). One sample shall be sent to an approved laboratory for peel and shear testing (ASTM D6392) by owner’s representative. At least five replicate specimens should be tested for each test method. To be acceptable, four of the five replicates shall pass seam strength and peel adhesion criteria (Table 3).</p>	<p>locations on the HDPE liner panel placement plan. Remove two coupons of one-inch or less in width from sample for field testing then divide the sample into three approximately 12 x 12 inch samples. One of the samples should be sent to an approved laboratory for peel and shear testing. The remaining samples should be provided to the CQA Consultant.</p>	<p>Collect two 12x12 inch samples from Geosynthetic Installer. Test one sample (minimum 5 replicate specimens) for seam strength and peel adhesion. Archive remaining samples as directed by Owner. Review, document, and approve seams. Notify Construction Manager and Contractor of any deficiencies and review and document corrective actions.</p>
<p>72) If destructive test seam failure is</p>	<p>Review and document all seam failures</p>	<p>Review documentation of all seam failures</p>

**TABLE 1
LANDFILL CELL CONSTRUCTION AND CLOSURE – CQC/CQA ACTIVITIES**

SPECIFICATION	CONSTRUCTION QUALITY CONTROL	CONSTRUCTION QUALITY ASSURANCE
<p>identified, the following procedures shall apply:</p> <ul style="list-style-type: none"> a. Reconstruct the seam between any two passes test locations, or: b. Retrace the welding path to intermediate location, at 10 ft minimum from location of failed test in each direction and take samples for additional field tests. If the second test passes, then seam shall be either reconstructed or cap stripped between the two passes locations. If any sample fails, the process shall be repeated. c. The boundary samples shall be tested in the same manner as the original sample. In any case, acceptable seams shall be bounded by two pass test locations (i.e., above procedures shall be followed in both directions from original failed location. d. In the event that seam sample fails laboratory destructive test, then above procedures shall be followed considering laboratory tests exclusively. Because final seam must be bounded by two passing test locations, it may be necessary to take one or more 	<p>and confirm corrective actions are performed in accordance with the specifications.</p>	<p>and corrective actions. Review laboratory test results for compliance with specifications and notify Construction Manager and Contractor of passing tests and failures.</p>

**TABLE 1
LANDFILL CELL CONSTRUCTION AND CLOSURE – CQC/CQA ACTIVITIES**

SPECIFICATION	CONSTRUCTION QUALITY CONTROL	CONSTRUCTION QUALITY ASSURANCE
<p>samples for laboratory testing. e. Each sample hole and coupon hole shall be patched, along with the entire length of the defective seam,</p>		
<p>73) Any sample holes in a fusion welded seam shall be repaired by sealing the air space between the wedge tracks at both ends of the sample hold using a leister instrument and vice grips. A patch will be welded over any sample holes using the extrusion welding technique. Patches or caps shall be circular or oval in shape, be of the same HDPE material as the liner, and extend a minimum of six (6) inches over the edge of the sample hole. The corners of the patches will have a radius of not less than three (3) inches. Caps over seams shall also be extrusion welded. The welds on the patches and caps shall be non-destructive tested. Caps greater than 150 feet in length shall be destructively tested.</p>	<p>Observe that seams for all patches and caps are clean, dry and have adequate overlaps in accordance with specifications prior to welding. Perform non-destructive testing on the seams of all patches and caps (Geosynthetic Installer). Observe and document repairs where defective results are obtained. Record and document non-destructive test results on the applicable forms in Appendix A, or similar forms.</p>	<p>Review documentation to confirm that all non-destructive testing is performed on seams of all patches and that results meet the specifications. Where defective results are obtained, require, verify and document that seams are repaired.</p>
<p>DRAINAGE NET</p>		
<p>74) Submit manufacturer conformance testing in accordance frequencies listed with Table 4. Material shall meet minimum requirements in Table 4. All rolls not meeting project specifications shall be</p>	<p>Collect samples of the drainage net material for quality control certifications in accordance with the requirements of Table 4. Conformance testing results shall be submitted to the CQA Consultant</p>	<p>Review and approve required submittals for compliance with specifications. Approve and document materials meeting project specifications. Notify Construction Manager and Contractor (Geosynthetic</p>

**TABLE 1
LANDFILL CELL CONSTRUCTION AND CLOSURE – CQC/CQA ACTIVITIES**

SPECIFICATION	CONSTRUCTION QUALITY CONTROL	CONSTRUCTION QUALITY ASSURANCE
<p>removed from the construction area. Drainage net shall not be deployed until it has been approved by CQA Consultant.</p>	<p>for review and acceptance.</p>	<p>Installer) of any deficiencies and confirm that all failing rolls are moved from the construction area.</p>
<p>75) Drainage net rolls shall be identified, handled and stored in accordance with ASTM D4873. Each roll shall be identified and labeled with a unique identification number.</p>	<p>Observe and document that the drainage net rolls are identified, handled, and stored in accordance with ASTM D4873.</p>	<p>Review handling and storage techniques of geosynthetics. Notify Construction Manager and Contractor of any deficiencies and confirm and document any corrective actions.</p>
<p>76) Prior to deployment of drainage net, the underlying HDPE liner is to be cleaned of soil and debris. The drainage net shall then be covered and maintained free from blowing or placed sand or soil material. Sand or soil material in the drainage net, whether placed by machine or weather related, shall be removed from the drainage net.</p>	<p>Observe the drainage net prior to placement and confirm the underlying HDPE liner has been cleared of dust and debris prior to drainage net placement.</p>	<p>Review net placement procedures for compliance with specifications. Report deficiencies to Construction Manager and Contractor and confirm and document any corrective actions.</p>
<p>77) The drainage net shall be installed by hand to prevent damage to the underlying surface(s). Adjacent rolls shall be joined by overlapping the edges by a minimum of two inches. The upslope net is to overlap the downslope net, where possible. Adjacent rolls shall be connected by tying adjacent net rolls together. The tying material shall be a polymer braid or</p>	<p>Observe placement and joining of adjacent rolls of net for compliance with the specifications. Notify the CQA Consultant and Contractor (Geosynthetic Installer) of any deficiencies and verify that corrective actions have been performed.</p>	<p>Review placement procedures for damage to drainage net. Review and document that overlapping and tying or welding meets the project specifications. Report deficiencies to Construction Manager and Contractor and confirm and document any corrective actions.</p>

**TABLE 1
LANDFILL CELL CONSTRUCTION AND CLOSURE – CQC/CQA ACTIVITIES**

SPECIFICATION	CONSTRUCTION QUALITY CONTROL	CONSTRUCTION QUALITY ASSURANCE
<p>polymer cable ties of a different colored material than the drainage net. The edges of the net shall be tied or secured at no greater than five foot intervals along the sides of the net and two foot intervals along the ends of the rolls.</p>		
<p>78) A double sided or single sided geocomposite incorporating a drainage net and one or two filter fabrics may be used in lieu of a separate drainage net and filter fabric provided it meets the specifications provided in Tables 4 and 6 and design intent of the separate products.</p> <p>Double-sided geocomposite can be installed using low ground pressure all-terrain vehicles (ATVs) provided that no sudden stops, starts or turns are made. Additional equipment may be allowed if approved by the CQA Officer.</p>	<p>Collect samples of the drainage net or geocomposite material for quality control certifications in accordance with the requirements of Table 4 and 6. Conformance testing results shall be submitted to the CQA Consultant for review and acceptance.</p>	<p>Review and approve Geosynthetic Installer/Contractor submittals for conformance with project specifications.</p>
FILTER FABRIC		
<p>79) Submit manufacturer conformance testing in accordance frequencies listed with Table 6. Material shall meet minimum requirements in Table 6. All rolls not meeting project specifications shall be removed from the construction area. Drainage net shall not be deployed until it has been approved by CQA Consultant.</p>	<p>Observe and document the condition of</p>	<p>Review the condition of filter fabric materials. Approve rolls based on tag or</p>

**TABLE 1
LANDFILL CELL CONSTRUCTION AND CLOSURE – CQC/CQA ACTIVITIES**

SPECIFICATION	CONSTRUCTION QUALITY CONTROL	CONSTRUCTION QUALITY ASSURANCE
<p>Filter fabric shall be nonwoven polypropylene or polyester material.</p> <p>80) Filter fabric shall not be used on the project until it has been accepted by the CQA Consultant. Acceptance of the material will be based on visual observation of the condition of each roll of filter fabric, and observation that the tag or printing on each roll indicates that the roll is the type that has been specified.</p>	<p>filter fabric materials. Collect samples of the filter fabric material for quality control certifications in accordance with the requirements of Table 4 and 6. Conformance testing results shall be submitted to the CQA Consultant for review and acceptance. Observe and document that rejected rolls/material is removed from the construction area.</p>	<p>printing on each roll and condition of material. Confirm that rejected rolls/material is removed from the construction area.</p>
<p>81) The filter fabric shall be installed by hand to prevent damage to the underlying surface(s) if a separate geotextile and geonet component are used. Small floatation tired ATV's are acceptable for installation if a geocomposite material is used. The rolls of geotextile filter fabric shall be placed to provide a minimum width of 12 inches of overlap for each joint, or the overlap shall not be less than 3 inches for joining the adjacent sheets by either the sewing or fusion weld methods. The fabric shall be placed such that the upslope fabric will overlap the downslope fabric, if possible.</p>	<p>Observe placement and joining of adjacent rolls of net for compliance with the specifications. Notify the CQA Consultant and Contractor (Geosynthetic Installer) of any deficiencies and verify that corrective actions have been performed.</p>	<p>Review filter fabric placement, overlapping and joining for conformance with specifications. Report deficiencies to Construction Manager and Contractor (Geosynthetic Installer) and confirm and document any corrective actions.</p>
PROTECTIVE SOIL COVER		
<p>82) Satisfactory protective soil cover materials are defined as those with a</p>	<p>Visually observe materials and advise the Contractor which materials meet the</p>	<p>Review results of CQC testing listed in Table 2 for conformance with</p>

**TABLE 1
LANDFILL CELL CONSTRUCTION AND CLOSURE – CQC/CQA ACTIVITIES**

SPECIFICATION	CONSTRUCTION QUALITY CONTROL	CONSTRUCTION QUALITY ASSURANCE
<p>maximum particle size of 1 inch and complying with the Unified Soil Classification System of SP, SW, ML, CL, SM, or SC materials, or combination thereof, or other suitable material as approved by the Director, i.e., screened waste for bottom liner system applications.</p>	<p>specification and may be used. Collect and sample soil in accordance with requirements of Table 2 and listed below:</p> <ul style="list-style-type: none"> • Visual Classification (ASTM D2488) – 1 per 10,000 cy (min 1 per material type) • #200 Wash (ASTM D1440) – 1 per 10,000 cy (min 1 per material type) <p>Notify Contractor of acceptable materials.</p>	<p>specifications. Document any deficiencies and notify Construction Manager and Contractor of unacceptable material and observe and document that this material is not utilized. Observe sampling locations and confirm that samples are representative of source material.</p>
<p>83) Equipment used to place protective cover soil above geosynthetic materials shall be limited to the following:</p> <ol style="list-style-type: none"> a. Allowable ground pressure of less than 10 psi when within 12 to 24 inches of the geosynthetic material b. Allowable ground pressure of less than 20 psi when within 24 to 36 inches of the geosynthetic material 	<p>Observe and document equipment used to place protective soil cover.</p>	<p>Review and approve list of equipment proposed to place protective cover soil. Report deficiencies to Contractor and Construction Manager and confirm and document any corrective actions.</p>
<p>84) No compaction or moisture requirements are specified for the protective soil cover except in the designated zone around the leachate withdrawal pipes and in the access ramp into the interior of the cell. Compaction requirement for these two areas are a minimum of 90% relative</p>	<p>Observe, test, and document compaction of protective soil cover is performed as required by the specifications. A minimum of one nuclear density test (ASTM D6938) shall be performed per 30 feet of pipe length. In the case of the ramp down into the cell, a minimum of</p>	<p>Observe testing and document soil compaction operations. Testing shall be in accordance with frequencies in Table 2. Notify Construction Manager and Contractor of any failing tests and confirm that the failing areas are reworked and retested in accordance with requirements</p>

**TABLE 1
LANDFILL CELL CONSTRUCTION AND CLOSURE – CQC/CQA ACTIVITIES**

SPECIFICATION	CONSTRUCTION QUALITY CONTROL	CONSTRUCTION QUALITY ASSURANCE
compaction (per ASTM D698).	two tests per lift. A minimum of one passing test should be performed for each area where a failing test has been recorded. Report deficiencies to Contractor and CQA Consultant and retest and document any corrective actions.	of Table 2. Review in-situ density testing for conformance with the requirements (ASTM D6938).
85) The grading tolerance limit for the surface of the protective soil cover is minus one tenth of a foot to plus two tenths of a foot. Grade for the protective soil cover will be established by standard survey methods approved by the CQA Consultant that can adequately determine the thickness of the protective soil cover (such as Total Station or other survey methods approved by the CQA Consultant) on at least a 60-foot grid and at all control points. After the grade for the protective soil cover has been checked and approved by the CQA Consultant, the grade poles shall be removed.	Conduct survey measurement at completion by licensed surveyor (Surveyor). Survey points will be on at least a 60-foot grid and at all control points. Corrective grading, if necessary, will be re-surveyed. Final as-built survey data will be prepared and submitted to the CQA Consultant for review.	Verify and document that the required grading tolerance is achieved. Report deficiencies to Construction Manager and Contractor and retest and document any corrective actions. Confirm that all grade poles are removed after approval of cover placement.
COMPACTED CLAY SOIL		
86) Satisfactory compacted clay soil materials	Collect and sample soil sample in	Review results of testing for conformance

**TABLE 1
LANDFILL CELL CONSTRUCTION AND CLOSURE – CQC/CQA ACTIVITIES**

SPECIFICATION	CONSTRUCTION QUALITY CONTROL	CONSTRUCTION QUALITY ASSURANCE
<p>are defined as those with a maximum particle size of 1 inch and complying with the Unified Soil Classification System of CH, CL,CL-ML, ML, MH or combination thereof, or other suitable material as approved by the CQA Officer (and Director in the case of screened waste).</p>	<p>accordance with requirements of Table 2 and listed below:</p> <ul style="list-style-type: none"> • Visual Classification (ASTM D2488) – 1 per 10,000 cy (min 1 per material type) • Standard Proctor (ASTM D698) – 1 per 10,000 cy (min 1 per material type) • Nuclear Density/Moisture (ASTM D6938) – 1 per 500 cy (min 1 per lift) • #200 Wash (ASTM D1140) – 1 per 10,000 cy (min 1 per material type) • Notify Contractor of acceptable materials. 	<p>with specifications. Document any deficiencies and notify Construction Manager and Contractor of unacceptable material and observe and document that this material is not utilized. Observe sampling locations and confirm that samples are representative of source material.</p>
<p>87) Equipment used to place compacted clay soil above geosynthetic materials shall be limited to the following:</p> <ol style="list-style-type: none"> a. Allowable ground pressure of less than 10 psi when within 12 to 24 inches of the geosynthetic material b. Allowable ground pressure of less than 20 psi when within 24 to 36 inches of the geosynthetic material 	<p>Observe and document equipment used to place compacted clay soil.</p>	<p>Review and approve list of equipment proposed to place compacted clay soil. Report deficiencies to Contractor and Construction Manager and confirm and document any corrective actions.</p>
<p>88) Loose lift thickness of the compacted clay</p>	<p>Observe, test, and document compaction</p>	<p>Observe testing and document soil</p>

**TABLE 1
LANDFILL CELL CONSTRUCTION AND CLOSURE – CQC/CQA ACTIVITIES**

SPECIFICATION	CONSTRUCTION QUALITY CONTROL	CONSTRUCTION QUALITY ASSURANCE
<p>soil is dependent on equipment used. Compaction requirement for the CCS is 90% of maximum dry density (per ASTM D698).</p>	<p>of compacted clay soil is performed as required by the specifications. A minimum of one nuclear density test per 1,000 cy of compacted clay soil. A minimum of one nuclear density test shall be performed per 30 feet of pipe length a A minimum of one passing test should be performed for each area where a failing test has been recorded. Report deficiencies to Contractor and Construction Manager and retest and document any corrective actions.</p>	<p>compaction operations. Testing shall be in accordance with frequencies in Table 2. Notify Construction Manager and Contractor of any failing tests. Review in-situ density testing for conformance with the requirements.</p>
<p>89) The grading tolerance limit for the surface of the compacted clay soil is minus one tenth of a foot to plus two tenths of a foot. Grade for the compacted clay soil will be established by standard survey methods approved by the CQA Consultant (such as Total Station or other survey method approved by the CQA Consultant) that can adequately determine the thickness of the compacted clay soil on at least a 60-foot grid and at all control points. After the grade for the compacted clay soil has been checked and approved by the CQA Consultant, the grade poles shall be removed.</p>	<p>Conduct survey measurement at completion by licensed surveyor (Surveyor). Survey points will be on at least a 60-foot grid and at all control points. Corrective grading, if necessary, will be re-surveyed. Final as-built survey data will be prepared and submitted to the CQA Consultant for review.</p>	<p>Verify and document that the required grading tolerance is achieved. Report deficiencies to Contractor and Construction Manager and retest and document any corrective actions. Confirm that all grade poles are removed after approval of cover placement.</p>

**TABLE 1
LANDFILL CELL CONSTRUCTION AND CLOSURE – CQC/CQA ACTIVITIES**

SPECIFICATION	CONSTRUCTION QUALITY CONTROL	CONSTRUCTION QUALITY ASSURANCE
GRAVEL ARMOR PLATING		
90) Gradation: Gravel armor plating shall have at least 85 percent by weight passing the 5-inch sieve, not more than 50 percent by weight passing a 3/4 –inch sieve, and not more than 25 percent by weight passing a #10 sieve or an alternative as approved by the Design Engineer. Submit gradation for material.	Collect samples of proposed gravel armor plating material and provide samples to the CQA Consultant for review and approval.	Review and approve material supplier sieve analysis. Advise the Contractor and Construction Manager of compliance with specifications.
91) Gravel armor plating shall be placed in the locations shown on the drawings to a minimum thickness of 4 inches. Material thickness to the bottom of the gravel armor plating shall be verified on a grid of at least 60 feet for inspection by the CQA Consultant. Areas not meeting the criteria shall be reworked.	Verify that the required minimum thickness of gravel armor is achieved. Measure and document excavated zones in accordance with the specifications.	Review thickness verification activities and notify Contractor and Construction Manager of deficiencies. Document any corrective actions.
ANCILLARY CONSTRUCTION WORK NOT OTHERWISE SPECIFIED		
92) For any work which may impact the construction or performance of the landfill cell or its closure, specifications will be	As part of the development of the specifications, CQC shall include testing, measurements, inspections or other	As part of the development of the specifications, CQA shall evaluate both the Specifications and the CQC tasks

**TABLE 1
LANDFILL CELL CONSTRUCTION AND CLOSURE – CQC/CQA ACTIVITIES**

SPECIFICATION	CONSTRUCTION QUALITY CONTROL	CONSTRUCTION QUALITY ASSURANCE
developed. These specifications must be approved by the CQA Consultant and Design Engineer prior to commencement of the work.	evaluations, as necessary, to demonstrate that the work has been performed as required by the specifications.	developed, to determine their adequacy and suitability for the work proposed. During the actual performance of the work, CQA shall verify that all specified procedures and CQC procedures are being carried out. Reports and records shall become part of the permanent record for the cell(s) involved.

**TABLE 2
EARTHWORK CQC TESTING REQUIREMENTS**

MATERIAL TYPE	TEST METHOD		MIN CQA FREQUENCY
Foundation/Subgrade Recompaction	Nuclear Density/Moisture Content	ASTM D6938	General: 1 per 1,000 cy Retest: 2 passing retests for each area where a failing test is documented. For test areas that represent less than 500 cy, one passing retest shall be required.
	Standard Proctor	ASTM D698	1 per material type
Compacted Soil/Engineered Fill	Nuclear Density/Moisture Content	ASTM D6938	General: 1 per 1,000 cy (min 1 per lift) Retest: 2 passing retests for each area where a failing test is documented. For test areas that represent less than 500 cy, one passing retest shall be required.
	Standard Proctor	ASTM D698	1 per 10,000 cy (min 1 per material type)
	Atterberg Limits	ASTM D4318	1 per 25,000 cy (min 1 per material type)
	#200 Wash	ASTM D1140	1 per 25,000 cy (min 1 per material type)
	Visual Classification	ASTM D2488	1 per 5,000 cy (min 1 per material type)
	Clay Liner/Cap Test Fill	Nuclear Density/Moisture Content	ASTM D6938
	Standard Proctor	ASTM D698	Min 3 or per material type, whichever is greater
	Atterberg Limits	ASTM D4318	Min 3 or per material type, whichever is greater
	Sieve Analysis	ASTM D422	Min 3 or per material type, whichever is greater
	Visual Classification	ASTM D2488	Min 3 or per material type, whichever is greater
	Field Hydraulic Conductivity	ASTM D5126	Min 1 per lift (min 1 for small test pad)
	Laboratory Hydraulic Conductivity	ASTM D5084	Min 1 per lift (min 1 for small test pad)
Compacted Clay Liner/Cap	Nuclear Density/Moisture Content	ASTM D6938	General: 1 per 500 cy (min 1 per lift) ; [1 per 250 cy for first 5,000 cy of clay placed] Retest: 2 passing retests for each area where a failing test is documented.
	Sand Cone/Moisture Content, Drive Cylinder/Moisture Content	ASTM D1556/2216 or D2937/ D2216	1 per every 40 nuclear density/moisture test
	Standard Proctor	ASTM D698	1 per 10,000 cy (min 1 per material type)

**TABLE 2 Continued
EARTHWORK CQA TESTING REQUIREMENTS**

MATERIAL TYPE	TEST METHOD		MIN CQA FREQUENCY
Compacted Clay Liner/Cap Cont.	Hydraulic Conductivity ²	ASTM D5084	1 per ; 1,000 cy (min 1 per material type)
	Atterberg Limits	ASTM D4318	1 per 3,000 cy (min 1 per material type)
	Sieve Analysis	ASTM D422	1 per 3,000 cy (min 1 per material type)
	Visual Classification	ASTM D2488	1 per 3,000 cy (min 1 per material type)
Sand Layer	Grain Size Analyses	ASTM D422	1 per 5,000 cy (min 1 per material type)
Protective Soil Cover	Visual Classification	ASTM D2488	1 per 10,000 cy (min 1 per material type)
	Standard Proctor ¹	ASTM D698	1 per 10,000 cy (min 1 per material type)
	Nuclear Density/Moisture Content ¹	ASTM D6938	General: Min 2 per lift (cap shoulder construction) or 1 per 30 feet of pipe length (riser trench)
			Retest: 2 passing retests for each area where a failing test is documented. For test areas that represent less than 500 cy, one passing retest shall be required.
#200 Wash ³	ASTM D1140	1 per 10,000 cy (min 1 per material type)	
Compacted Clay Soil	Visual Classification	ASTM D2488	1 per 10,000 cy (min 1 per material type)
	Standard Proctor ¹	ASTM D698	1 per 10,000 cy (min 1 per material type)
	Nuclear Density/Moisture Content ¹	ASTM D6938	1 per 1000 cy (min 1 per lift)
			Retest: minimum of 1 passing retest for each area where a failing test is documented.

Notes: (1) Protective soil cover testing for compaction is only required for cap shoulder construction and for cell ramps and leachate riser trenches.

(2) Field samples shall be collected in Shelby (thin walled) tubes and transported to the laboratory for testing. Laboratory hydraulic conductivity shall be performed at 5 psi for the final cover and 40 psi for the liner.

(3) No. 200 Wash required only for compacted clay soil placed on landfill cover sideslopes.

**TABLE 3
MATERIAL PROPERTIES FOR HDPE LINER¹**

PROPERTIES	QUALIFIERS	UNITS	60 MILS	60 MILS TEXTURED	80 MILS	80 MILS TEXTURED	ASTM TEST METHOD	MQC FREQUENCY	CQA FREQUENCY
<u>Physical Properties</u>									
Thickness	Min. Average	mils	60	60	80	80	ASTM D 5199	Per roll	200,000 ft ²
	Lowest Individual	mils	54	54	72	72			
	(8 of 10 value)	mils	54	51	72	68			
	Lowest Individual								
	(of 10 value)								
Carbon Black Content	Range	%	2-3	2-3	2-3	2-3	ASTM D 1603	20,000 lb	200,000 ft ²
Carbon Black Dispersion	N/A	none	Note 2	Note 2	Note 2	Note 2	ASTM D 5596	45,000 lb	200,000 ft ²
Density	Minimum	g/cc	0.94	0.94	0.94	0.94	ASTM D 792 Method A or ASTM D 1505	200,000 lb	200,000 ft ²
<u>Mechanical Properties</u>									
Tensile Properties (each direction)									
1. Tensile (Break) Strength	Minimum	lb/in	228	90	304	120	ASTM D 638	20,000 lbs	200,000 ft ²
2. Elongation at Break		%	700	100	700	100			
3. Tensile (Yield) Strength		lb/in	126	126	168	168			
4. Elongation at Yield		%	12	12	12	12			
Tear Resistance (min ave)	Minimum	lb	42	42	56	56	ASTM D 1004	45,000 lbs	200,000 ft ²
Puncture Resistance	Minimum	lb	108	90	144	120	ASTM D4833	45,000 lbs	200,000 ft ²
Stress Crack Resistance	Minimum	hr	300	300	300	300	ASTM D 5397	Per GRI-GM10	--
Oxidative Induction Time									
Standard OIT, - or -	Minimum Average	Minutes	100	100	100	100	ASTM D 3895	200,000 lb	--
High Pressure OIT			400	400	400	400	ASTM D 5885		
Oven Aging at 85 degrees C									
Standard OIT - % retained after 90 days, - or -	Minimum Average	%	55	55	55	55	ASTM 5721	Per each formulation	--
High Pressure OIT - % retained after 90 days			80	80	80	80	ASTM D 5885		

**TABLE 3 Continued
MATERIAL PROPERTIES FOR HDPE LINER¹**

REQUIRED GEOMEMBRANE SEAM PROPERTIES⁵									
PROPERTIES	QUALIFIERS	UNITS	60 MILS	60 MILS TEXTURED	80 MILS	80 MILS TEXTURED	ASTM TEST METHOD	MQC FREQUENCY	CQA FREQUENCY
<u>Shear Strength⁽³⁾</u>									
Fusion	Minimum	lb/in	120	120	160	160	ASTM D 6392	NA	500 linear feet
Extrusion	Minimum	lb/in	120	120	160	160	ASTM D 6392	NA	500 linear feet
<u>Peel Adhesion</u>									
FTB ⁽⁴⁾							Visual Observation		500 linear feet
Fusion	Minimum	lb/in	91	91	121	121	ASTM D 6392	NA	500 linear feet
Extrusion	Minimum	lb/in	78	78	104	104	ASTM D 6392	NA	500 linear feet

- Notes: (1) Material requirements, manufacturer conformance testing frequency and minimum seam properties are based on the most recent version of Geosynthetic Research Institute (GRI) Specifications GM13 and GM19.
(2) Minimum 9 of 10 in Categories 1 or 2; 10 in Categories 1, 2, or 3.
(3) Also called "Bonded Seam Strength".
(4) FTB = Film Tear Bond means that failure is in the parent material, not the seam. The maximum seam separation is 25 percent of the seam area.
(5) Four of five specimens per destructive sample must pass both the shear and peel strength tests.

**TABLE 4
MATERIAL PROPERTIES FOR DRAINAGE NET**

PROPERTIES	QUALIFIERS	UNITS	SPECIFIED⁽¹⁾ VALUES	TEST METHOD	MQC FREQUENCY	CQA FREQUENCY
Resin Density	Minimum	g/cc	0.94	ASTM D792 or D1505	100,000 ft ²	200,000 ft ²
Carbon Black Content	Range	%	2.0 – 3.0	ASTM D1603 or D4218	100,000 ft ²	200,000 ft ²
Thickness	Minimum	mils	205	ASTM D5199	100,000 ft ²	200,000 ft ²
Transmissivity ⁽²⁾	Minimum	m ² / sec	5 x 10 ⁻⁴	ASTM D4716	500,000 ft ²	200,000 ft ²
Peel Strength/Ply Adhesion ⁽³⁾	Minimum	lb/in	0.5	ASTM D7005	100,000 ft ²	200,000 ft ²

Notes: (1) All values (except transmissivity) represent average roll values.

(2) Transmissivity shall be measured using water at 68°F with a gradient of 0.05 under a confining pressure as directed by CQA engineer for site specific application. The geonet shall be placed in the testing device between 60-mil HDPE smooth geomembrane. Measurements are taken one hour after application of confining pressure.

(3) Peel strength testing is required only if a geocomposite is selected in lieu of a separate geonet and geotextile filter fabric.

**TABLE 5
MATERIAL PROPERTIES FOR GEOSYNTHETIC CLAY LINER**

PROPERTIES	QUALIFIERS	UNITS	SPECIFIED⁽¹⁾ VALUES	TEST METHOD⁽⁴⁾	MQC FREQUENCY	CQA FREQUENCY
Bentonite Content ³	minimum	lb/ft ³	0.75	ASTM D 5993	5,000 yd ²	100,000 ft ²
Hydraulic Index Flux	maximum	m ³ /m ² -s	1 x 10 ⁻⁸	ASTM D 5887 ²	30,000 yd ²	400,000 ft ²
Bentonite Swell Index	minimum	mL/2g	24	ASTM D 5890	50 tonnes	--
Bentonite Fluid Loss	maximum	mL	18	ASTM D 5891	50 tonnes	--

- Notes: (1) All values represent minimum average roll values (i.e., any roll in a lot should meet or exceed the values in this table).
 (2) Hydraulic flux testing shall be performed under an effective confining stress of 5 pounds per square inch.
 (3) Measured at a moisture content of 0 percent; also known as mass per unit area
 (4) Material requirements and manufacturer conformance testing frequency are based on the most recent version of GRI Specification GCL-3.

**TABLE 6
MATERIAL PROPERTIES FOR FILTER FABRIC**

PROPERTY	QUALIFIERS	UNITS	SPECIFIED VALUES	TEST METHOD (ASTM) ⁽¹⁾	MQC FREQUENCY	CQA FREQUENCY
Type			Non-woven			
Mass Per Unit Area	Minimum Average Roll Value	oz/sq-yd	8	D5261	1 per 100,000 ft ²	1 per 200,000 ft ²
Grab Tensile Strength	Minimum Average Roll Value	lbs	220	D4632	1 per 100,000 ft ²	1 per 200,000 ft ²
Trapezoidal Tear Strength	Minimum Average Roll Value	lbs	85	D4533	1 per 100,000 ft ²	1 per 200,000 ft ²
Puncture Strength	Minimum Average Roll Value	lbs	120	D6241	1 per 100,000 ft ²	1 per 200,000 ft ²
Apparent Opening Size	Minimum Average Roll Value	Sieve Size	80	D4751	1 per 540,000 ft ²	1 per 200,000 ft ²
Permittivity	Minimum Average Roll Value	s ⁻¹	1.3	D4491	1 per 540,000 ft ²	1 per 200,000 ft ²
UV Resistance	Minimum Average Roll Value	percent	70 retention at 500 hours	D4355	Per formulation	Not Required

Note:

- (1) Specified test methods and parameters may be modified by the CQA Engineer to be consistent with changes to the industry standard for the specified mass per unit area non-woven geotextile, and consistent with changes to ASTM or GRI methods as they become available.

APPENDIX A-1: SAMPLE FORMS

APPENDIX A-2: TEST METHODS

APPENDIX A-2: TEST METHODS

All testing shall be performed with the most recent approved test method.

ASTM D 422	Standard Test Method for Particle-Size Analysis of Soils
ASTM D 638	Standard Test Method for Tensile Properties of Plastics
ASTM D 698	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft ³ (600 kN-m/m ³))
ASTM D 792	Standard Test Methods 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 1140	Standard Test Method for Amount of Material in Soils Finer than the No. 200 (74- μ m)
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 2216	Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
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 3895	Standard Test Method for Oxidative Induction Time of Polyolefins by Thermal Analysis
ASTM D 4218	Standard Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique.
ASTM D 4318	Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

- 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 Determining the (In-Plane) Flow Rate per Unit Width and Hydraulic Transmissivity of a Geosynthetic using a Constant Head
- ASTM D 4718 Standard Practice for Correction of Unit Weight and Water Content for Soils Containing Oversize Particles
- ASTM D 4833 Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products
- ASTM D 4873 Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples
- ASTM D 4959 Standard Test Method for Determination of Water (Moisture) Content of Soil by Direct Heating
- ASTM D 5084 Standard Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter
- ASTM D 5126 Standard Guide for Comparison of Field Methods for Determining Hydraulic Conductivity in the Vadose Zone
- ASTM D 5199 Standard Test Method for Measuring the Nominal Thickness of Geosynthetics
- ASTM D 5397 (Appendix A) - Environmental Stress Crack Resistance of Polyolefin Geomembranes Using Single-Point Notched Constant Tensile Load Test.
- 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 5721 Standard Practice for Air-Oven Aging of Polyolefin Geomembranes
- ASTM D 5820 Standard Practice for Pressurized Air Channel Evaluation of Dual Seamed Geomembranes
- ASTM D 5885 Standard Test Method for Oxidative Induction Time of Polyolefin Geosynthetics by High-Pressure Differential Scanning Calorimetry
- ASTM D 5887 Standard Test Method for Measurement of Index Flux through Saturated Geosynthetic Clay Liner Specimens using the Flexible Wall Permeameter
- ASTM D 5888 Standard Guide for Storage and Handling of Geosynthetic Clay Liners

ASTM D 5890	Standard Test Method for Swell Index of Clay Mineral Component of Geosynthetic Clay Liners
ASTM D 5891	Standard Test Method for Fluid Loss of Clay Component of Geosynthetic Clay Liners
ASTM D 5993	Standard Test Method for Measuring the Mass per Unit of Geosynthetic Clay Liners
ASTM D 6102	Standard Guide for Installation of Geosynthetic Clay Liners
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 6938	Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
ASTM D 7005	Standard Test Method for Determining the Bond Strength (Ply Adhesion) of Geocomposites
GRI GM13	Test Properties, Testing Frequency, and Recommended Warranty for High Density Polyethylene (HDPE) Geomembranes.
GRI GM19	Seam Strength and Related Properties of Thermally Bonded Polyolefin Geomembranes

APPENDIX A-3

PERMEABILITY TEST PROCEDURES

A-3-1: PROCEDURE FOR SEALED SINGLE RING INFILTROMETER FIELD PERMEABILITY TEST

The sealed single ring infiltrometer testing procedure for field permeability testing is as follows:

1. Equipment
 - a. Metal Ring – With a minimum area of 1294 cm². The bottom of the ring is beveled for a cutting edge. A flange welded to the top of the metal ring is provided to allow connection of a lid.
 - b. Lid – Cover for the metal ring. Provided with a gasket to seal the cover to the ring flange. Also provided with a nipple to connect a water supply hose and vent valve.
 - c. Water Reservoir – Supplies water for the saturation portion of the test. Connects to the lid and the readout tube.
 - d. Readout Tube – Approximately .32 cm diameter to measure the flow of water into the system.
 - e. Stand – Method to support the water reservoir and the readout tube.
 - f. Static Weight Penetrometer – The probe construction will be a stainless steel rod with a quarter (1/4) inch nominal diameter and a flat tip. The probe will have a weight such that the minimum tip pressure is one hundred pounds per square inch (100 psi).

2. Testing Procedures
 - a. Metal rings with a minimum radius of 20.3 cm will be utilized for permeability testing during test pad construction.
 - b. Prepare the area to be tested by smoothing the ground surface and removing any loose or disturbed soil.
 - c. Place the metal ring on the area prepared. Push the metal ring at least 15.2 cm into the soil.
 - d. Remove any soil disturbed from inside the metal ring by the insertion process.
 - e. Seal the inside of the metal ring by compacting the soil immediately adjacent to the ring.
 - f. Place a small plate on the soil surface and pour water over the plate into the ring, filling the ring with water to within approximately 1.3 cm of the top of the ring.
 - g. Place the lid on the ring and seal with clamps or other devices.
 - h. Connect the water reservoir and readout tube to the lid and set on support stand.
 - i. Fill the system with water, filling the ring, reservoir and all hoses.
 - j. Secure the reservoir at least 91.4 cm above the ring.
 - k. Allow the water to permeate into the soil for a minimum of 4 hours (for test pads only: Minimum 0.76 cm wet from depth for each wet front depth test. The average wet front depth for all 9 SSRI tests performed for each test pad must be at least 0.86 cm).
 - l. Fill the readout tube with water and secure the readout tube so that the water level in the tube is approximately 152.4 cm above the ring. Allow the readings to stabilize prior to starting the test. The water level shall be greater than or equal to 121.9 cm

when the test starts. Record the initial height of the water above the soil surface inside the ring.

- m. Record the water level in the readout tube every 20 seconds for 8 minutes. Plot the water drop over time.
- n. Dismantle the system and measure the temperature at the soil-water interface (inside the ring, measured in °C). The appropriate Temperature Correction Factor shall be identified from Figure 1 of the Field Permeability Test Form EC-1906, or from Table 1 of ASTM D 5084. Then measure the depth that the water penetrated into the soil, using the static weight penetrometer. The average of at least three wet front depth tests shall be used for calculating the water penetration depth.
- o. Calculate the Change in Head during the test based on a linear regression analysis of the plotted results.
- p. Calculate the permeability. Report permeability to two significant digits.

3. Documentation

Record the following items. (Record all length measurements in cm.)

- a. Date and time soil saturation began and when permeability test readings were taken.
- b. Test location and elevation.
- c. Timed water drop readings.
- d. Height of water at beginning of readings.
- e. Size of ring and readout tube (if required).
- f. Soil-water interface temperature.
- g. Average depth of wet front.
- h. Plot of water level drop with time.
- i. Plot the calculated regression line of water level drop with time.
- j. Calculated permeability.

A-3-2: Procedure for Obtaining Large Scale Block Samples

This procedure is intended for guidance only. Actual procedures may be modified by the Project Manager and CQA Engineer. This procedure is based on an approximately 12- to 14-in. diameter block sample.

Step 1. Put the sample ring on to the ground where block sample will be carved. (Fig. 1)

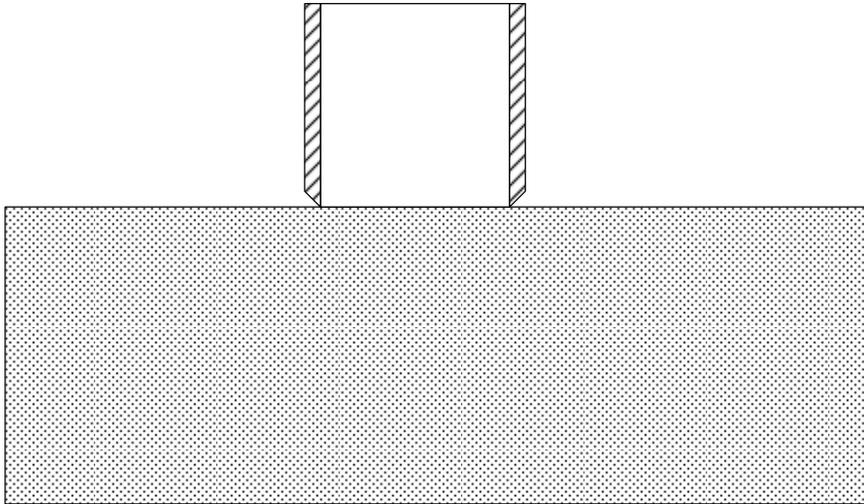


Figure 1.

Step 2. Carefully dig soil around the sample ring about 10" to 16" depth, leave about 14" – 15" soil core. (Fig. 2)

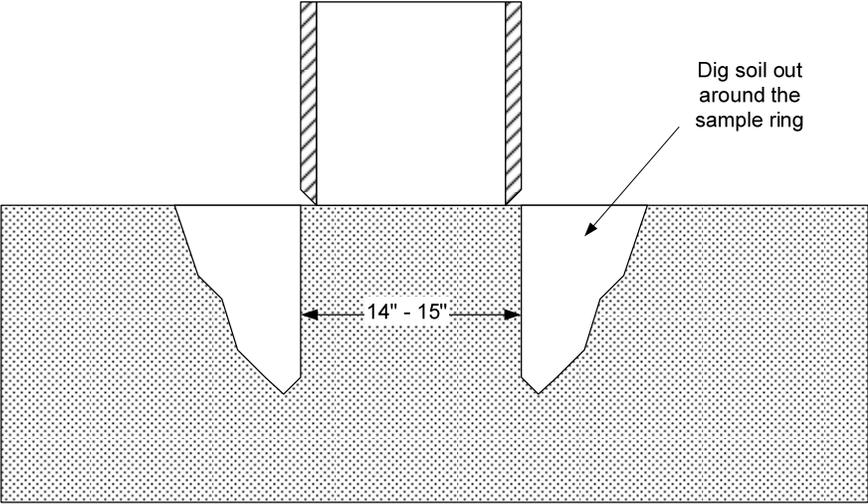


Figure 2.

Step 3. Use a small knife or spatula carefully trim soil about 1" down around bottom edge of sample ring and then push the ring down (Fig. 3)

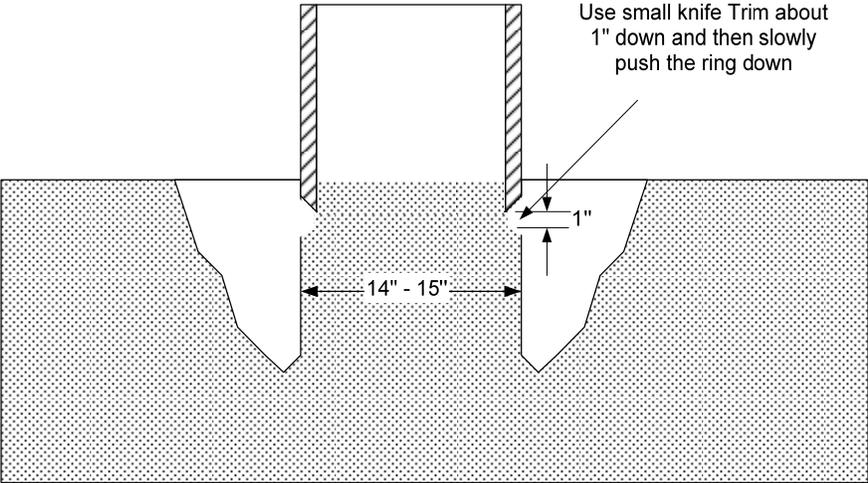


Figure 3.

Step 4. Continue step 3, until soil fits inside the sample ring. (Fig. 4, 5)

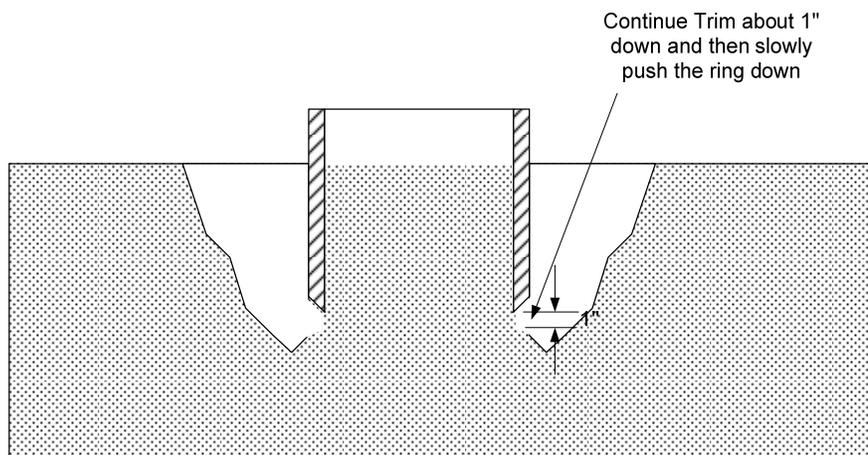


Figure 4.

NOTE: Steps 3 and 4 may be combined into a single alternate step whereby the trimming process may be eliminated and instead the ring may be carefully pushed to its full depth in one step to yield the configuration shown below (Fig. 5).

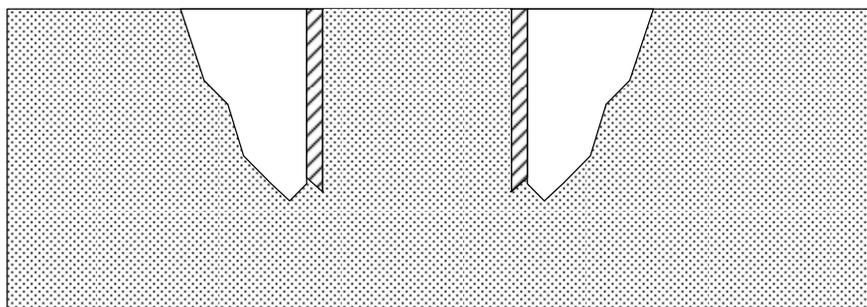


Figure 5.

Step 5. Put 2 layers of plastic sheet on top of the sample ring, and then use duck tape wrap it around the ring. (Fig. 6)

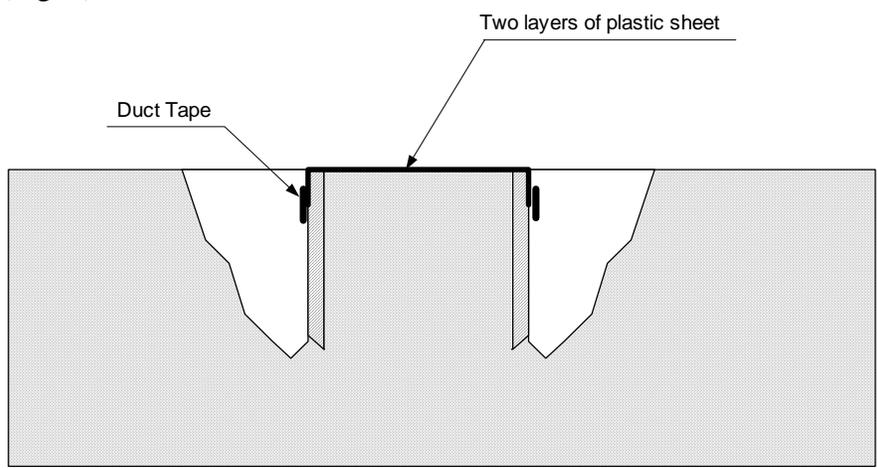


Figure 6.

Step 6. Use a shovel dig soil at the bottom of the ring for whole around the sample ring (Figure 7).

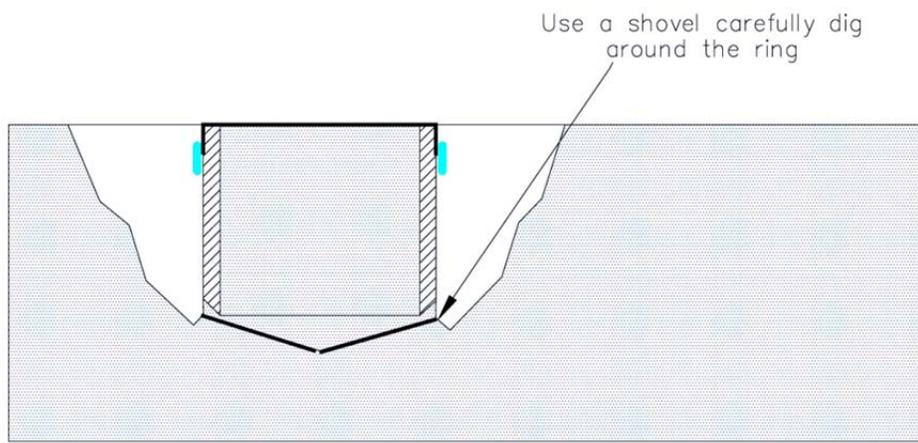


Figure 7

Step 7. Carefully move the sample ring with soil out of the pit, flip over and carefully trim soil at bottom end (Figure 8).

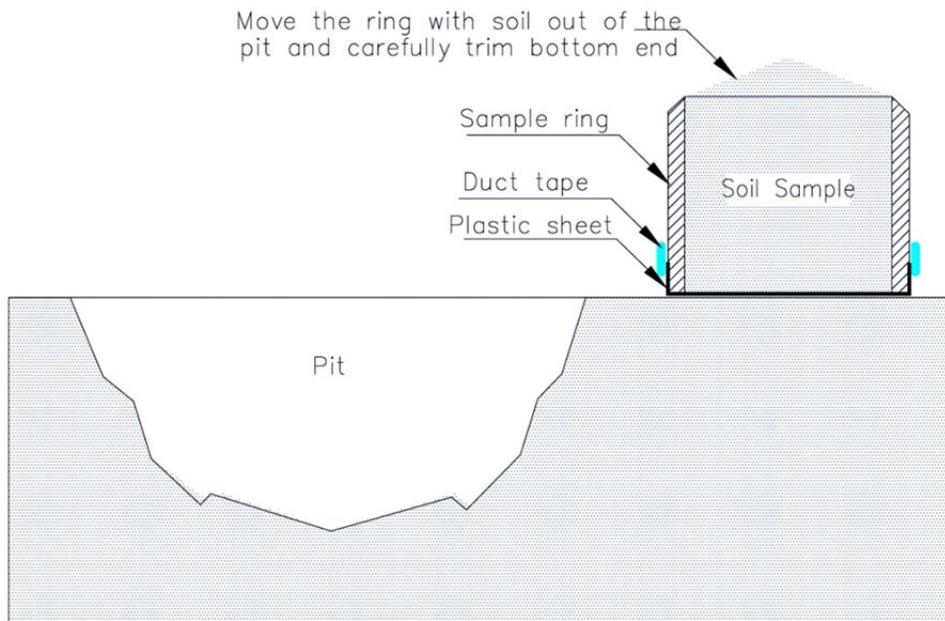


Figure 8.

Step 8. Put 2 layers of plastic sheet on to the sample ring, and then use duck tape wrap it around the ring. (Fig. 9)

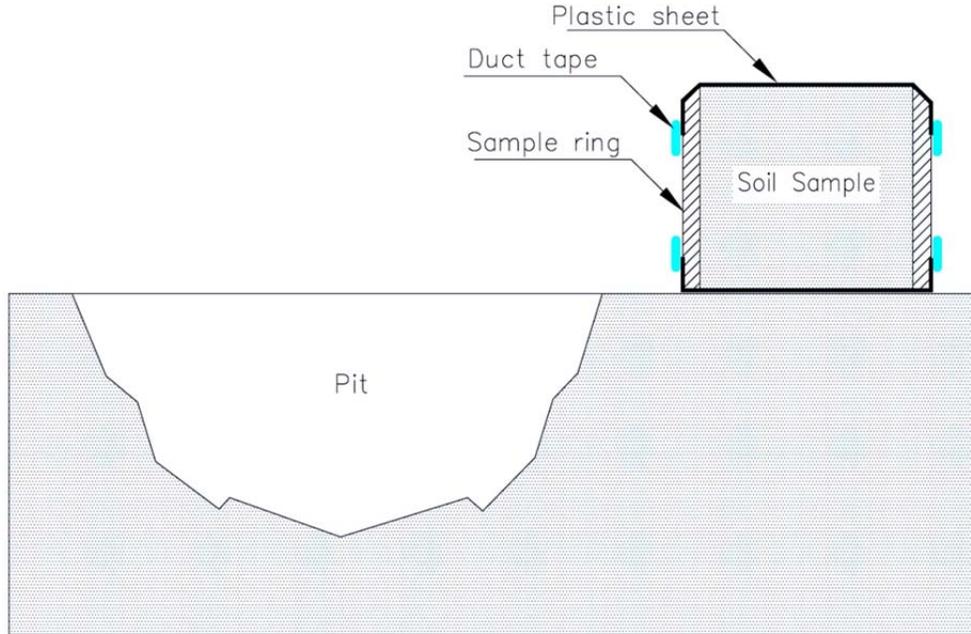


Figure 9.

Step 9. Finally, pack and bolt the sample ring between two boards (see below), or using other packing methods, to keep the sample secure and protected for shipping.

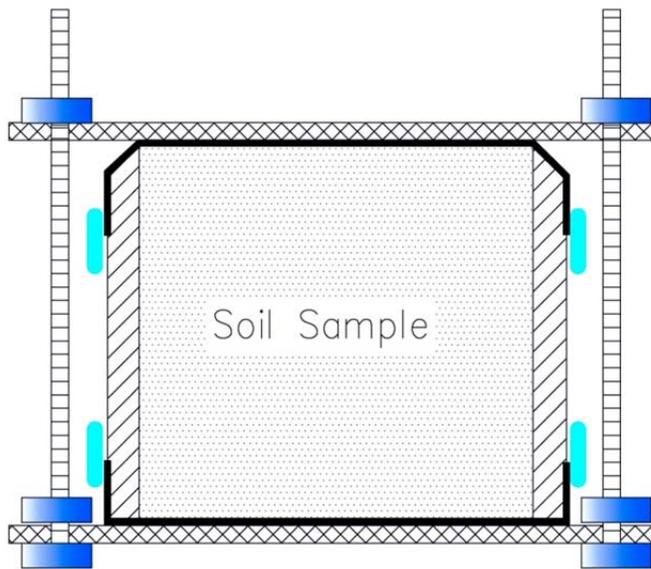


Figure 10.

APPENDIX A-4: VERIFICATION/CALIBRATION REQUIREMENTS

Verification/Calibration Requirements

Testing equipment shall be verified/calibrated at minimum frequencies recommended by the manufacturer or referenced testing standard (e.g., ASTM standard). Details of verification/calibration requirements are listed below:

C.1 Geosynthetics

All geosynthetics laboratory testing shall be performed by a GAI-LAP accredited laboratory (accredited for each test to be performed). Accreditation requirements are summarized at www.geosynthetic-institute.org/gai/appl.pdf and typically require the following:

- A quality manual which follows the outline and intent of ANSI/ASQC Q9001-2008 “Quality management systems – Requirements;
- A standard operating procedure (SOP) for each test for which accreditation is obtained; and
- Conduct business as per ISO 19025 “General requirements for the competence of testing and calibration laboratories”.

Field testing equipment of geosynthetics should be verified/calibrated in accordance with manufacturer’s recommendations or ASTM standard, whichever is more frequent, and includes the following equipment¹:

- D76/E4 – Tensile testing machine – verify/calibrate annually
- D5641 – Vacuum Gauge – verify/calibrate annually
- D5820 – Pressure Gauge – verify/calibrate annually

C.2 Soils Testing

Field and laboratory testing equipment of soil should be verified/calibrated in accordance with manufacturer’s recommendations or ASTM standard, whichever is more stringent. The following table summarizes the soils testing equipment and the corresponding ASTM standards for equipment verification/calibration:

ASTM Designation	Equipment Description	Verification/Calibration Requirements
D4753	Balance/Scales	Annually, or per the standard verification procedures of the laboratory.
D698/D2168	Hammer/Mold	Upon repair, every 1000 tests, or annually, whichever comes first
D1556	Sand	(Bulk Density of Sand) Every 14 days or new batch, significant atmospheric changes

¹ Additional testing/equipment may be required and approved by the CQA Consultant.

D6938	Nuclear Density/Moisture Gauge	After repairs, annually
E145	Drying Oven	Temperature Gauge - Annually, or per the standard verification procedures of the laboratory.
E11 (for ASTM D1140 and D422)	Sieves	Annually, or per the standard verification procedures of the laboratory.

C.3 Survey Equipment

Survey control will be performed with a total station with an accuracy of 5 seconds. The total station shall be calibrated on an annual basis.