Geosyntec consultants

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CONSTRUCTION QUALITY ASSURANCE PLAN, INITIAL REMEDIATION – LANDFILL AREA

ROUGH AND READY ISLAND

PORT OF STOCKTON

Prepared for

Port of Stockton
2201 West Washington Street
Stockton, California 95203

Prepared by

Geosyntec Consultants, Inc.
1111 Broadway, 6th Floor
Oakland, California 94607

Project Number: WR2501B

July 2021

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ACRONYMS AND ABBREVIATIONS

AOC	area of contamination
APN	Assessor Parcel Number
API	American Petroleum Institute
ASTM	American Society for Testing and Materials
Cal-EPA	California Environmental Proection Agency
CCR	California Code of Regulations
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CM	Construction Manager
CQA	Construction Quality Assurance
CQC	Construction Quality Control
CULs	cleanup levels
CVRWQCB	Central Valley Regional Water Quality Control Board
Delta	Sacramento-San Joaquin River Delta
DTSC	Department of Toxic Substances Control
DTSC-SLs	DTSC-Modified Screening Levels
GRI	Geosynthetic Research Institute
Geosyntec	Geosyntec Consultants, Inc.
HASP	Health and Safety Plan
HDPE	High-density polyethylene
Landfill Area	17 of the 52 remedial sites transferred to the Port by the Navy
LLDPE	Linear low-density polyethylene
Navy	United States Navy
NSF	National Sanitation Foundation
Port	Port of Stockton
PM	Project Manager
QA	Quality Assurance
QC	Quality Control
RAP	Remedial Action Plan

RWQCB	Central Valley Regional Water Quality Control Board
SWPPP	Stormwater Pollution Prevention Plan
TBD	to be determined
USCS	United Soil Classification System
USEPA	United States Environmental Protection Agency

1. INTRODUCTION

1.1 Purpose

The purpose of this Construction Quality Assurance (CQA) Plan is to describe the CQA procedures to be used by the CQA organization during the Initial Remedial Construction at the landfill area at the Port of Stockton in Stockton, California.

The CQA Plan is a guidance document that contains general and specific work element requirements for monitoring construction. General requirements include the organization and responsibilities of the Owner, General Contractor, subcontractors, and CQA personnel, documentation control, and reporting procedures. Specific work elements include, but are not limited to, the following:

1. Clearing and grubbing;
2. Dewatering;
3. Stockpiling and soil management;
4. Control of stormwater and erosion during construction;
5. Excavating;
6. Placing earthfill,
7. Placing backfill;
8. Placing drainage gravel;
9. Placing excavated waste material and impacted soil;
10. Placing foundation layer;
11. Preparing subgrade;
12. Placing vegetative layer;
13. Placing road base;
14. Installing Hydroseed;
15. Placing rip-rap;
16. Installing polyethylene pipe;
17. Installing geocomposites;
18. Installing geotextiles;
19. Installing geomembrane; and
20. Performing Surveys.

The CQA Organization will prepare a Final CQA Report upon completion of construction. The report will include information generated by the CQA program and will document the extent to which construction was performed in accordance with the intent of the contract documents and design. The CQA Organization will be required to submit the report within **60 calendar days** of construction completion.

1.2 CQA Organization

The CQA Organization has the primary responsibility for implementing and managing the CQA program described in this CQA Plan and will document to the Department of Toxic Substances (DTSC) that the Initial Remedial Construction at the landfill area was performed in compliance with the design and the contract documents. Specific responsibilities for the CQA organization site personnel are presented in Section 2.2 (Responsibilities of CQA Staff).

1.3 Addresses

The following addresses, phone numbers, facsimile numbers, and contacts of organizations involved with the Initial Remedial Construction project are provided for informational purposes only.

Owner

Port of Stockton
2201 West Washington Street
Stockton, California 95203
Phone: (209) 946-0246
email: jwingfield@stocktonport.com
Contact: Jeff Wingfield
Director of Environmental & Public Affairs

Design Engineer

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Oakland, California 94607
Phone: 510-285-2744
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Contact: Jay Merani, PE
Senior Engineer

1.4 Document Format

This CQA Plan is presented in the following sections:

- Section 1 includes the introduction, document format, and the definitions and terms used throughout the document;
- Section 2 presents general requirements of the CQA program and organization;
- Section 3 presents requirements for earthwork;
- Section 4 presents requirements for geosynthetics;
- Section 5 presents requirements for miscellaneous materials; and
- Section 6 outlines the required documentation for construction.

All parties involved in the construction should be thoroughly familiar with this document, the project Construction Drawings, and the Technical Specifications.

1.5 Reference Documents

The following reference documents provide background information and support this CQA Plan for the Initial Remedial Construction at the landfill area.

- American Society for Testing and Materials (ASTM) – Annual Book of ASTM Standards. Section 4 – Construction, Volume 04.02, Concrete and Aggregates, Latest Edition.
- American Society for Testing and Materials (ASTM) - Annual Book of ASTM Standards. Section 4 – Construction, Volumes 04.08 and 04.09, Soil and Rock (I) and (II), Latest Editions.
- American Society for Testing and Materials (ASTM) - Annual Book of ASTM Standards. Section 4 – Construction, Volume 04.13, Geosynthetics, Latest Edition.
- American Society for Testing and Materials (ASTM) - Annual Book of ASTM Standards. Section 8 Plastics, Volumes 08.01 Plastics (I), 08.02 Plastics (II), and 08.03 Plastics (III), Latest Edition.
- Geosyntec Consultants, Inc., Focused Feasibility Study, Landfill Area, Rough and Ready Island, Port of Stockton, Stockton, California [March 31, 2021].
- DTSC and Central Valley Regional Water Quality Control Board. 2021. Remedial Action Plan for Soil, Landfill Area. Rough and Ready Island, Port of Stockton, California, prepared for the Port of Stockton. __ August.
- National Sanitation Foundation (NSF) International Standard – NSF/ANSI 14, Plastics Piping System Components and Related Materials, Latest Edition.
- State of California Department of Transportation (Caltrans) - Standard Specifications for Construction of Local Streets and Roads., Latest Edition.
- United States Environmental Protection Agency (USEPA) – EPA Method 9090A, Compatibility Test for Wastes and Membrane Liners, Latest Edition.

1.6 Definitions

Whenever the terms listed below are used, the intent and meaning shall be interpreted as indicated.

As-Builts. See "Record Drawings."

ASTM. American Society for Testing and Materials.

Contract Documents. The official set of documents issued by the Owner, which includes bidding requirements, contract forms, contract conditions, specifications, contract drawings, addenda, and contract modifications.

Construction Drawings. The official plans, profiles, typical cross-sections, elevations, and details, as well as their amendments and supplemental drawings, which show the locations, character, dimensions, and details of the work to be performed. Construction drawings are also referred to as the "plans."

Construction Manager (CM). The individual or firm responsible for administering the construction contract and providing overall construction management for the project. The Construction Manager is the primary contact on the project site representing the Owner.

Construction Quality Assurance (CQA). A planned and systematic pattern of procedures and documentation designed to provide confidence that items of work or services meet the requirements of the contract documents. Construction quality assurance (CQA) includes verifying that the Contractor is performing quality control requirements of the specifications.

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

Construction Specifications. See Technical Specifications.

Contractor. The person or persons, firm, partnership, corporation, or any combination, private, municipal, or public, who, as an independent Contractor, has entered into a contract with the Owner, and who is referred to throughout the Contract Documents by singular number and masculine gender.

CQA Consultant. See CQA Organization.

CQA Manager. Authorized representative of the CQA Organization responsible for managing the CQA program.

CQA Monitor. Authorized representative of the CQA organization, responsible for observing and documenting activities related to CQA during construction.

CQA Officer. Authorized representative of the CQA organization and professional engineer registered in the state of California responsible for certifying that construction was performed in accordance with the intent of the contract documents and design.

CQA Organization. A firm contracted by Owner responsible for observing and documenting activities related to CQA during construction. CQA Organization typically employs CQA Monitors and CQA Officer. Also known as CQA Consultant.

Designer. See Design Engineer.

Design Engineer. The individuals or firms responsible for the design and preparation of the project construction drawings and specifications. Also referred to as "Designer" or "Engineer."

Earthwork. A construction activity involving the use of soil materials as defined in the construction specifications and Section 3 of this CQA Plan.

Engineer. See Design Engineer.

Flexible Membrane Liner (FML). A synthetic lining material, also referred to as "geomembrane," "membrane," "geosynthetic liner," or "sheet."

Geosynthetics Contractor. Also referred to as the "Installer." The person or firm responsible for geosynthetic construction. This definition applies to any party installing geomembrane, geotextile, or other geosynthetic material, even if not his primary function.

Installer. See Geosynthetics Contractor.

Non-Conformance. A deficiency in characteristic, documentation, or procedure that renders the quality of an item or activity unacceptable or indeterminate. Examples of non-conformance include, but are not limited to, physical defects, test failures, and inadequate documentation.

NSF. National Sanitation Foundation.

Owner. Port of Stockton (Port).

Panel. A unit area of the geomembrane (FML), geotextile, geocomposite or geogrid that will be seamed in the field or in the fabricator's plant.

PPI. The Plastic Pipe Institute.

Procedure. A document that specifies or describes how an activity is to be performed.

Project Documents. Contractor submittals, construction drawing, record drawings, specifications, shop drawings, construction quality control and quality assurance plans, health and safety plan, and project schedule.

Project Manager (PM). Authorized representative of the Owner responsible for planning, organizing, and control of the design and construction activities. Responsibility includes scheduling, cost control, engineering, procurement, and contracting functions.

Record Drawings. Drawings recording the constructed dimensions, details, and coordinates of the project. Also referred to as "As-Builts."

Surveyor. A licensed surveyor in the State of California responsible for checking locations and elevations of the completed work, and if requested by Owner, estimating construction quantities. The surveyor is also responsible for producing stamped as-built drawings for inclusion in the Final CQA Report.

Technical Specifications. The requirements for products, materials, and workmanship, upon which the contract is based. Also referred to as Technical Specifications. Also referred to as Construction Specifications.

Testing. Verification that an item meets specified requirements by subjecting that item to a set of physical, chemical, environmental, or operating conditions.

Testing Laboratory. A laboratory capable of conducting the tests required by this CQA Plan and the Technical Specifications.

Waste Material. Consists of a mixture of solid waste (municipal solid waste and construction and demolition debris), impacted soil, and native and fill soils excavated from the waste cells.

Impacted Soil. Materials excavated from the designated areas of known contamination are to be considered impacted soil.

Native and Fill Soils. Soil material within the project area, but outside of waste cell areas and areas of known or potential contamination, including material excavated from the Rail Line Excavation area.

Earthfill. Onsite or approved off-site soil that meets the requirements of Section 31222.

1.7 Units

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

2. GENERAL REQUIREMENTS

2.1 Meetings

In order to facilitate construction and to clearly define construction goals and activities, close coordination between Port of Stockton (Owner), Construction Manager, Design Engineer, CQA Organization, and Contractor is essential. To meet this objective, pre-construction, progress, weekly, and other meetings will be held.

2.1.1 Preconstruction Meeting

Following bid award, a pre-construction meeting will be held at the site. The purpose of this meeting, attended by the Owner, Construction Manager, Contractor, Design Engineer, CQA Organization, regulatory agencies (optional), and others designated by the Owner, will be to:

- Review the Construction Drawings, Specifications, CQA Plan, work area security, health and safety procedures, and related issues;
- Provide all parties with relevant project documents;
- Review responsibilities and qualifications of each party;
- Define lines of communication and authority;
- Establish reporting and documenting procedures;
- Review procedures for handling submittals;
- Review testing equipment and procedures;
- Review procedures for field directives and change orders;
- Establish testing protocols and procedures for correcting and documenting construction or non-conformance;
- Establish weekly meeting schedule;
- Conduct a site tour to discuss work areas, stockpile areas, lay down areas, critical Refinery infrastructure, sensitive habitat/wildlife areas, access roads, haul roads, and related items;
- Review the project schedule and critical path items; and
- Discuss the Contractor's work plan(s).

Port (or its designee) will document the meeting. Copies of the minutes and relevant documents will be prepared and provided to all parties.

2.1.2 Progress Meeting

At the discretion of Port, informal progress meetings will be held each morning before the start of work. At a minimum, this meeting will be attended by the Construction Manager, CQA Monitor, and Contractor. The purpose of this meeting is to:

- Discuss health and safety issues;
- Discuss problems and resolutions;
- Review test data;
- Discuss the Contractor's personnel and equipment assignments for the day;
- Review the previous day's activities and accomplishments; and
- Resolve any outstanding problems or disputes.

2.1.3 Weekly Meeting

Weekly scheduled meetings will be held. The Owner, the Construction Manager or Project Manager, CQA Manager, and Contractor shall be present. The meetings will be held to discuss progress, problems, construction schedule, changes, test data, safety, environmental issues, and any other issues necessary. Port or the Construction Manager will prepare the agenda for each meeting and prepare meeting minutes for distribution to all parties.

2.1.4 Other Meetings

As required, special meetings will be held to discuss problems or non-conformance. These meetings will be attended by parties as directed by Owner. If the problem requires a design modification and subsequent change order, the Design Engineer and CQA Manager should also be present. The meeting will be documented as directed by Port or the Project Manager.

2.2 Responsibilities of the Construction Quality Assurance Staff

2.2.1 Communications with Contractor

Only the individuals assigned to this project, as defined in this CQA Plan, can communicate with the Contractor. Communications of an official nature must be clear, direct, and professional. When written communications are required, they must be documented on the appropriate forms. Formal letters to the Contractor should normally be signed by the CQA Manager and reviewed by the Owner or the Construction Manager.

2.2.2 Communications with Owner

Only those individuals assigned to this project, as defined in this CQA Plan, can communicate with the Owner. All communications must be through proper channels as defined in the project

organization chart. Communications of an official nature must be written, be clear, direct, and professional.

2.2.3 Responsibilities of CQA Manager

The CQA Manager administers the CQA program. CQA procedures and reports must be reviewed by the CQA Manager for compliance with the project CQA Plan. The CQA Manager acts as an auditor to verify and document the proper and complete implementation of the CQA program. The CQA Manager has authority to identify deficiencies and implement corrective action to the CQA program. The CQA Manager collects, distributes, and addresses disposition of Contractor submittals approved by the Design Engineer. The CQA Manager coordinates testing with independent testing laboratories and maintains record drawings. The CQA Manager reports directly to the Project Manager. The CQA Manager will write the Final CQA Report under the direction of the CQA Officer.

2.2.4 Responsibilities of CQA Officer

The CQA Officer is responsible for documenting and certifying to Port and regulatory agencies, as appropriate, that construction was performed in accordance with the intent of the design and the Contract Documents. At the discretion of Port, the CQA Manager and CQA Officer can be the same person.

2.2.5 Responsibilities of Design Engineer(s)

During construction, the Design Engineer is responsible for site engineering services related to their design. Those services include reviewing Contractor submittals, resolving technical issues related to construction, providing interpretation of the Construction Drawings and Specifications, and approving substantial design modifications and technical revisions.

2.2.6 Responsibilities of CQA Monitor(s)

The CQA Monitors implement the CQA program under the direction of the CQA Manager. The CQA Monitors perform all construction monitoring and construction materials testing. The CQA Monitors maintain all documentation and test data summaries related to construction monitoring and construction material testing. The CQA Monitors report directly to the CQA Manager.

2.3 Control of Documents, Records, and Forms

2.3.1 Project Control of Construction Documents

Contract Documents, including Technical Specifications and Drawings and change orders, are controlled by the Construction Manager. The Construction Manager maintains one or more copies of the most current set of construction documents for use by the CQA Organization. Upon issuance of new copies or revisions, it is the responsibility of the Construction Manager to notify the Contractor of the revisions, provide revised Contract Documents, and order the recall of all

unrevised copies of the contract documents. The Construction Manager also provides the latest revised set of Contract Documents to the CQA Organization.

2.3.2 Project Control of As-Built Information

As-built information generated by the Contractor and CQA Organization is controlled by the CQA Manager. During the progress of the work, the CQA Manager obtains as-built information provided by the CQA Monitors, Contractor, Surveyors, or others and compiles all as-built data onto one set of drawings. At the completion of the project, this information is presented to the Design Engineer for use in preparing final drawings for the Final CQA Report. The as-built drawings set should be maintained on site and be clearly marked as Record Drawings.

2.3.3 Project Control of Forms

Daily report forms, test report forms, and other project forms are controlled by the CQA Manager, who maintains a master of each form for copies. Upon the issuance of a new form, the CQA Manager must recall and remove all superseded copies along with the master, notify the CQA Monitors, and provide new copies for their use.

2.3.4 Processing Daily Reports

The CQA Monitors and CQA Manager, if appropriate, write a daily record of work progress. The daily reports are reviewed by the CQA Manager (or his/her designee) for legibility, clarity, traceability, and completeness. The review must be evidenced by signature. Daily reports are submitted to the Construction Manager on a daily basis (if required by the Owner) and are maintained at the site. A weekly summary construction report will be prepared, if required by the Owner, by the CQA Manager and submitted to the Construction Manager.

2.3.5 Processing Test Reports

A test report must be completed by the CQA Monitors whenever testing is performed. The test reports must be reviewed by the CQA Manager. The review includes a check for mathematical accuracy, conformance to test requirements, conformance to Technical Specifications, and for clarity, legibility, traceability, and completeness. The review must be evidenced by a signature of the reviewer. Test reports (or summaries) from independent testing laboratories will also be transmitted to the CQA Manager for review.

2.3.6 Processing Project Reports

Project records are completed as needed. Use of the project records is limited to the scope for which they are intended. The record must be completed by filling in all of the blanks provided on the form, followed by the signature of the individual completing the form. All project records must be maintained at the site.

2.4 Documentation and Control of Non-Conformance

2.4.1 Observation of Non-Conformance

Whenever a non-conformance is discovered or observed in the construction process, product, job-related materials, documentation, or elsewhere, the CQA Manager and CQA Monitors should first notify the Contractor (foreman or superintendent supervising the work in question). The CQA Manager should then notify the Construction Manager.

2.4.2 Evaluating Extent of Non-Conformance

Whenever a non-conformance is discovered or observed in the construction process, product, job-related materials, documentation, or elsewhere, the CQA Organization will evaluate the extent of the non-conformance. The extent of the deficiency may be evaluated by additional sampling, testing, observations, review of records, or any other means deemed appropriate.

2.4.3 Documenting Non-Conformance

All non-conformance must be documented in writing on the daily records, logs, and elsewhere, as appropriate. The documentation must occur immediately upon evaluating the extent of the non-conformance. For those non-conformances that are considered serious or complex in nature or require engineering analyses, a Non-conformance Report will be prepared and issued to the Construction Manager and Contractor.

2.4.4 Corrective Measures

For a simple or routine non-conformance, corrective measures will be evaluated by specification direction, or if none exists, the Construction Manager, CQA Manager and Contractor will discuss standard construction methods to correct the deficiency. For Non-conformance Reports that require engineering analyses, the Design Engineer must evaluate corrective measures. A copy of the Non-conformance Report, with the Design Engineer's corrective measure evaluation, will be forwarded to the Construction Manager, CQA Manager and Contractor for implementation of the corrective action.

2.4.5 Verification of Corrective Measures

Upon notification by the Contractor that a corrective measure is complete, the CQA Manager will verify its completion. The verification must be accomplished by documenting observations, retesting, and documenting photographically. Written documentation of the corrective measures must be made by the CQA Manager on daily reports, logs, and forms, and the Non-conformance Report, if applicable. Verification of corrective measure will be reviewed by the Construction Manager. Corrective action measures that require an engineering evaluation will be reviewed and verified by the Design Engineer.

2.5 Construction Monitoring

2.5.1 Monitoring Priorities

Before the commencement of construction, the CQA Manager will establish a list of monitoring priorities. The list includes the various construction activities and the monitoring priority of those activities. The monitoring priorities may change during construction, based on Contractor performance and Port's request. Changes in the monitoring priorities must be approved by the CQA Manager.

2.5.2 Discrepancies

All CQA testing must be conducted in accordance with this CQA Plan and Contract Documents. The document that requires the most frequent tests or has more stringent test requirements will govern unless otherwise specified by the Design Engineer and/or CQA Manager.

2.6 Materials Quality Verification

2.6.1 General

Material sources will be identified, and samples tested to evaluate if the material meets specifications for specific work elements. Definitions and requirements of materials are provided in the Technical Specifications. Test samples will be obtained, generally, in accordance with applicable ASTM standards. Archive samples and test results of the test samples will be maintained and stored at the project site. The CQA Monitors will establish and maintain a materials quality verification list. The list will include material sources, sample locations, testing requirements, test results, and verification action items.

2.6.2 Materials Submittals

Material submittals may be used by the CQA Organization to establish the acceptability of materials. When sample submittals are required, they will be made available to the CQA Organization by the Contractor. Acceptance and proper review of submittals are the responsibility of the CQA Manager.

2.6.3 Certification of Compliance and Conformance

Certificates of compliance and conformance may be used by the CQA Manager to establish the acceptability of materials. Those certificates generally state that the material is in compliance or conformance with a particular code, standard, or specification. The certificate may be used for acceptance of a product before or in lieu of testing if allowed by the Technical Specifications.

2.7 Equipment Control

2.7.1 Equipment List

Before the start of construction, the CQA Manager will complete a list of all measuring, sampling, and testing equipment being used at the site. As new equipment becomes available during the course of the project, it must be added to the list. When more than one type of equipment is available, a unique number will be affixed to each piece to maintain identity. The equipment list is maintained in the project files by CQA Monitors and contains the following information:

- Type of equipment;
- Serial number or identifying number;
- Date item received at site;
- Use of the equipment; and
- Date removed from service.

2.7.2 Calibration of Equipment and Materials

Before placing a piece of testing equipment into service, its accuracy must be established and calibrated by the CQA Manager. Types of equipment requiring calibration include (but are not limited to): nuclear gauges, sand cone devices, sand to be used in sand cones, and scales. The calibration procedures and frequencies must be as per manufacturer's instructions or ASTM standards. Whenever the equipment is suspect or is producing questionable results, it must be removed from service immediately and re-calibrated.

3. CONSTRUCTION QUALITY ASSURANCE FOR EARTHWORK

3.1 Introduction

This section describes CQA procedures for earthwork operations. The scope of earthwork and related CQA includes the following elements:

- Construction Dewatering;
- Decontamination;
- Earthfill;
- Erosion and Sediment Control (Temporary and Permanent);
- Excavating;
- Foundation Layer;
- Vegetative Layer;
- Stockpiling and Soil Management;
- Subgrade Preparation;
- Trenches and Backfilling; and
- Waste Consolidation.

3.2 Earthwork Construction Testing

3.2.1 Testing Standards

The following soil test standards apply as called out in this CQA Plan or the Technical Specifications:

Standard	Test Description
ASTM C136	Sieve Analysis of Fine and Coarse Aggregates.
ASTM D422	Particle-Size Analysis of Soils
ASTM D1140	Material Finer than 75-µm (No. 200) Sieve in Soils by Washing
ASTM D1556	Density and Unit Weight of Soil in Place by Sand-Cone Method
ASTM D1557	Laboratory Compaction Characteristics of Soil Using Modified Effort (modified Proctor)
ASTM D2216	Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D2434	Permeability of Granular Soils (Constant Head)

Standard	Test Description
ASTM D2487	Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D2488	Description and Identification of Soils (Visual-Manual Procedure)
ASTM D2937	Density of Soil in Place by the Drive-Cylinder Method
ASTM D4318	Liquid Limit, Plastic Limit, and Plasticity Index of Soils (Atterberg Limits)
ASTM D5084	Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter
ASTM D5321	Shear Strength of Soil-Geosynthetic and Geosynthetic-Geosynthetic Interfaces by Direct Shear
ASTM D6938	In-Place Density and Water Content of Soil and Soil-AggregaAppente by Nuclear Methods (Shallow Depth)

Table 3-1: Test Procedures for Evaluation of Soils

Test Method	To Evaluate	Test Standard
Laboratory Testing		
Moisture Content	Moisture Content	ASTM D2216
Modified Proctor	Moisture/Density Relationship of Soil (10-pound hammer and 18-inch drop)	ASTM D1557
Atterberg Limits	Liquid Limit and Plastic Limit	ASTM D4318
Sieve Analysis	Particle Size Distribution of Coarse-Grained Soils Amount of Material in Soils Finer Than the #200 Sieve	ASTM D422 ASTM D1140
Hydraulic Conductivity (Flexible Wall Permeameter)	Laboratory Hydraulic Conductivity of Remolded Low Permeability Soil Liner Samples	ASTM D5084
Hydraulic Conductivity (Rigid Wall Permeameter)	Hydraulic Conductivity of Granular Drainage Materials	ASTM D2434
Field Testing		
Visual-Method Soil Classification	Conformance with Specifications for Material Type	ASTM 2488
Nuclear Moisture-Density Gauge	In-Situ Soil Density and Moisture Content	ASTM D6938
Sand Cone or Drive Tube	In-Situ Soil Density and/or Moisture Content	ASTM D1556 or ASTM D2937
Surveying	Grades and Location	N/A

3.2.2 Testing Frequencies

Tables 3-2 through 3-4 establish the testing frequencies for earthwork CQA. The test frequencies listed establish a minimum number of required tests for the conformance testing. Extra testing must be performed whenever work or materials are suspect, marginal, or of inadequate quality. Extra testing may also be performed to provide additional data for engineering evaluation. Any re-tests performed as a result of a failing test do not contribute to the total number of tests performed in satisfying the minimum test frequency.

Table 3-2: Earthfill CQA Testing Frequencies

Test Method	Frequency
Visual – Manual Soil Classification (D2488)	Continual during excavation and placement
Particle Size (D422)	1 per 5,000 cy and at least 1 per material type/source
Compaction Curve (Modified Proctor) (D1557)	1 per 3,000 cy and at least 1 per material type/source
Density and Moisture - Nuclear Test Method (D6938)	1 per 500 cy and every lift, and at least 1 per 100 lineal feet of trench or 1 per shift, whichever results in largest number of tests
Sand Cone (D1556) or Drive Tube (D2937)	1 per 20 nuclear density tests
Moisture Content – Oven (D2216)	1 per 10 nuclear moisture tests

Table 3-3: Foundation Layer CQA Testing Frequencies

ASTM Test Method	Frequency[1]
Visual – Manual Soil Classification (D2488)	Continual during excavation and placement
Particle Size (D422)	1 per 5,000 cy and at least 1 per material type/source
Compaction Curve (Modified Proctor) (D1557)	1 per 3,000 cy and at least 1 per material type/source
Density and Moisture - Nuclear Test Method (D6938)	1 per 500 cy and every lift or 1 per shift, whichever results in largest number of tests
Sand Cone (D1556) or Drive Tube (D2937)	1 per 20 nuclear density tests
Moisture Content – Oven (D2216)	1 per 10 nuclear moisture tests

Note:
(1) Testing frequencies may be reduced with concurrence of Engineer once sufficient testing has demonstrated repeatability of results.

Table 3-4: Vegetative Soil Layer CQA Testing Frequencies

ASTM Test Method	Frequency
Visual-Manual Soil Classification (D2488)	Continual during excavation and placement
Particle Size (D422)	1 per 500 cy and at least 1 per material type/source
Atterberg Limits (D4318)	1 per 500 cy and at least 1 per material type/source

ASTM Test Method	Frequency
Hydraulic Conductivity (D2434 or D5084)(1)	1 per 1,000 cy and at least 1 per material type/source
Compaction Curve (Modified Proctor) (D1557)	1 per 3,000 cy and at least 1 per material type/source
Density and Moisture - Nuclear Test Method (D6938)	1 per 500 cy and every lift
Sand Cone (D1556) or Drive Tube (D2937)	1 per 20 nuclear density tests
Moisture Content – Oven (D2216)	1 per 10 nuclear moisture tests
Surveying and Layer Thickness	50-feet grid and at all grade breaks

Note: Tests shall be performed under an effective consolidation pressure of **5 psi**. Test standard to be determined based on results of soil classification test results.

Table 3-5: Gravel CQA Testing Frequencies

ASTM Test Method	Frequency
Visual-Manual Soil Classification (D2488)	Continual during excavation and placement
Particle Size (D422)	1 per 2,500 cy and at least 1 per material type/source
Hydraulic Conductivity (D2434)(1)	1 per 1,000 cy and at least 1 per material type/source

Note: Tests shall be performed under an effective consolidation pressure of **5 psi**.

3.2.3 Soil Sample Identification

The CQA Monitor maintains soil sample identifications in a master log maintained at the site. Samples shall have the initials corresponding to their soil type (EF – earthfill, W – Waste, FL – foundation layer, VEG – vegetative layer) before the sample numbers (e.g. the first earthfill soil sample shall be EF001). Sample numbers begin with (001) and proceed upward. No sample number can be repeated, and re-tests of a failing sample are given the original number with a letter suffix (i.e., re-tests for a failing sample 021 would be: 021A, 021B, etc.). Information contained in the master log of test samples includes[1]:

- Sample identification;
- Test(s) to be performed;
- Date sampled;
- Monitor obtaining sample;
- Location sampled;
- Location of testing (site vs. offsite);

[1] Information required to be contained in the master log may be modified by the CQA Officer.

- Date sample sent off site;
- Date test results received;
- Site testing monitor;
- Date testing completed at site; and
- Test results and remarks.

3.2.4 Soil Sample Tagging

The CQA Monitor is responsible for maintaining sample identification and inventory for all soil samples while on site, from time of sampling through completion of testing. The CQA Monitor must place a sample tag on the soil sample container immediately upon sampling. The tag must remain with the soil sample throughout processing. The tag contains the following information:

- Sample identification;
- Material type;
- Project name and project number;
- Sampling monitor;
- Date sampled; and
- Test(s) to be performed.

3.2.5 Soil Sample Processing

The CQA Monitor is responsible for the timely processing of soil test samples. The CQA Manager also selects which samples are tested onsite and which are tested offsite. The selection is made based on manpower available, equipment available, complexity of the test, and time available for results. For expediency, samples to be tested offsite should be shipped the same day as they are obtained.

Sample drive tubes of the in-place, compacted waste fill as per ASTM D2937. Drive tube samples designated for strength testing shall be handled with caution to mitigate any unnecessary damage to the soil fabric and changes in moisture content. Additional precautions include:

- Place plastic or rubber caps over the ends of the drive tubes and tape the ends with duct tape or packing tape to create tight seals;
- Store the samples in an upright position and in a secure case with cushioning;
- Limit the impacts to the samples including bumping, dropping, rattling, or moving after sampling and during transportation to the laboratory; and
- Deliver the samples to the laboratory within a reasonable time frame to maintain similar moisture conditions.

3.2.6 Procedures for Conformance Test Failure

If a sample fails to achieve required strengths and/or density as described in the Technical Specifications, the soil or waste layer from which the sample was collected must be exposed, even if the material has been covered by approved compacted soil or waste. Contractor shall excavate the failing material down to the top of any previously approved layer (e.g. subgrade or underlying approved soil or waste). The horizontal extent of removal shall be approved by the ENGINEER and Owner and be based on the proximity of adjacent passing samples placed during the same lift.

Any unsatisfactory waste or soil must be reworked, moisture conditioned, and/or recompacted with a higher compaction effort depending on the failure condition. Excavated waste may require additional Portland Cement and/or borrow soils to be blended with the waste. After Contractor completes the rework and/or reprocessing, the CQA Monitor shall collect another sample of the material for strength, density, and moisture content testing prior to acceptance.

3.3 Field Density Tests

3.3.1 Test Numbering

The CQA Monitor is responsible for maintaining test numbers and results for field density tests performed by the nuclear moisture density method (ASTM D6938/D2922). All other tests correspond to the sample identification (Section 3.2.3). The CQA Monitors will maintain field books that identify material segments, date tested, CQA Monitor performing the test, and sequential test number. Each material segment will have a series of numbers, for instance, as listed below. No test number can be repeated for a given material segment, and re-tests of failing tests must be given a letter suffix along with the original test number (i.e., re-tests for a failing Test #1201 would be: 1201A, 1201B, etc.). Test data and results must be filled out on the field density test form.

Material Segment	Test Number Series
Earthfill	1000 – 1999
Foundation Layer	2000 – 2999
Vegetative Layer	3000 – 3999

3.3.2 Test Locations

The intention of the CQA program is to provide confidence that the earthwork materials and work conform to the Technical Specifications. To meet this intent, the CQA Monitor will perform density tests of earthfill, waste fill, and any other compacted soil products used during construction. Density tests must be located at various elevations and uniformly dispersed throughout the entire plan dimensions of the fill. Density test locations must be chosen without bias; however, additional testing can be performed in any areas that are suspect, marginal, or

appear to be of inadequate quality. During the progress of the work, density test locations will be plotted on a drawing by the CQA Monitor to verify that no significant areas are untested. The drawing becomes part of the Final CQA Report.

3.4 Monitoring and Testing Requirements

Earthwork components of the construction are summarized in Paragraph 3.1 of this section. Each component has specific construction requirements that must be monitored. The following sections list monitoring requirements for each type of earthwork.

3.4.1 Site Preparation

- Review Section 31110 of the Technical Specifications.
- Verify that erosion and sediment control silt fences, straw bale barriers, and other measures are securely in place prior to initiating clearing, grubbing, and stripping operations in any area.
- Verify that existing plant life designated to remain is tagged, identified, and protected against damage during construction.
- Verify that clearing and stripping in areas required for site access and execution of the work are completed.
- Verify that vegetation, roots, and soil within marked areas are removed to a minimum depth of 6 inches below the existing ground surface.
- Verify that roots with diameters greater than 1 inch encountered within the rail line excavation area are removed to a minimum depth of 2 ft below the original grade.
- Verify that all stumps and plant life are properly disposed of off-site or stockpiled on site.
- Verify that stockpile subgrades are surveyed prior to stockpiling.

3.4.2 Decontamination

- Review Section 31130 of the Technical Specifications and the approved Contractor's Decontamination Plan.
- Verify that equipment and vehicles leaving the site have been decontaminated and thoroughly inspected following the procedures detailed in the approved plan, including the undercarriage and tarped covers of transport vehicles.
- Verify that decontamination facilities are properly disposing of the waste in accordance with the Owner's requirements and all applicable laws and that the waste is not being discharged onsite.

- Verify that the waste is being contained and that no waste is in contact with the ground outside the decontamination area.
- Verify that rainwater and surface runoff are not entering the decontamination area.

3.4.3 Dewatering

- Review Section 31140 of the Technical Specifications and the approved Contractor's Dewatering Plan. Verifying dewatering procedures, discharge point, equipment, and erosion, sediment and drainage control measures. Note corrective action items if applicable.
- Verify that the static water level is drawn down in the excavation areas to allow for excavation of the soil and placement of backfill materials.
- Verify that water is discharged only to approved areas outside the excavation and the water is properly treated prior to discharge.
- Verify that the dewatering operations are not causing adverse effects on adjacent structures, wells, utilities, and water courses (e.g., settlement, tilting, cracking, movement). Document conditions of facilities and infrastructure with photographs and in the daily field log prior to the start of dewatering operations and after signs of potential damage caused by dewatering.

3.4.4 Stockpiling and Soil Management

- Review Section 31210 of the Technical Specifications and the Contractor's approved work plan submittal. Verify stockpile locations; stockpile dimensions; haul routes; material segregation procedures; and erosion, sediment, and drainage control measures.
- During excavation, hauling, and stockpiling operations, continually identify and verify material classifications in accordance with ASTM D2478 and ASTM D2488 as necessary to characterize material stockpile designations. Work closely with Contractor's quality control personnel to classify materials using the rapid field tests described in ASTM D2488.
- Verify that the Contractor is suitably separating materials in various stockpiles dependent on material classification.
- Verify that the slopes are no steeper than 4H:1V with a maximum height of 15 ft and there are no visual signs of instability along each stockpile (e.g., excessive and deep cracking in the surface, bulging of the toe).
- Verify that the stockpiles are properly graded inward to reduce runoff flow towards the face of the stockpile and that sheet runoff is directed towards ditches and pipes.

- Verify that the stockpiles are being properly protected to minimize erosion, dust, and sediment runoff with the use of approved SWPPP erosion control measures and/or water.

3.4.5 Excavation

- Review Section 31221 of the Technical Specifications and the approved Contractor's Excavation Plan.
- Verify that construction staking is performed before work and that survey benchmarks with elevations are secured outside the work area.
- If applicable, verify that the Contractor has notified the Utility Notification Center, to identify and locate underground utilities at a minimum of 72 hours prior to the start of excavation.
- Verify that the excavation operations are being performed in safe working conditions as described in the Contractor's Site-Specific Health and Safety Plan.
- Verify that dewatering systems are operational and that the static groundwater level is sufficiently drawn down to allow excavations to proceed.
- Verify that the excavated materials are being properly handled and segregated into proper stockpiles.
- During waste cell excavation operations:
    - verify that design excavation depths have been achieved;
    - verify that the Contractor removed the full depth of the solid waste within the waste cells based on visual classification (i.e., no additional visible solid waste remaining in the waste cell excavation); and
    - verify that the Contractor is mitigating odors and fugitive dust and is performing air monitoring during excavation operations.
- During areas of known contamination excavation operations:
    - verify that design excavation depths have been achieved for the areas of known contamination;
    - verify that the Contractor is mitigating odors and fugitive dust and is performing air monitoring during excavation operations.
- During rail line excavation operations:
    - verify that design excavation depths have been achieved;
    - verify that the Contractor is mitigating odors and fugitive dust and is performing air monitoring during excavation operations.
    - verify that organic material is removed as described in Section 31221.
- Coordinate with the Contractor for performance of excavation verification surveys upon completion of excavating operations. Verify corrective action measures as determined by

verification surveys. Verification surveys will also be used to determine limits of excavation for measurement and payment applications. Submit copy of verification surveys to the construction manager.

3.4.6 Earthfill

- Review Section 31222 of the Technical Specifications.
- Verify that construction staking is performed before work and that survey benchmarks with elevations are secured outside the work area.
- Perform visual and manual soil classifications (ASTM D2488) to verify that material source is suitable for earthfills. Verify that the material is free of organic and oversized materials. Perform classifications continually during excavation of borrow materials.
- Perform moisture-density relationship testing (ASTM D1557) to estimate the maximum dry density and optimum moisture content of earthfill materials. Perform tests at testing frequencies specified in Table 3-2.
- Collect bulk samples of the earthfill for particle size (ASTM D422) and Modified Proctor compaction (ASTM D1557) tests and deliver/send the samples to the laboratory for testing based on the frequencies stated in Table 3-2.
- Verify that earthfill materials are compacted in loose lifts not exceeding **8 inches**. If a sheepsfoot compactor is not used, verify that the top of each compacted lift is scarified before placing the subsequent lift.
- Perform nuclear density-moisture tests (ASTM D6938) to verify that each lift is compacted as required by the Technical Specifications. Perform tests at testing frequencies specified in Table 3-2.
- Verify that earthfill soils are properly moisture conditioned or aerated and processed to bring the moisture content within the acceptable range of the optimum moisture content, per Section 31222.
- Verify that desiccated earthfills are properly repaired or removed before placing subsequent lifts.
- Verify that there is no free water where earthfill is to be placed.
- Verify that final earthfill surfaces are free of ruts, gouges, and other features that might contribute to erosion and sediment run-off.
- Verify that any equipment placing earthfill on top of geosynthetics adheres to the maximum ground pressure requirements in Section 31222 of the Technical Specifications.
- During earthfill operations field verify lines, grades, and dimensions using hand-held levels and inclinometers, range poles and measuring tapes.

- Coordinate with the Contractor for performance of verification surveys at the completion of earthfill operations. Verify corrective action measures as evaluated by verification surveys. Verification surveys will also be used to estimate the limits of earthfills for measurement and payment applications. Submit copy of the verification surveys to the Construction Manager.

3.4.7 Excavation Backfill

- Review Sections 31222 and 31224 of the Technical Specifications.
- Verify that construction staking is performed before work and that survey benchmarks with elevations are secured outside the work area.
- Perform visual and manual soil classifications (ASTM D2488) to verify that material source is suitable for excavation backfill. Verify that the material is free of organic and oversized materials. Perform classifications continually during excavation of borrow materials.
- Perform moisture-density relationship testing (ASTM D1557) to estimate the maximum dry density and optimum moisture content of earthfill materials. Perform tests at testing frequencies specified in Table 3-2.
- Collect bulk samples of the earthfill for particle size (ASTM D422) and Modified Proctor compaction (ASTM D1557) tests and deliver/send the samples to the laboratory for testing based on the frequencies stated in Table 3-2.
- Collect bulk samples of the gravel for particle size (ASTM D422) and hydraulic conductivity (ASTM D2434) tests and deliver/send the samples to the laboratory for testing based on the frequencies stated in Table 3-5.
- Verify that drainage gravel is placed in excavations where free water has been observed to a minimum of 2 ft above the highest observed free water.
- Verify that gravel material is placed in loose lifts not exceeding 8 inches and compacted according to the methods described in the specification.
- Verify that a separator geotextile has been installed at the top of any drainage gravel prior to placement of earthfill materials.
- Verify that a geotextile has been installed at the base of any excavation that extends below the water table or cannot be proof rolled.
- Verify that earthfill materials are compacted in lifts not exceeding **12 inches** for the first lift to backfill excavations and **6 inches** for all subsequent lifts.
- Perform nuclear density-moisture tests (ASTM D6938) to verify that each lift is compacted as required by the Technical Specifications. Perform tests at testing frequencies specified in Table 3-2. If backfill is not accessible for testing, observe and document construction of

a test pad that meet the requirements and verify that the compaction effort within the excavation meets or exceeds the effort used for the test pad.

- Verify that earthfill soils are properly moisture conditioned or aerated and processed to bring the moisture content within the acceptable range of the optimum moisture content, per Section 31222.
- During earthfill operations field verify lines, grades, and dimensions using hand-held levels and inclinometers, range poles and measuring tapes.
- Coordinate with the Contractor for performance of verification surveys at the completion of earthfill operations. Verify corrective action measures as evaluated by verification surveys. Verification surveys will also be used to estimate the limits of earthfills for measurement and payment applications. Submit copy of the verification surveys to the Construction Manager.

3.4.8 Waste Placement

- Review Section 31223 of the Technical Specifications.
- Verify that the Contractor is utilizing odor suppressants and dust control measures to mitigate odors and fugitive dust as described in the approved Community Air Monitoring Plan.
- Verify that the waste and impacted soil material is being spread and compacted uniformly across the site to gradually raise the waste fills to mitigate the potential for instability caused by placing locally high waste piles over native soils.
- Verify that material is not placed under water.
- Verify that material is placed in loose lifts not exceeding **8 inches** and compacted according to the methods described in the specification.
- Verify that the top of each layer is scarified prior to the placement of subsequent lifts, unless a sheepsfoot or padfoot roller is utilized for compaction.
- Verify that the final waste surfaces have neither ruts nor gouges.

3.4.9 Foundation Layer Placement

- Review Section 31223 of the Technical Specifications.
- Verify that construction staking is performed before work and that survey benchmarks with elevations are secured outside the work area.
- Perform visual and manual soil classifications (ASTM D2488) to verify that material source is suitable for foundation layer. Perform classifications continually during excavation of borrow materials.

- Perform moisture-density relationship testing (ASTM D1557) to estimate the maximum dry density and optimum moisture content of earthfill materials. Perform tests at testing frequencies specified in Table 3-3.
- Collect bulk samples of the foundation layer for particle size (ASTM D422) and Modified Proctor compaction (ASTM D1557) tests and deliver/send the samples to the laboratory for testing based on the frequencies stated in Table 3-3.
- Verify that foundation layer materials are compacted in lifts not exceeding **6 inches** in compacted thickness. If a sheepsfoot compactor is not used, verify that the top of each compacted lift is scarified before placing the subsequent lift.
- Perform nuclear density-moisture tests (ASTM D6938) to verify that each lift is compacted as required by the Technical Specifications. Perform tests at testing frequencies specified in Table 3-3.
- Verify that foundation layer soils are properly moisture conditioned or aerated and processed to bring the moisture content within the acceptable range of the optimum moisture content, per Section 31223.
- During foundation layer construction operations field verify lines, grades, and dimensions using hand-held levels and inclinometers, range poles and measuring tapes.
- Coordinate with the Contractor for performance of verification surveys at the completion of earthfill operations. Verify corrective action measures as evaluated by verification surveys. Verification surveys will also be used to estimate the limits of earthfills for measurement and payment applications. Submit copy of the verification surveys to the Construction Manager.
- Verify that the final waste surface that will receive geosynthetics is prepared in accordance with Section 31225 (Subgrade Preparation).

3.4.10 Subgrade Preparation

- Review Section 31225 of the Technical Specifications.
- Verify that the surface is properly proof-rolled to create a firm and non-yielding surface and any yielding areas are repaired.
- Verify that there are no angular or sharp rocks or debris from the finished surface.
- Verify that all rocks or clods greater than 1-inch in largest diameter are removed from the completed surface.
- Verify that the subgrade is free of irregularities and is steel drum rolled smooth prior to geosynthetic placement (except for geogrid installation).

- Verify that the final surface provides continuous and intimate contact with the overlying geosynthetic.
- Perform the necessary in-place density and moisture tests and collect samples of the subgrade material based on the frequencies of the respective materials described in Tables 3-2 and 3-3.
- Verify that the completed subgrade is surveyed and as-built survey meets the project requirements prior to placement of any material over the subgrade. Verify corrective action measures as determined by the verification surveys. Verification surveys will also be used to determine the limits of the subgrade preparation for measurement and payment applications.

3.4.11 Gravel

- Review Section 31224 of the Technical Specifications.
- Perform continuous visual inspections of the Gravel material as per ASTM D2488.
- Verify that the material is free of organics and other deleterious materials.
- Verify that placement of the Gravel does not damage the underlying geosynthetics.
- Verify that the Gravel is placed from the bottom of the slope upwards and that placement operations do not damage underlying geosynthetic installations.
- Verify that the Gravel is placed only to the extent shown on the Construction Drawings.
- Verify that only equipment specified in the Technical Specifications and Construction Drawings or approved equipment by the Engineer is used to place the Gravel.
- Verify that no sharp equipment turns or sudden braking are made during Gravel placement.
- Verify that material is placed in loose lifts not exceeding 8 inches and compacted according to the methods described in the specification.
- Collect bulk samples of the gravel for laboratory testing at the frequencies summarized in Table 3-5.
- Coordinate with the Contractor for performance of verification surveys upon completion of placement operations. Verify corrective action measures as evaluated by the verification surveys. Verification surveys will also be used to estimate the limits of the drainage gravel for measurement and payment applications. Submit copy of verification surveys to the Construction Manager.

3.4.12 Road Base

- Verify that construction staking is performed before work and that survey benchmarks with elevations are secured outside the work area.

- Perform visual and manual soil classifications (ASTM D2488) to verify that material source is suitable for road base. Verify that the material is free of organic and oversized materials.
- Verify that material is placed in loose lifts not exceeding 8 inches and compacted according to the methods described in the specification.
- Collect bulk samples of the road base for particle size (ASTM D422) and Modified Proctor compaction (ASTM D1557) tests and deliver/send the samples to the laboratory for testing based on the frequencies stated in Table 3-5.
- Verify that road base materials are compacted in loose lifts not exceeding **8 inches**.
- Perform nuclear density-moisture tests (ASTM D6938) to verify that each lift is compacted as required by the Technical Specifications. Perform tests at testing frequencies specified in Table 3-6.
- Verify that final road base surfaces are free of ruts and gouges.
- During operations field verify lines, grades, and dimensions using hand-held levels and inclinometers, range poles and measuring tapes.
- Coordinate with the Contractor for performance of verification surveys at the completion of earthfill operations. Verify corrective action measures as evaluated by verification surveys. Verification surveys will also be used to estimate the limits of earthfills for measurement and payment applications. Submit copy of the verification surveys to the Construction Manager.
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3.4.13 Rip-Rap

- Review the Caltrans Standard Specifications for requirements for Rock Rip-Rap Class I.
- Receive and review submittal for proposed material and verify that material meets the project requirements.
- Verify that the Rip-Rap material is reasonably free of fines and well graded to minimize voids.
- Verify that the Rip-Rap is hand-placed in accordance with Method B of the Caltrans Standard Specifications. Verify that placement avoids segregation and that the placed rock is well graded throughout the entire mass (i.e. free from objectionable pockets of small or large pieces).
- Verify that the Rip-Rap material placement does not damage the underlying geotextile and that any damaged segment of geotextile is repaired by placing a piece of geotextile large

enough to cover the damaged area with adequate overlap and seaming the two geotextiles together per Specification 31720.

3.4.14 Vegetative Layer

- Review Section 31240 of the Technical Specifications.
- Verify that material source is suitable for the vegetative layer, free of deleterious materials, and free of particles greater than **1 inch** in diameter.
- Perform sieve analysis (ASTM D422) to verify that Vegetative Layer material(s) comply with gradation and hydraulic conductivity requirements specified in the Technical Specifications. Perform tests at testing frequencies specified in Table 3-4.
- Verify that grade control construction staking is performed before work.
- Verify that the Vegetative Layer is placed from the bottom of the slope upwards and that placement operations do not damage underlying geosynthetic installations.
- Verify that the Vegetative Layer is placed only to the extent shown on the Construction Drawings.
- Verify that only equipment specified in the Technical Specifications and Construction Drawings or approved equipment by the Engineer is used to place the Vegetative Layer.
- Verify that no sharp equipment turns or sudden braking are made during Vegetative Layer placement.
- Perform nuclear density-moisture tests (ASTM D6938) to verify that each lift is compacted as required by the Technical Specifications. Perform tests at testing frequencies specified in Table 3-4.
- Coordinate with the Contractor for performance of verification surveys upon completion of Vegetative Layer placement operations. Verify corrective action measures as evaluated by the verification surveys. Verification surveys will also be used to estimate the limits and volume of the Vegetative Layer for measurement and payment applications. Submit copy of verification surveys to the Construction Manager.

3.4.15 Erosion and Sediment Control

- Review Section 31310 and 31320 of the Technical Specifications.
- Verify that the Contractor has prepared an approved SWPPP. Secure and review a copy of the SWPPPto verify that the Contractor is implementing practices and procedures described in the SWPPP. Verify that all erosion and sediment control facilities are approved by Port before beginning site earthwork.
- Verify that all temporary erosion and sediment control facilities (sediment basin, straw bale barriers, and silt fences) are in place and operational prior to construction. Note

additional erosion control opportunities and bring to the attention of the construction manager.

- Verify that disturbed ground surfaces are stabilized at the end of each workday. Verify that ground surfaces are immediately roughened by dozer track-walking upon reaching final grade. Verify that the dozer track imprints are perpendicular to the contours of the slope.
- Verify that permanent soil stabilization and erosion and sediment controls are implemented upon reaching final grade.
- Verify that the seed mix and installation is consistent with Section 31320 of the Technical Specifications.
- Verify that silt fence materials comply with product requirements of the technical specifications.
- Verify that silt fence lines are at a constant elevation for each continuous length of fence.
- Verify that all erosion and sediment control measures are installed in accordance with the manufacturer recommendations.
- Verify that regularly scheduled maintenance inspections are conducted on all erosion and sediment control facilities and are in accordance with the technical specifications.

4. CONSTRUCTION QUALITY ASSURANCE FOR GEOSYNTHETICS

4.1 General

The objectives of the geosynthetics CQA program are to: (i) assure that proper construction techniques and procedures are used; and (ii) that the project is completed in accordance with the project Construction Drawings and Technical Specifications. The intents of the CQA program are: (i) to identify and define problems that may occur during construction; and (ii) to verify that these problems are corrected before construction is complete.

This section describes CQA procedures for the installation of geosynthetic components. The following types of geosynthetics will be utilized for this project:

- 40 mil double-sided textured LLDPE geomembrane;
- Nonwoven geotextiles; and
- Double-sided geocomposites.

CQA for the geosynthetics installations will be performed to verify that geosynthetics are installed in accordance with the design. Construction must be conducted in accordance with the project Construction Drawings and Specifications. To monitor compliance, CQA program will: (i) review the Contractor's quality control (CQC) submittals; (ii) perform material conformance testing; (iii) monitor construction testing; and (iv) monitor installations. Conformance testing refers to activities that take place before geosynthetics installation. Construction testing includes activities that occur during geosynthetics installation.

All CQA testing will be conducted in accordance with this CQA Plan, and the project Construction Drawings and Specifications. If a discrepancy exists in the testing requirements, the document that requires the most stringent testing will govern.

4.2 Geomembrane

4.2.1 Delivery

4.2.1.1 Transportation and Handling

Transportation of the geomembrane is the responsibility of the Geomembrane MANUFACTURER. All handling on site is the responsibility of the Contractor prior to the start of installation; Installer is responsible for protection and handling once installation begins.

The CQA Monitor will verify that:

- Handling equipment used on the site is adequate and does not pose a risk of damage to the geomembrane;
- The roll numbers of the delivered geosynthetics match the list of approved rolls; and

- The Installer's personnel handles the geomembrane with care.

Upon delivery at the site, the Installer and the CQA Organization will conduct a surface observation of all rolls or factory panels for defects and damage. This examination will be conducted without unrolling rolls or unfolding factory panels unless defects or damages are found or suspected. Upon delivery of geomembrane, the CQA Monitor will:

- Inspect geomembrane rolls for damage during shipping and handling. Identify damaged materials and verify that damaged materials are set aside.
- Verify that the geomembrane is stored in accordance with the specifications and is protected from puncture, dirt, grease, water, moisture, mud, mechanical abrasions, excessive heat, direct sunlight, and other damage.
- Verify that all manufacturing documentation required by the specifications has been received.
- Verify that the geosynthetics receipt log form has been completed for all geomembrane materials received.
- Verify that the quality control certificates have been provided at the specified frequency for all rolls and that each certificate identifies the rolls related to it.
- Review the quality control certificates and verify that the certified roll properties meet the specifications.
- Verify that the property values certified by the Geomembrane Manufacturer meet all of the specifications; and
- Verify that the measurements of properties by the Geomembrane Manufacturer are properly documented and that the test methods used are acceptable.

The CQA Monitor will indicate to the Construction Manager/Owner:

- Any rolls, factory panels, or portions thereof, which should be rejected and removed from the site because they have severe flaws; and
- Any rolls or factory panels that include minor repairable flaws.

Damaged geomembrane may be rejected. If rejected, verify that material is removed from the site or stored at a location, separate from accepted geomembrane. Geomembrane that does not have proper manufacturer's documentation must be stored at a separate location, until all documentation has been received, reviewed and accepted.

4.2.1.2 Storage

The Contractor and/or Installer will be responsible for the storage of the geomembrane on site. Owner will provide storage space in a location (or several locations) such that onsite transportation and handling are optimized if possible. Storage space should be protected from theft, vandalism, passage of vehicles, etc.

The CQA Organization will verify that the storage of the geomembrane provides adequate protection against dirt, shock, and other sources of damage.

4.2.2 Conformance Testing

4.2.2.1 Tests

One (1) geomembrane sample will be obtained for every **100,000 square feet per lot/batch** of material supplied. The material will be sampled at the site by the CQA Monitor(s) or at the manufacturing plant by an independent third party under the direction of the CQA Organization. The samples will be forwarded to an independent testing laboratory for the following conformance test:

- Specific Gravity (Density) (ASTM D1505 or D792-Method B);
- Asperity (textured geomembrane only) (ASTM D7466);
- Carbon Black Content (ASTM D4218);
- Carbon Black Dispersion (ASTM D5596);
- Thickness (ASTM D5994);
- Puncture Resistance (ASTM D4833); and
- Tensile properties (ASTM D6693).

Direct Shear Testing (ASTM D5321)

Perform direct shear testing for 40 mil LLDPE (minimum one test per project or material type) per ASTM D5321 as described in Section 31750 of the Technical Specifications. Two tests should be performed, 1) top of geomembrane to bottom of drainage geocomposite; and 2) bottom of geomembrane to top of landfill gas blanket geocomposite.

The CQA Manager will review all conformance test results and report any non-conformance to the Construction Manager and Installer.

4.2.2.2 Sampling Procedure

Samples will be obtained across the entire roll width and will be 3 feet long. However, samples may be cut for shipping purposes, but a minimum of five (5) square feet (ft^2) must be sent to the testing laboratory. Samplers must mark the machine direction and the manufacturer's roll identification number in the sample (each piece). Samplers will also assign a conformance test number to the sample and mark the sample with that number.

4.2.2.3 Procedures for Conformance Test Failure

The following procedure will apply whenever a sample fails a conformance test that is conducted by the Geosynthetics CQA Laboratory:

- The Installer will replace any roll of geomembrane that is in nonconformance with the specifications with a roll that meets specifications.
- The Installer will remove conformance samples for testing by the Geosynthetics CQA Laboratory from the closest numerical roll on both sides of the failed roll. These two samples must both conform to specifications. If either of these samples fails, conformance samples will continue to be obtained from the closest numerical rolls until the failing samples are isolated by rolls meeting the specifications. The remainder of geomembrane on site and rolls delivered subsequently may be tested at a frequency of one test per 50,000 square feet per lot/batch by the Geosynthetics CQA Laboratory for conformance to the specifications. This additional conformance testing will be at the expense of the Geomembrane Manufacturer.

The geosynthetics CQA Organization will document actions taken in conjunction with conformance test failures.

4.2.3 Geomembrane Installation

4.2.3.1 Surface Preparation

Geomembrane will be installed over the Earthfill and Foundation Layer. Before geomembrane installation, the subgrade shall be inspected by the CQA Monitor, Installer, and Contractor. The CQA Monitor must verify the following:

- All lines and grades for soil surface have been verified by the Contractor.
- The soil surface has been rolled and compacted to be free of surface irregularities, loose soil, and protrusions.
- The soil surface does not contain stones or other objects that could damage the geomembrane.
- The anchor trench dimensions have been checked, and the trenches are free of sharp objects and stones.
- There are no excessively soft areas.
- The soil surface is not saturated, and no standing water is present.
- The soil surface has not desiccated.
- All construction stakes have been removed, and there is no debris, rocks, or any other objects in or on the soil surface.
- The geosynthetics Contractor/Installer has certified in writing that the surface on which the geosynthetics will be installed, is acceptable.

4.2.3.2 Panel Placement

Before installing any of the geomembrane, the Installer must submit panel layout(s) in accordance with the Technical Specifications. The drawings will show the proposed layout of the panels, including panel identification numbers, field seams, and any other proposed details that do not conform to the Construction Drawings.

The CQA Monitors will maintain an up-todate as-built panel layout drawing that shows the following: (i) roll numbers; (ii) panel numbers; (iii) seam numbers; (iv) test locations; (v) repair locations; and, (vi) non-destructive testing information.

During geomembrane panel placement operations, the CQA Monitor will:

- Record panel numbers and dimensions on the panel/seam log.
- Observe the panel surface as it is deployed and record all panel defects and defect corrective actions (panel rejected, patch installed, extrudate placed over the defect, etc.) on the repair sheet. Verify that corrective actions are made in accordance with the specifications.
- Verify that equipment used during deployment operations does not damage the geomembrane. Verify that equipment used on the geomembrane does not leak hydrocarbons onto the geomembrane or that corrective measures are taken to prevent leakage.
- Verify that the surface beneath the geomembrane has not deteriorated since previous acceptance. Verify that no stones, construction debris, or other items are beneath the geomembrane that could damage the geomembrane.
- Verify that the geomembrane is not dragged across an unprotected surface. If the geomembrane is dragged across an unprotected surface, the geomembrane must be inspected for scratches and repaired or rejected if necessary.
- Record weather conditions including temperature, wind speed and direction, and humidity. Verify that the geomembrane is not deployed in the presence of excess moisture (fog, dew, mist, etc.). In addition, verify that the geomembrane is not placed when the air temperature is less than 40 °F, or when standing water of frost is on the ground.
- Verify that crews working on the geomembrane do not smoke, wear shoes that could damage the liner, or engage in activities that could damage the geomembrane.
- Verify that methods used to deploy the geomembrane minimize wrinkles, and that panels are anchored to prevent movement by the wind. Verify that the Installer corrects any damage resulting to or from windblown geomembrane.
- Verify that no more panels are deployed than can be seamed on the same day.

The CQA Monitor must inform both the Installer and the CQA Manager if any of the above conditions are not met.

4.2.3.3 Field Seaming

Before the start of geomembrane welding and during welding operations, each welder and welding apparatus will be tested in accordance with the specifications to verify that the equipment is functioning properly. One trial weld will be taken before the start of work and one at mid-shift. The trial weld sample will be 3 feet long and 12 inches wide, with the seam centered lengthwise. The CQA Monitor will observe all welding operations and verify that the Installer quantitatively test each trial weld for peel adhesion and bonded seam strength (ASTM D 6392). (Peel adhesion tests will be referred to as "peel" and bonded seam strength tests will be referred to as "shear" in this CQA Plan.) The purpose of peel and shear tests is to evaluate seam strength and to evaluate long-term performance. Shear strength measures the continuity of tensile strength through the seam and into the parent material. Peel adhesion measures the strength of the bond created by the welding process. The results of the peel and shear tests will be recorded on the trial weld form. Trial welds must be completed under conditions similar to those under which the panels will be welded. Trial welds must meet specified requirements for peel and shear, and the failure must be ductile or a film tearing bond (FTB) for a wedge weld. An FTB means the test specimen breaks at the edge of the outside of the seam, but not in the same seam. If at any time the CQA Monitor believes that welding apparatus is not functioning properly, a trail weld must be performed. If there are wide changes in temperature (± 30°F), humidity, or wind speed, another trail weld must be performed. The trail weld must be allowed to cool to ambient temperature before it is tested.

During geomembrane welding operations, the CQA Monitor will:

- Verify that the Contractor has the number of welding apparatuses and spare parts necessary to perform the work.
- Verify that equipment used for welding will not damage the geomembrane.
- Verify that extrusion welders are purged before beginning a weld so that all heat-degraded extrudate is removed from the nozzle of the welder.
- Verify that seam grinding is completed less than 1 hour before seam welding, and the upper sheet is beveled (extrusion welding only).
- Verify that ambient temperature measured 6 inches above the geomembrane surface is between 40° and 110° Fahrenheit.
- Verify that ends of extrusion welds that are more than 5 minutes old, are ground to expose new material before restarting a weld.
- Verify that contact surfaces of the panels are clean, and free of dust, grease, dirt, debris and moisture before welding.
- Verify that welds are free of dust, rocks and other debris.
- Verify that cross seams are ground to a smooth incline before welding (fusion welding only).

- Verify that all seams are overlapped a minimum of 3 inches or in accordance with manufacturer's recommendations, whichever is more stringent.
- Verify that solvents or adhesives are not present in the seam area.
- Verify that procedures used to hold temporarily the panels together do not damage the panels and do not preclude CQA testing.
- Verify that strips of geomembrane, wide enough and long enough to protect the hot wedge welder from running on the subgrade is placed below the geomembrane. These strips may be as long as the seam itself or shorter and moved with the seaming equipment. If necessary, a firm material such as a flat board or similar hard surface may be placed directly under the weld overlap to achieve firm support.
- Verify that panels are being welded in accordance with the plans and specifications.
- Verify that there is no free moisture in the weld area.
- Measure surface temperature of the panels **every two hours**.

4.2.4 Construction Testing

4.2.4.1 Nondestructive Seam Testing

The purpose of nondestructive geomembrane testing is to detect discontinuities or holes in the seams. Nondestructive geomembrane tests include vacuum and air pressure testing. Nondestructive testing must be performed over the entire length of the seam.

It is the Installer's responsibility to perform all nondestructive testing as part of his quality control (QC) program. The CQA Monitor's responsibility is to observe and document that the Installer's QC testing is in compliance with the specifications and to document seam defects and repairs.

Nondestructive testing procedures are described below:

- For welds tested by Vacuum Method - the weld is placed under suction utilizing a vacuum box constructed with rigid sides, a transparent top for viewing the seams, a neoprene rubber gasket attached to the bottom of the rigid sides, a vacuum gauge on the inside, and a valve assembly attached to a vacuum hose connection. The box is placed over a seam section that has been thoroughly saturated with a soapy water solution (1 oz. soap to 1 gallon water) [30 mL soap to 3.7 L water]. The rubber gasket on the bottom of the box must fit snugly against the soaped seam section of the panel, to ensure a leak-tight seal. A vacuum pump is energized and the vacuum box pressure reduced to approximately 5 psi gauge (34 kPa-gauge). Any pinholes, porosity or non-bonded areas are detected by the appearance of soap bubbles in the vicinity of the defect. Dwell time must not be less than 10 seconds.
- Air Pressure Testing - is used to test double seams that have enclosed air space between them. Both ends of the air channel must be sealed. A pressure feed device, usually a needle

equipped with a pressure gauge, is inserted into one end of the channel. Air is then pumped into the channel to a minimum pressure of 20 psi or 0.5 psi (34 kPa) per mil of geomembrane thickness, whichever is greater. A two-minute relaxing period is allowed for the pressure to stabilize. The air chamber must sustain the pressure for a further five minutes without losing more than 2 psi (14 kPa). Following a passed pressure test, the opposite end of the tested seam must be punctured to release the air. The pressure gauge must return to zero; if not, a blockage is likely in the seam channel. Locate the blockage and test the seam on both sides of the blockage. The penetration holes must be sealed after testing.

During nondestructive testing, the CQA Monitor will:

- Review Technical Specifications regarding test procedures.
- Verify that equipment operators are fully trained and qualified to perform their work.
- Verify that test equipment meets project specifications.
- Verify the entire length of each seam is tested in accordance with the specifications.
- Observe all continuity testing and record results on the panel/seam log and the panel layout drawing.
- Verify that all testing is completed in accordance with the project specifications.
- Identify any failed areas, by marking the area with a waterproof marker compatible with geomembrane, inform the Contractor of any required repairs, and record the repair on the panel/seam log.
- Verify that all repairs are completed and tested in accordance with the project specifications.
- Record all completed and tested repairs on a repair sheet, and the panel layout drawing.

4.2.4.2 Destructive Seam Sampling Procedures and Field Testing

Destructive seam samples will be taken at intervals of at least one test per **500 linear feet** of geomembrane seams. However, additional samples will be taken if the CQA Monitor suspects that a seam does not meet the specification requirements. Reasons for taking additional samples may include but are not limited to:

- Wrinkling in seam area;
- Excess crystallinity;
- Suspect seaming equipment or techniques;
- Weld contamination;
- Insufficient overlap;

- Adverse weather conditions; and
- Failing tests.

The CQA Monitor selects the locations from where seam samples will be cut for destructive laboratory testing as follows:

- A minimum of one test per 500 feet of seam length. This is an average frequency for the entire installation; individual samples may be taken at greater or lesser intervals. The testing frequency would be increased if welding operations were conducted at temperatures below 40° F. This increase will be agreed upon by the Construction Manager, CQA Manager, and Installer.
- A maximum frequency must be agreed to by the Construction Manager, CQA manager, and Installer at the pre-construction meeting. However, if the number of failed samples exceeds five percent of the tested samples, this frequency may be increased at the discretion of the CQA Manager. Samples taken as the result of failed tests do not count toward the total number of required tests.

The CQA Monitor will not inform the Installer in advance of selecting the destructive sample locations. The Installer will remove specimens and samples at locations identified by the CQA Monitor and field test the specimens for peel and shear before the samples are shipped offsite for laboratory testing. During sampling procedures, the CQA Monitor will:

- Observe sample cutting.
- Mark each specimen and sample with an identifying number that contains the seam number, destructive sample test number, welder, and date and time welded.
- Record sample locations on the panel layout drawing and panel-seam logs.
- Record the sample locations, weather conditions, and reasons samples were taken (e.g., a random sample, visual appearance, result of a previous failure, etc.) in the destructive seam test form.

At each location, obtain two-seam specimens that are 42 inches apart. The specimens should be 1 inch wide and 12 inches long with the weld centered across the length of the specimen. The Installer must test these samples to failure in the field using a tensiometer capable of quantitatively measuring shear and peel strengths. For double wedge welding, the Contractor must test both welds. The CQA Monitor will observe the tests. Geomembrane seam specimens pass when the break is a ductile FTB. A film tearing bond means the test specimen breaks at the edge of the outside of the seam, but not in the seam. In addition, the seam strength must meet the specified values.

If one or both of the 1-inch specimens fails in either peel or shear, the Installer can, at his discretion: (i) reconstruct the entire seam between passed test locations; or (ii) take another test sample 10 feet from the point of the failed test and repeat this procedure. If the second test passes, the Installer can either reconstruct or cap strip the seam between the two passed test locations. If subsequent tests fail, the sampling and testing procedure is repeated, until the length

of the poor quality seam is established. Repeated failures indicate that either the seaming equipment or operator is not performing properly, and appropriate corrective action must be taken immediately.

Once the field tests specimens have passed, a sample must be recovered for laboratory testing from between the passing field specimen locations. The sample must be 42 inches long and 12 inches wide, with the weld centered along the length of the sample. The sample must be divided into three sections: (i) one 12-inch by 12-inch section for the Installer, (ii) one 12-inch by 18-inch section for laboratory testing, and (iii) one 12-inch by 12-inch for Owner to archive. Record the results of field testing on the destructive seam tests form, the panel/seam log.

4.2.4.3 Third Party Laboratory Testing

All CQA destructive samples must be shipped to the testing laboratory to verify seam quality. The laboratory will test five specimens from each sample in each method used. Minimum test values are presented in the Specifications. The testing laboratory must provide test results within 24 hours, in writing or via telephone, to the CQA Manager (or his/her representative); certified test results are to be provided within five days.

The CQA Manager must immediately notify the Construction Manager and Installer in the event of failed test results.

If the laboratory test fails in either peel or shear, The Installer must either reconstruct the entire seam, or recover additional samples at least 10 feet on either side of the failed sample for retesting. This process is repeated until passed tests bracket the failed seam section. All seams must be bounded by locations from which passing laboratory tests have been taken. Laboratory testing governs seam acceptance. In no case can field testing of repaired seams be used for final acceptance.

4.2.5 Repairs

Portions of geomembrane panels and seams that: (i) contain a flaw; (ii) a destructive test; or (iii) nondestructive test cuts of holes, must be repaired in accordance with the specifications. The CQA Monitor must locate and record all repairs on the repair sheet and panel layout drawing. Acceptable repair techniques include the following:

- Patching – Used to repair large holes, tears, large panel defects, undispersed raw materials, welds, contamination by foreign matter, and destructive sample locations.
- Extrusion – Used to repair small defects in the panels and seams. In general, this procedure should be used for defects less than 2 inches in the largest dimension.
- Capping – Used to repair failed welds or to cover seams where welds cannot be nondestructively tested.
- Removal – Used to replace area with large defects where preceding methods are not appropriate. Also used to remove excess material (wrinkles, fishmouths, intersections, etc.) from the installed geomembrane. Areas of removal shall be patched or capped.

Repair procedures include the following:

- Abrade geomembrane surfaces to be repaired (extrusion welds only) no more than 1 hour before the repair.
- Clean and dry all surfaces at the time of repair.
- Verify acceptance of the repair procedures, materials and techniques by the CQA Monitor in advance of the specific repair.
- Extend patches or caps at least 6 inches beyond the edge of the defect, and round all corners of material to be patched and the patches to a radius of at least 3 inches. Bevel the top edges of patches before extrusion welding.

4.2.6 Wrinkles

During the placement of materials over the geomembrane, temperature changes or creep may cause wrinkles to develop in the geomembrane. Any wrinkles that can fold over must be repaired either by cutting out excess material or if possible, by allowing the geomembrane to contract by temperature reduction. In no case can material be placed over the geomembrane, which could result in the geomembrane folding. The CQA Monitor must monitor geomembrane for wrinkles and notify the CQA Manager and Installer if wrinkles are being covered with soil. The CQA Monitor is then responsible for documenting corrective action to remove the wrinkles.

4.2.7 Folded Material

All folded geomembrane must be removed.

4.2.8 Geomembrane Anchor Trench

The geomembrane anchor trench should be left open until seaming is completed. Expansion and contraction of the geomembrane should be accounted for in the liner placement. The anchor trench should be filled in the morning when temperatures are coolest to reduce bridging of the geomembrane.

4.2.9 Geomembrane Acceptance

The Installer retains all ownership and responsibility for the geomembrane until acceptance by Owner. In the event the Installer is responsible for placing cover over the geomembrane, the Installer retains all ownership and responsibility for the geomembrane until all required documentation is complete, and the cover material is placed. After panels are placed, seamed, tested successfully and repairs made, the completed installation will be walked by the CQA Monitor and Installer. Any damage or defect found during this inspection will be repaired properly by the Installer. The installation will not be accepted until it meets the requirements of both parties. In addition, the geomembrane will be recommended for acceptance by the CQA Monitor only when the following have been completed:

- The installation is finished.
- All seams have been inspected and verified to be acceptable, and that all required laboratory and field tests have been completed and reviewed.
- All required Contractor-supplied documentation has been received and reviewed.
- All as-built record drawings have been completed and verified by the CQA Monitor to show the true panel dimensions, the locations of all seams, trenches, pipes, repairs, etc.
- A leak location survey(s) has been completed.

4.2.10 Qualifications

Part 1.06 of Sections 31740 and 31750 of the Technical Specifications provides minimum required qualifications for all personnel involved with the installation of the geomembrane.

4.3 Geotextile

4.3.1 Delivery

During the delivery of geotextiles, the CQA Monitor will:

- Verify that equipment used to unload the rolls will not damage the geotextile.
- Verify that rolls are wrapped in impermeable and opaque protective covers.
- Verify that care is used to unload the rolls.
- Verify that all documentation required by the specifications has been received.
- Verify that each roll is marked or tagged with the following information: manufacturer's name; project identification; lot number; roll number; roll dimensions. Log this information on the geosynthetic receipt form.
- Verify that the geosynthetic receipt form is completed.
- Verify that materials are stored in a location that will protect the rolls from ultraviolet light exposure, precipitation, mud, dirt, dust, puncture, cutting, or any other damaging or deleterious conditions.

Any damaged rolls may be rejected. Verify that rejected material is removed from the site or stored at a location separate from accepted rolls. Geotextile rolls, which do not have proper manufacturer's documentation must also be stored at a separate location until all documentation has been received and approved.

4.3.2 Conformance Testing

4.3.2.1 Tests

One (1) geotextile sample will be obtained for every **100,000 square feet per lot/batch** of material supplied. The material will be sampled at the site by the CQA Monitors or at the manufacturing plant by an independent third party under the direction of the CQA Organization. The samples will be forwarded to an independent testing laboratory for the following conformance test:

- Grab strength (ASTM D4632);
- Mass per unit area (ASTM D5261);
- Puncture resistance (ASTM D6241);
- Trapezoidal tear strength (ASTM D4533);
- Permittivity (filter geotextile only) (ASTM D4491); and
- AOS (filter geotextile only) (ASTM D4751).

The CQA Manager will review all conformance test results and report any non-conformance to the Construction Manager and Contractor/Installer.

4.3.2.2 Sampling Procedure

Samples will be obtained across the entire roll width and will be 3 feet long. Samplers must mark the manufacturer's roll identification number, as well as the machine direction, on the sample. Samplers will also assign a conformance test number to the sample and mark the sample with that number.

4.3.2.3 Procedures for Conformance Test Failure

The following procedure will apply whenever a sample fails a conformance test that is conducted by the geosynthetics CQA Laboratory:

- The Installer will replace any roll of geotextile that is in nonconformance with the specifications with a roll that meets specifications.
- The Installer will remove conformance samples for testing by the geosynthetics CQA Laboratory from the closest numerical roll on both sides of the failed roll. These two samples must both conform to specifications. If either of these samples fails, conformance samples will continue to be obtained from the closest numerical rolls until the failing samples are isolated by rolls meeting the specifications. The remainder of geotextile on site and rolls delivered subsequently may be tested at a frequency of one test per 50,000 sf per lot/batch by the CQA Laboratory for conformance to the Specifications.

The CQA Organization will document actions taken in conjunction with conformance test failures.

4.3.3 Geotextile Installation

4.3.3.1 Surface Preparation

Before geotextile installation, the CQA Monitor will:

- Verify that all lines and grades have been verified by the Contractor.
- Verify that the subgrade has been prepared in accordance with the earthfill specifications.
- Verify that the underlying layer is approved and can be covered with geotextile.
- Verify that the Vegetative Layer is carefully placed so that it does not damage the geotextile.
- Verify that there are no excessively soft areas on soil surfaces that could damage the geotextile.
- All construction stakes have been removed.

4.3.3.2 Geotextile Placement and Seaming

During geotextile placement and seaming operations, the CQA Monitor will:

- Observe the geotextile as it is deployed and record all defects and defect corrective actions (panel rejected, patch installed, etc.). Verify that corrective actions are performed in accordance with the specifications.
- Verify that construction equipment does not drive directly over the geotextile.
- Verify that equipment used does not damage the geotextile by handling, equipment transit, leakage of hydrocarbons, or other means.
- Verify that crews working on the geotextile do not smoke, wear shoes that could damage the geotextile, or engage in activities that could damage the geotextile.
- Verify that the geotextile is securely anchored in an anchor trench and is temporarily anchored to prevent movement by the wind.
- Verify that adjacent panels are overlapped and seamed in accordance with the specifications.
- Verify that the geotextile was not exposed to direct sunlight for more than **15 calendar days**.
- Examine the geotextile after installation to ensure that no potentially harmful foreign objects are present.

The CQA Monitor must inform both the CQA Manager and Installer if the above conditions are not met.

4.3.4 Repairs

Repair procedures include:

- Patching – Used to repair large holes, tears, and small defective areas.
- Removal – Used to replace large defective areas where the preceding method is not appropriate.

Repair procedures shall be performed per Technical Specifications. Care will be taken to remove any soil or other material, which may have penetrated the torn geotextile. All repairs will be made at no additional cost to Owner. If approved by Owner, the patch may be nailed or stapled.

4.4 Geocomposite

4.4.1 Delivery

During the delivery of geocomposite material the CQA Monitor will:

- Verify that equipment used to unload the rolls will not damage the geocomposite.
- Verify that care is used to unload the rolls.
- Verify that all documentation required by the specifications has been received.
- Verify that each roll is marked or tagged with the following information: manufacturer's name; project identification; lot number; roll number; roll dimensions. Log this information on the geosynthetic receipt form.
- Verify that the geosynthetic receipt form is completed.
- Verify that materials are stored in a location that will protect the rolls from ultraviolet light exposure, precipitation, mud, dirt, dust, puncture, cutting, or any other damaging or deleterious conditions.

Any damaged rolls may be rejected. Verify that rejected material is removed from the site or stored at a location separate from accepted rolls. Geocomposite rolls that do not have proper manufacturer's documentation must also be stored at a separate location until all documentation has been received and approved.

4.4.2 Conformance Testing

4.4.2.1 Tests

One (1) geocomposite sample will be obtained for every **100,000 square feet per lot/batch** of material supplied. The material will be sampled at the site by the CQA Monitors or at the manufacturing plant by an independent third party under the direction of the CQA Organization. The samples will be forwarded to an independent testing laboratory for the following conformance test:

The geotextile component of geocomposite shall be tested for the following characteristics:

- Grab strength (ASTM D4632);
- Mass per unit area (ASTM D5261);
- Puncture resistance (ASTM D6241);
- Trapezoidal tear strength (ASTM D4533);
- Permittivity (filter geotextile only) (ASTM D4491); and
- AOS (filter geotextile only) (ASTM D4751).

The geonet component of geocomposite shall be tested for:

- Density (ASTM D1505 or D792-Method B);
- Thickness (ASTM D5199); and
- Carbon black content (ASTM D1603 or ASTM D4218).

The geocomposite characteristics shall be confirmed by the following conformance tests:

- Peel strength (ASTM D7005); and
- Transmissivity (ASTM D4716).

The CQA Manager will review all test results and report any non-conformance to the Construction Manager and Installer.

4.4.2.2 Sampling Procedure

Samples will be obtained across the entire roll width and will be 3 feet long. Samplers must mark the manufacturer's roll identification number, as well as the machine direction, on the sample. Samplers will also assign a conformance test number to the sample and mark the sample with that number.

4.4.3 Geocomposite Installation

4.4.3.1 Surface Preparation

Before geocomposite installation, the CQA Monitor will:

- Verify that all lines and grades have been verified by the Contractor.
- Verify that the subgrade has been prepared in accordance with the subgrade preparation specifications.
- Verify that subgrade surfaces do not contain protrusions that could damage the geocomposite.

- Verify that there are no excessively soft areas in the foundation layer that could damage the geocomposite.
- All construction stakes have been removed.
- Verify that all aspects of surface preparation have been performed according to the specifications.

4.4.3.2 Geocomposite Placement and Seaming

During geocomposite placement the CQA Monitor will:

- Observe the geocomposite as it is deployed and record all defects and defect corrective actions (panel rejected, patch installed, etc.). Verify that corrective actions are performed in accordance with the specifications.
- Verify that construction equipment does not drive directly over the geocomposite.
- Verify that equipment used does no damage the geocomposite by handling, equipment transit, leakage of hydrocarbons, or other means.
- Verify that crews working on the geocomposite do not smoke, wear shoes that could damage the geocomposite, or engage in activities that could damage the geocomposite.
- Verify that the geocomposite is securely anchored to prevent movement by the wind.
- Verify that adjacent panels are overlapped and seamed in accordance with the specifications.
- Examine the geocomposite after installation to ensure that no potentially harmful foreign objects are present.

The CQA Monitor must inform both the CQA Manager and Contractor if the above conditions are not met.

5. CONSTRUCTION QUALITY ASSURANCE FOR MISCELLANEOUS ITEMS

5.1 General

This section of the CQA Plan addresses the miscellaneous components of construction about materials selection and evaluation and work deficiencies.

CQA will be performed on all miscellaneous components of construction. The criteria to be used for evaluating acceptability of the construction work will be as identified in the project specifications.

5.2 Erosion and Sediment Control Measures

Temporary and permanent erosion control measures will be installed in conformance with the SWPPP, Construction Drawings, and the Technical Specifications.

5.2.1 Monitoring

The CQA Monitor shall monitor the installation and performance (during construction) of all erosion control measures. Monitoring activities shall include:

- Observing installation activities;
- Monitoring performance of the erosion control measures and informing Owner of deficiencies and need for maintenance and repair; and
- Measuring quantities of installed components.
- Verifying that surface preparation and hydroseeding is performed in accordance with Section 31320 of the project Technical Specifications

5.3 Polyethylene Pipe and Fittings

This section describes CQA procedures for high-density polyethylene (HDPE) pipe installations. Perforated and solid HDPE pipe will be utilized to construct the landfill gas venting system.

CQA for the HDPE pipe installations will be performed to verify that HDPE pipe systems are installed in accordance with the design. Construction must be conducted in accordance with the project Construction Drawings and Specifications. To monitor compliance, the CQA program will (i) review the Contractor's quality control (CQC) submittals; (ii) monitor construction testing; and (iii) monitor installations.

All construction testing will be conducted in accordance with the project Technical Specifications.

5.3.1 Delivery, Handling, and Storage

- Verify that chains, end hooks, cable slings, or any other devices that may scar the pipe are not used to handle pipe. Wide nylon web slings are recommended to handle the pipe.
- Verify that the pipe is not damaged during handling operations and that damaged pipe is separated from accepted pipe.
- Verify that construction equipment does not drive directly over the pipes.
- Verify that pipe will not warp due to excessive stacking heights when the pipe is stored at the site. Recommended stacking heights for pipe are provided in Table 7-1.
- Verify that the pipe is not damaged by sharp rocks or excessive abrasion when the pipe is pulled into place during fusion welding and installation operations.
- Verify that the quality control certificates have been provided at the specified frequency for all lots/batches of pipe and that each certificate identifies the pipe lot/batch related to it.
- Review the MQC certificates and verify that the certified properties including size and strength, meet the specifications.
- Verify that the pipe perforations are sized and spaced as specified.

Table 5-1: Recommended Stacking Heights of Pipe

Number of Pipe Rows Height			
Nominal Pipe Size (inches)	**For SDRs* 18 and Under**	**For SDRs* Over 18 and Up to 26**	**For SDRs* Over 26 and Up to 32.5**
3	45	26	14
4	45	26	14
6	31	17	10
8	24	13	8
10	17	10	6
12	13	8	5
14	12	7	4
16	11	6	4
18	10	6	4
* SRD – Standard Dimension Ratio (= Nominal Pipe Diameter/Minimum Wall Thickness)			

5.3.2 Fusion Welding

- Before pipe fusion welding operations and installations verify that solid walled pipe, perforated pipe, fittings, and flanged couplings comply with product requirements of the Technical Specifications.
- Verify that certified fusion welding operators will be performing the welding.
- Verify that caution is taken to prevent water from contacting the pipe and heater plates during welding operations. A shelter may be required for the fusion welding machine to allow operations to continue in adverse weather conditions.
- Verify that heater plate surface temperatures are maintained between 375°F and 400°F for both coated plates and uncoated plates. Verify that operator checks heater plate surface temperatures with pyrometer.
- Verify that inside and outside of pipe ends are cleaned to remove dirt, water, grease, and other foreign material.
- Verify that pipe ends are squarely faced with the facing tool of the fusion welding machine.
- Verify that pipe ends line up in the fusion welding machine and that the pipe ends meet squarely and completely over the entire surface to be welded. Verify at this point that the pipe is securely clamped into place so that the pipe does not move during the fusion welding process.
- Verify that the heater plate is clean and maintains the appropriate temperature. Verify that the heater plate is inserted between the aligned pipe ends and that the pipe ends are firmly brought into contact with the heater plate. NO PRESSURE should be applied to achieve the melt pattern.
- Verify that the pipe ends are allowed to heat and soften. As the pipe heats and softens, a melt bead begins to roll back from the contact point of the heater plate, and the pipe ends. Approximate diameter size of melt beads for various sizes of pipe are presented in Table 7-2.
- Verify that the heater plate is removed quickly and cleanly when the appropriate melt bead is achieved and that no melted pipe material sticks to the heater plate. If melted material sticks to the heater plate, verify that this joint is discontinued, the heater plate is cleaned, the pipe ends are re-faced, and that the joint is re-started.
- Verify that the melted pipe ends are rapidly joined together and that enough pressure is applied to the joint to form a melt bead 1/8 inches to 3/16 inches (3 mm to 5 mm) in diameter around the entire circumference of the pipe. Pressure is critical to cause the heated material of each pipe end to flow together.

- Verify that the joint is allowed to cool and solidify properly before the pipe is released from the fusion welding machine. Cooling and solidification is completed when your finger can remain comfortably on the bead.
- Examine the joint when the pipe is released from the fusion welding machine to verify that the weld is completely around the entire circumference of the pipe.

Table 5-2: Approximate Melt Beat Diameter

Pipe Size	Diameter of Melt Bead
2 inches and below	1/16 inches
3 to 5-inches	3/16 inches
5 to 12-inches	3/16 to 1/4 inches
12 to 24-inches	3/16 to 5/16 inches
24 to 54-inches	5/16 to 7/16 inches

6. DOCUMENTATION

The quality assurance plan depends on thorough monitoring and documentation of the construction activities. For this reason, the CQA Manager will document that the quality assurance requirements have been addressed and satisfied. Documentation will consist of daily record keeping, testing and installation reports, non-conformance reports (if necessary), progress reports, photographic records, design and specification revisions, and a construction report. Report forms are presented in Appendices A, B and C of this CQA Plan.

6.1 Daily Record Keeping

At a minimum, daily records will consist of a daily record of construction progress, daily construction report, observation and test data sheets, and, as needed, non-conformance/corrective measure reports. All forms will have peer review.

6.1.1 Daily Record of Construction Progress

The daily field report will summarize ongoing construction and discussions with the Contractor and will be prepared by the CQA Manager and CQA Monitors. At a minimum, the report will include the following:

- Date, project name, project number, and location.
- A unique number for cross-referencing and document control.
- Weather data.
- A description of all ongoing construction for the day in the area of the CQA Monitor's responsibility.
- An inventory of equipment utilized by the Contractor and Installer.
- Items of discussion and names of parties involved in discussions.
- A brief description of tests and observations, identified as passing of failing, or, in the event of failure, a retest.
- Areas of non-conformance/corrective actions, if any, (non-conformance /corrective action form to be attached).
- Summary of materials received and quality documentation.
- Follow-up information on previously reported problems or deficiencies.
- Record of any site visitors.
- Signature of CQA Manager or CQA Monitor.
- Signature of the peer reviewer.

6.1.2 Observation and Test Data Sheets

Observation and test data sheets should include the following information as is appropriate for the form being used.

- Date, project name, and location.
- A unique number for cross-referencing and document control.
- Weather data, as applicable.
- A reduced scale site plan showing sample and test locations.
- Test equipment calibrations, if applicable.
- A summary of test results identified as passing, failing, or, in the event of a failed test, retest.
- Completed calculations.
- Signature of the CQA Manager or CQA Monitor.
- Signature of the peer reviewer.

6.1.3 Non-Conformance Reports

In the event of a non-conformance event, a non-conformance verification report form will be included with the daily report. Procedures for implementing and resolving any non-conformances to the contract are outlined in Section 2.4 of this CQA Plan.

6.2 Weekly Progress Reports

If required by Owner, the CQA Manager will prepare weekly progress reports summarizing construction and quality assurance activities. The reports will contain, at a minimum, the following information:

- The date, project name, and location.
- A summary of work activities completed in the last week and those expected to be performed in the next week.
- A summary of deficiencies and/or defects and resolutions.
- Ongoing summary of changed and/or change orders to the work.
- The signature of the CQA Manager.
- On the fourth week of each month, the report will include a summary of onsite and third-party laboratory test results.

6.3 Photographs

Construction activities will be photographed. Photographs will include any significant problems encountered and corrective actions, as well as document construction progress. The photographs will be identified by number, location, time, date, and photographer. The photographer should document the subject or the photograph, either on the back of the picture or in a photograph log. One copy of the photographs will be given to the CQA Manager.

6.4 Design and Specification Revisions

Design and specification changes may be required during construction. Design and specification changes will only be made with written agreement of the Design Engineer, Owner and Contractor. These changes will be made by change order to the contract. When change orders are issued, they will be prepared by the Construction Manager. The Construction Manager will distribute change orders for signature and execution to the required parties.

6.5 Final CQA Certification Report

At the completion of the project, the CQA Manager and CQA Officer will submit a Final CQA Report. This report will document that the work has been performed in compliance with the Construction Drawings, Technical Specifications and this CQA Plan.

At a minimum, the Final CQA Report will contain:

- A summary of all construction activities.
- A summary of all laboratory and field test results.
- Sampling and testing location drawings.
- A description of significant construction problems and the resolution of these problems.
- A list of changes from the construction drawings and specifications and the justifications for these changes.
- As-built record drawings.
- A statement of compliance with the construction contract documents and design intent signed and stamped by the CQA Officer, a professional engineer registered in the State of California.

The (as-built) record drawings will accurately locate the constructed location of all work items, including the location of piping, anchor trenches, etc. The Contractor will prepare all surveying and base maps required for the development of the record drawings. The CQA Manager must review and verify that as-built are correct. As-built record drawings will be included in the Final CQA Report.

6.6 Storage of Records

All handwritten data sheet originals, including those containing signatures, should be stored by Owner in a safe location after project completion. Other reports may be stored by any standard method, which will allow for easy access.