

APPENDIX O

CONSTRUCTION QUALITY ASSURANCE PLAN



PRELIMINARY CONSTRUCTION QUALITY ASSURANCE & INSPECTION PLAN SONOMA COUNTY CENTRAL DISPOSAL SITE SONOMA COUNTY, CALIFORNIA

Presented to:

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and:

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Table of Contents

Section	Page
1 INTRODUCTION	1
2 DEFINITIONS	3
2.1 CONSTRUCTION QUALITY ASSURANCE OFFICER	3
2.2 CONSTRUCTION QUALITY ASSURANCE MONITOR	3
2.3 CONTRACTOR	4
2.4 OWNER	4
2.5 OPERATOR	4
2.6 DESIGN ENGINEER	4
2.7 CAPILLARY BREAK/UNDERDRAIN LAYER	4
2.8 LOW-PERMEABILITY COMPACTED SOIL LAYER	4
2.9 GEOSYNTHETIC CLAY LINER	5
2.10 GEOMEMBRANE	5
2.11 GEOMEMBRANE MANUFACTURER	5
2.12 GEOCOMPOSITE DRAINAGE LAYER	5
2.13 GEOTEXTILE	5
2.14 GEOTEXTILE MANUFACTURER	5
2.15 SAND DETECTION LAYER	5
2.16 LEACHATE COLLECTION AND RECOVERY SYSTEM LAYER	6
2.17 OPERATIONS LAYER	6
2.18 FOUNDATION LAYER	6
2.19 VEGETATIVE LAYER	6
2.20 INSTALLER	6
2.21 QUALITY ASSURANCE	6
2.22 QUALITY CONTROL	6
2.23 REGULATORY AGENCIES	7
2.24 MATERIALS TESTING LABORATORY	7
2.25 CONSTRUCTION DOCUMENTS	7
3 PERSONNEL QUALIFICATIONS AND ORGANIZATION	8
3.1 CQA OFFICER	8
3.2 CQA MONITOR	8
3.3 CONTRACTOR	8
4 PROJECT MEETINGS	10
4.1 PRE-CONSTRUCTION MEETINGS	10
4.2 DAILY PROGRESS MEETINGS	11
4.3 WEEKLY PROGRESS MEETINGS	11
4.4 PROBLEM OR WORK DEFICIENCY MEETINGS	11
5 CQA TESTING STRATEGIES	12
5.1 CAPILLARY BREAK/UNDERDRANE LAYER TESTING	12

5.2	LOW-PERMEABILITY COMPACTED SOIL LAYER TESTING	12
5.3	GEOSYNTHETIC CLAY LINER TESTING.....	13
5.4	GEOMEMBRANE LINER TESTING.....	13
5.5	GEOCOMPOSITE LAYER TESTING	13
5.6	GEOTEXTILE LAYER TESTING.....	14
5.7	LEAK DETECTION LAYER TESTING.....	14
5.8	LEACHATE COLLECTION AND RECOVERY SYSTEM LAYER TESTING	14
5.9	OPERATIONS LAYER TESTING	14
5.10	FOUNDATION LAYER TESTING.....	14
5.11	VEGETATIVE LAYER TESTING	15
6	INSPECTION ACTIVITIES	16
6.1	CAPILLARY BREAK/UNDERDRAIN LAYER	16
6.2	LOW-PERMEABILITY COMPACTED SOIL LAYER.....	18
6.3	GEOSYNTHETIC CLAY LINER.....	21
6.4	GEOMEMBRANE LINER.....	23
6.5	GEOCOMPOSITE LAYER	31
6.6	GEOTEXTILE LAYER.....	34
6.7	LEAK DETECTION LAYER.....	37
6.8	LEACHATE COLLECTION AND RECOVERY SYSTEM LAYER.....	39
6.9	OPERATIONS LAYER	41
6.10	FOUNDATION LAYER.....	44
6.11	VEGETATIVE LAYER	46
6.12	FINAL INSPECTION.....	49
7	DOCUMENTATION	50
7.1	DAILY RECORD KEEPING AND REPORTING	50
7.2	INSPECTION DATA SHEETS.....	50
7.3	PHOTOGRAPHIC REPORTING DATA SHEETS	51
7.4	ACCEPTANCE OF COMPLETED COMPONENTS.....	51
7.5	FINAL DOCUMENTATION	51
7.6	DOCUMENT CONTROL AND STORAGE.....	52

List of Exhibits

Geosynthetics Received Log

1 INTRODUCTION

This Preliminary Construction Quality Assurance (CQA) and Inspection Plan has been prepared by SCS Engineers (SCS) for evaluating the construction of landfill cell floor area and slope base liners and partial final cover systems at the Sonoma County Central Disposal Site, Sonoma County, California. Specifically, this CQA plan provides guidance for testing and inspection of: (1) the capillary break/underdrain layer, low-permeability compacted soil layer, geosynthetic clay liner (GCL), geomembrane liner, geocomposite layer, geotextile, leachate collection and recovery system (LCRS), sideslope/compost deck barrier and operations layer components of new base liners for areas of future waste placement at Landfill 1 and Landfill 2; and (2) foundation layer, geomembrane liner, geocomposite and vegetative layer for partial final closure of the “Front Face” area of Landfill 1. A final CQA Plan shall be prepared for each specific landfill capital improvement construction project undertaken at the facility.

This CQA Plan sets forth responsibilities and procedures to evaluate fulfillment of applicable requirements of: Title 27; California Code of Regulations administered by the CalRecycle, and the California Regional Water Quality Control Board, North Coast Region (NCRWQCB).

Implementation of this plan will aid the Sonoma County Department of Transportation and Public Works (OWNER) in documenting that these additional containment and cover systems are constructed in accordance with the Construction Documents and will provide protection to human health and the environment.

The CQA plan addresses the capillary break/underdrain layer, low-permeability compacted soil layer, GCL, geomembrane liner, geocomposite layer, geotextile, LCRS, operations layer, foundation layer, and vegetative layer as separate construction activities.

The design for the Landfill 1 (Rock Extraction Area) containment system consists of the following from top to bottom:

- 24-inch soil operations layer;
- 10-oz. nonwoven geotextile;
- 12-inch LCRS granular layer;
- 12-oz. nonwoven geotextile;
- 60-mil HDPE geomembrane (primary membrane);
- Geocomposite drainage layer;
- 60-mil HDPE geomembrane (secondary membrane);
- Geosynthetic clay liner;
- 12-inch low-permeability compacted soil liner layer;
- Minimum 24-inch compacted foundation soil;
- Underdrain geocomposite on side slopes (10-oz. nonwoven geotextile on containment floor);
- Underdrain drainage material and subdrain collection trench (on containment floor);
- 10-oz. nonwoven geotextile (on containment floor); and,
- Prepared subgrade.

The design for the Landfill 1 partial final cover consists of the following, from top to bottom:

- 18-inch vegetative layer;
- Geocomposite drainage layer;
- 60-mil HDPE geomembrane; and
- 24-inch foundation layer.

The design of the preferential pathway barrier system (barrier system) for areas where additional waste will be placed over Landfill 1 sideslopes or top deck areas will consist of the following, from top to bottom:

- 24-inch soil operations layer;
- 10-oz. nonwoven geotextile;
- 6-inch granular drainage layer;
- 10-oz non-woven geotextile; and,
- 12-inch interim cover layer.

The design for the Landfill 2 floor area containment system consists of the following, from top to bottom:

- 24-inch soil operations layer;
- 10-oz. nonwoven geotextile;
- 12-inch LCRS granular layer;
- 12-oz. nonwoven geotextile;
- 60-mil HDPE geomembrane (primary membrane);
- Geocomposite drainage layer;
- 60-mil HDPE geomembrane (secondary membrane);
- Geosynthetic clay liner;
- 12-inch low-permeability compacted soil liner layer;
- 10-oz. nonwoven geotextile;
- 12-inch capillary break/underdrain layer;
- 10-oz. nonwoven geotextile; and
- Prepared subgrade.

The CQA plan is divided into the following sections:

- 1 Introduction
- 2 Definitions
- 3 Personnel Qualifications and Organization
- 4 Project Meetings
- 5 Inspection Activities
- 6 Testing Strategies
- 7 Documentation

2 DEFINITIONS

This section provides definitions of terms used in this Construction Quality Assurance Plan.

2.1 CONSTRUCTION QUALITY ASSURANCE OFFICER

- The Construction Quality Assurance (CQA) Officer will be a party independent from the OWNER and the Contractor and is under contract with the OWNER to provide testing and construction quality assurance services for the closure of the landfill. Testing will be the responsibility of the CQA Officer and will be performed by an approved commercial soils and geosynthetic testing laboratories.
- The CQA Officer is responsible for issuing a final construction report, certified by a professional engineer registered in the State of California.

Other major duties and responsibilities of the CQA Officer are:

- Review of all design plans and specifications for accuracy and completeness;
- Instruction of CQA Monitors in CQA requirements and procedures pertaining to construction of the containment feature components, including capillary break/underdrain layer, low-permeability compacted soil layer, GCL, geomembrane liner, geocomposite layer, geotextile, LCRS, operations layer, foundation layer, and vegetative layer;
- Preparation of a schedule of CQA inspection activities and coordination of CQA Monitors necessary for conducting inspections;
- Review and interpretation of all data and reports prepared by CQA Monitor;
- Identification of work that would be either accepted or rejected based on observations or test results. The CQA Officer may require special testing, inspection, or approval in areas of questionable quality or deviations from the Construction Documents;
- Familiarization with the Contractor's work schedule and work phases; and
- Attendance at all pre-construction and construction problem or deficiency meetings;

2.2 CONSTRUCTION QUALITY ASSURANCE MONITOR

- The CQA Monitor works under the supervision and guidance of the CQA Officer.
- The CQA Monitor will perform on-site inspections of the containment feature components, including capillary break/underdrain layer, low-permeability compacted soil layer, GCL, geomembrane liner, geocomposite layer, geotextile, LCRS, operations layer, foundation layer, and vegetative layer during installation and evaluate whether the work meets requirements of the Construction Documents.

The CQA Monitor will perform various tests and observations during construction activities such as:

- Regularly documenting proper calibration of all testing equipment;

- Accurately recording all test data and organizing all test data in a manner which allows reference for the CQA Officer;
- Evaluating the Contractor's construction quality control plan to ensure that it meets or exceeds the CQA Plan requirements;
- Becoming familiar with the Contractor's work schedule and phasing of work; and
- Reporting to the CQA Officer observations and test results as the work progresses.

2.3 CONTRACTOR

- Party or parties entering into a contract with the OWNER to perform the work specified in the Construction Documents. The Contractor may, at his or her own expense, provide testing during construction to supplement the CQA Officer's testing program.

2.4 OWNER

- OWNER is the Sonoma County Department of Transportation and Public Works, or duly authorized representative.

2.5 OPERATOR

- OPERATOR is Republic Services, Inc., or duly authorized representative.

2.6 DESIGN ENGINEER

- SCS Engineers (SCS), preparer of the preliminary design for landfill containment features as presented in the Revised Joint Technical Document for Sonoma County Central Disposal Site (dated February, 2011). The OWNER may engage other qualified individuals or firms to serve as DESIGN ENGINEER for preparation of Construction Documents for each capital improvement project.

2.7 CAPILLARY BREAK/UNDERDRAIN LAYER

- Granular drainage material that will meet the size and permeability requirements of the Specifications. The capillary break/underdrain layer is a minimum of 12-inches thick. The capillary break/underdrain layer is intended to properly convey groundwater in a manner that will limit erosion and ballooning to the landfill base liner floor area containment system(s).

2.8 LOW-PERMEABILITY COMPACTED SOIL LAYER

- A layer of natural low-permeability soil or natural low-permeability soil mixed with bentonite. The soil must consist of relatively homogenous fine-grained soils which are free of debris, foreign objects, and organics. The layer must have a minimum thickness of 12-inches and must achieve a maximum hydraulic conductivity of 1×10^{-7} cm/sec.

2.9 GEOSYNTHETIC CLAY LINER

- A manufactured product of bentonite between two geotextiles that is stitched together to form a low permeability (1×10^{-9} cm/sec) layer that is used to replace a clay layer with a minimum hydraulic conductivity of 1×10^{-7} cm/sec.

2.10 GEOMEMBRANE

- A geosynthetic membrane with a nominal thickness of 60-mils and equivalent maximum permeability of 1×10^{-11} cm/sec. The geomembrane layer shall act as the primary barrier for containment of liquids from the waste materials, as defined in the Construction Documents.

2.11 GEOMEMBRANE MANUFACTURER

- The party who is responsible for the quality of the resin and production of the geomembrane rolls from resin. The manufacturer may also be responsible for transportation of the geomembrane rolls to the site.

2.12 GEOCOMPOSITE DRAINAGE LAYER

- A layer comprised of geotextile-geonet-geotextile. This layer acts as a leak detection component of the containment system that will channel leachate should a leak occur in the geomembrane liner.

2.13 GEOTEXTILE

- A manufactured drainage media that consists of a geotextile fabric, as defined in the Construction Documents.

2.14 GEOTEXTILE MANUFACTURER

- The party who is responsible for the quality of the production of the geotextile rolls. The manufacturer may also be responsible for transportation of the geotextile rolls to the site.

2.15 SAND DETECTION LAYER

- Sand layer with 1×10^{-3} cm/sec permeability. The detection layer is a minimum of 12-inches thick and is intended to collect and transport leakage through the primary liner components.

2.16 LEACHATE COLLECTION AND RECOVERY SYSTEM LAYER

- Gravel layer with 1 x 10⁻¹ cm/sec permeability. The LCRS layer is a minimum of 12-inches thick and is intended to collect and transport leachate that is released by the waste.

2.17 OPERATIONS LAYER

- A soil layer capable of protecting the geomembrane barrier and LCRS layers from damage caused by placement of waste. The operations layer is a minimum 24-inches thick.

2.18 FOUNDATION LAYER

- An earthfill layer with a minimum thickness of 24-inches will form the foundation layer for the Landfill 1 partial final cover system. The foundation layer may be constructed from native fill material provided that the material will meet the requirements of the specifications.

2.19 VEGETATIVE LAYER

- A soil or soil/compost layer capable of supporting vegetative growth, protecting the geomembrane barrier layer from damage caused by erosion, and providing stormwater runoff control. The vegetative layer on the Landfill 1 top deck areas shall be a minimum thickness of 18-inches.

2.20 INSTALLER

- The party who works for the OWNER and who is responsible for field handling, storing, placing, seaming, loading (against wind), anchoring, and other aspects of the HDPE geomembrane installation. The Installer may also be responsible for transportation of these materials to the site.

2.21 QUALITY ASSURANCE

- All planned and systematic actions necessary to provide assurance that the defined work will perform satisfactorily in service.
- All activities associated with correct performance of work, as well as verification and documentation of satisfactory completion of the work.

2.22 QUALITY CONTROL

- Those actions which provide a means of controlling and measuring the characteristics of the defined work as they relate to fulfillment of applicable established requirements.

2.23 REGULATORY AGENCIES

- Regulatory agencies involved with the project may include the California Regional Water Quality Control Board – North Coast Region, CalRecycle, and the Sonoma County Department of Health Services – Environmental Health Division, Local Enforcement Agency (LEA).

2.24 MATERIALS TESTING LABORATORY

- A commercial laboratory independent from the Contractor, and all Subcontractors, which has been approved by the OWNER, and specializes in the performance of soils and geosynthetic testing.

2.25 CONSTRUCTION DOCUMENTS

- Written and graphic documents for administering and communicating the design elements for a construction contract, including Pre-Bid Information, Forms for Bidding, Addendums, Contract Forms, Conditions of the Contract, Engineering Drawings and Technical Specifications.

3 PERSONNEL QUALIFICATIONS AND ORGANIZATION

The CQA team will consist of the following personnel:

3.1 CQA OFFICER

The CQA Officer will:

- Have formal academic training in civil engineering, or a closely related discipline;
- Have related experience in earthwork construction, landfill containment system and closure design and construction, and soils and geosynthetics testing;
- Be a registered civil engineer or engineering geologist in the State of California;
- Have practical, technical, and managerial experience that will allow the CQA plan to be properly implemented; and
- Be able to communicate effectively with the Contracting Officer, Design Engineers, Contractor, and Materials Testing Laboratory so that there will be a clear understanding of construction activities and the CQA Plan.

3.2 CQA MONITOR

The CQA Monitor will:

- Have formal training and practical experience in inspecting and testing construction work relative to earthwork construction, including conducting and recording inspection activities, preparing daily reports, and performing field testing.
- Possess knowledge required for specific field practices and construction techniques for landfill containment system and closure construction and all codes and regulations involving material handling, observation of testing procedures, equipment and reporting procedures.

3.3 CONTRACTOR

The Contractor shall:

- Be licensed in California as a Class A Hazmat Contractor for all work involving re-grading or hauling of in-place landfill waste materials (prior to placement of base liner, barrier and cover systems).
- Have practical and professional experience in landfill containment system and earthwork construction.
- Demonstrate the successful completion of at least three construction projects within the past three years involving the placement of landfill liner, barrier or cover systems to meet requirements of the permeability specifications.

- Submit a performance bond, if required by OWNER, as a guarantee that the work will be completed in a satisfactory manner.

The Contractor's site supervisor shall:

- Have formal training and practical experience in construction management; and
- Have specific knowledge of soil placement, equipment capabilities, dust and erosion control, soil compaction techniques, and preparation for geosynthetics placement.

4 PROJECT MEETINGS

Periodic meetings shall be held throughout the duration of the construction project to enhance communication between the OWNER, CQA Officer, CQA Monitor, Design Engineer, Installer, and the Contractor. These meetings will aid the organizations involved in construction activities in becoming familiar with facility design, construction procedures, and recent design changes, if any. Meetings to be conducted during closure activities are:

- Pre-Construction meetings
- Daily progress meetings
- Weekly progress meetings
- Problem or work deficiency meetings (as needed)

4.1 PRE-CONSTRUCTION MEETINGS

A Pre-Construction meeting will be held prior to the start of construction activity. Parties who should attend this meeting are: the OWNER, Design Engineer, CQA Officer and Monitor, Installer, and the Contractor. The purpose of this meeting will be to resolve any uncertainties regarding the Construction Document requirements, the CQA plan, and construction procedures. The meeting will cover the following:

- Each organization will be supplied with all relevant CQA documents and supporting information;
- The CQA Plan will be explained with respect to other sections of the Construction Documents;
- Any changes to the CQA Plan needed to meet or exceed the specified design will be identified;
- The responsibilities of each organization will be reviewed and discussed and proper lines of communication will be identified;
- Protocol for field observations and field tests;
- Protocol for all organizations for handling construction deficiencies, repair work, and retesting;
- Protocol for document reporting, handling, distribution, and storage during construction activities;
- Procedures to protect construction materials from adverse effects of weather during storage;
- Review of time schedule for all operations;
- A site walk-through to review storage locations for construction material, construction equipment, and inspection equipment.

The pre-construction meetings will be documented by the CQA Officer or Monitor and minutes will be transmitted to all parties.

4.2 DAILY PROGRESS MEETINGS

A progress meeting shall be held daily at the work area just before the beginning or after the end of work. At a minimum, parties attending the meeting should include the OWNER, the CQA Monitor, and the Contractor. The purpose of the meeting is to:

- Review the previous day's activities and accomplishments;
- Review the work location and activities for the day;
- Identify the Contractor's personnel and equipment assignments for the day;
- Discuss any potential construction problems;
- Define and discuss problems or deficiencies;
- Review alternative solutions; and
- Adopt plans to resolve the problems or deficiencies.

4.3 WEEKLY PROGRESS MEETINGS

A progress meeting will be held at the beginning or end of each week to review the previous week's activities or progress, discuss present and future work, and discuss any current or potential construction problems. The OWNER, CQA Officer and/or CQA Monitor, and Contractor shall attend. All weekly progress meetings will be documented by the CQA Officer or CQA Monitor and minutes transmitted to all parties.

4.4 PROBLEM OR WORK DEFICIENCY MEETINGS

Special meetings will be held when a problem or deficiency is occurring or is likely to occur. These meetings shall be attended by the OWNER, CQA Officer and CQA Monitor, and Contractor. The purpose of these meetings is to identify a problem or deficiency in the construction work, review alternative solutions, and select and implement a plan to resolve the problem or deficiency. The CQA Officer or CQA Monitor will document the meetings and transmit minutes to all parties.

5 CQA TESTING STRATEGIES

A field program is to be implemented during construction to verify that the various soil layer and liner systems meet the design requirements and are constructed or installed according to requirements of the Construction Documents. Testing strategies will be specified for the capillary break/underdrain layer, low-permeability compacted soil layer, GCL, geomembrane liners, geocomposite layers, geotextile liners, LCRS layer, operations layer, foundation layer, and vegetative cover layer construction, or installation activities as appropriate and described herein. All field sampling and tests will be conducted by the CQA Monitor.

5.1 CAPILLARY BREAK/UNDERDRANE LAYER TESTING

The capillary break/underdrain layer will be tested for consistency, minimum thickness, and final grade. The function of the capillary break/underdrain layer is to properly convey groundwater in a manner that will limit erosion and ballooning to the Landfill 1 and Landfill 2 floor area containment systems.

5.2 LOW-PERMEABILITY COMPACTED SOIL LAYER TESTING

The low-permeability compacted soil layer will be tested for consistency, minimum thickness, and final grade. The function of the low-permeability compacted soil layer is to provide a barrier between groundwater and the floor containment system. To accomplish this, the physical layer material will be compacted to the required strength and analyzed for conformation to the Construction Documents. The low-permeability layer material will be placed to achieve design grades and assure a minimum specified thickness in the layer. During the material placement operations, the CQA Monitor will visually examine the low-permeability layer material to verify the uniformity of the gradation and that excessive organic material, debris, or other deleterious materials are not present. The CQA Monitor will sample the low-permeability compacted soil layer material at a frequency of one sample per 250 cubic yards of material placed, or more frequently if there are indications that the material is not meeting the specification requirements. The samples will be forwarded to the Materials Testing Laboratory where the following tests will be performed:

- Moisture-density relationship test (ASTM D 1557).
- Particle size analysis (ASTM D 422).
- Soil classification (ASTM D 2487).

The CQA Monitor will review the moisture-density relationship test results and will determine the moisture content and soil density that provides 90 percent relative compaction for each grouping or classification of soils. The CQA Monitor will review the particle size analysis results for uniformity and to determine if the results meet the specification requirements. If the requirements are not met, the material will be rejected for use in the low-permeability compacted soil layer.

During construction, the density and moisture content of the low-permeability layer will be determined in accordance with ASTM D 6938 (Nuclear Method) at a minimum frequency of 1 test per 1,000 CY, with a minimum of 2 test per day. Density test quality assurance will be performed in accordance with ASTM D 1556 (Sand Cone) or tube method at a minimum

frequency of one test per 10 density tests, or 1 test per day, whichever is greater. Density tests will be considered as passing if the average of all density is 90 percent of maximum dry density or greater and no single test is below 88 percent of maximum dry density.

These tests will be scheduled by the CQA Officer and CQA Monitor on lifts that can practically be constructed over geomembrane and geotextile layers in consultation with the Contractor in order to minimize disruption of construction.

5.3 GEOSYNTHETIC CLAY LINER TESTING

The GCL will be tested for material conformance to the specification prior to deployment. In addition, GCL quality control certificates will be supplied by the GCL manufacture certifying that the GCL meets the specification requirements.

GCL seams will be visually observed by the CQA Monitor. A combination of observation and testing will provide a high level of confidence that the GCL will perform in accordance with the specifications.

5.4 GEOMEMBRANE LINER TESTING

The geomembrane will be tested for material conformance to the specification prior to deployment. In addition, geomembrane quality control certificates will be supplied by the geomembrane manufacture certifying that the geomembrane meets the specification requirements.

Geomembrane seams will be visually observed during the seaming process and all seams will be tested for seam continuity by non-destructive test methods. In addition, seams will be cut and removed for destructive testing at random locations and at locations selected by the CQA Monitor. The locations of destructive test samples will not be disclosed to the Contractor until the samples are cut and removed.

All test results will be reviewed by the CQA Monitor and CQA Officer. Areas where the test results indicate lack of seam continuity or seam strength shall be repaired in accordance with the specifications. This combination of observation and testing will provide a high level of confidence that the geomembrane will perform in accordance with the specifications.

5.5 GEOCOMPOSITE LAYER TESTING

Geocomposite is a layer comprised of geotextile-geonet-geotextile. The geocomposite will be tested for material conformance to the specification prior to deployment. In addition, geocomposite quality control certificates will be supplied by the geocomposite manufacture certifying that the geocomposite meets the specification requirements.

Geocomposite seams will be visually observed during the seaming process and all seams will be checked for seam continuity.

All test results will be reviewed by the CQA Monitor and CQA Officer. Areas where the test results indicate lack of seam continuity or seam strength shall be repaired in accordance with the

specifications. This combination of observation and testing will provide a high level of confidence that the geocomposite will perform in accordance with the specifications.

5.6 GEOTEXTILE LAYER TESTING

The geotextile will be tested for material conformance to the specification prior to deployment. In addition, geotextile quality control certificates will be supplied by the geotextile manufacture certifying that the geotextile meets the specification requirements.

Geotextile seams will be visually observed during the seaming process and all seams will be checked for seam continuity.

All test results will be reviewed by the CQA Monitor and CQA Officer. Areas where the test results indicate lack of seam continuity or seam strength shall be repaired in accordance with the specifications. This combination of observation and testing will provide a high level of confidence that the geotextile will perform in accordance with the specifications.

5.7 LEAK DETECTION LAYER TESTING

The detection layer will be tested for consistency, minimum thickness, and final grade. The function of the detection layer is to collect and transport leakage through the primary liner system components that allow its removal and disposal. Cleanliness and separation from the operations layer are important.

5.8 LEACHATE COLLECTION AND RECOVERY SYSTEM LAYER TESTING

The LCRS layer will be tested for consistency, minimum thickness, and final grade. The function of the LCRS layer is to collect and transport leachate to sump locations that allow its removal and disposal. Cleanliness and separation from the operations layer are important.

5.9 OPERATIONS LAYER TESTING

The Operations layer will be tested for consistency, minimum thickness, and final grade. The function of the operations layer is to protect the LCRS and HDPE geomembrane layers. Cleanliness and separation from the LCRS layer are important.

5.10 FOUNDATION LAYER TESTING

The function of the foundation layer is to provide a subgrade for placement of the geomembrane, geocomposite, and overlying vegetative layer that will result in a stable barrier over waste and partial final cover system and will bridge minor settlement. To accomplish this, the physical layer material can be compacted to provide the required strength. Foundation layer material will be placed over the existing waste material to achieve foundation layer design grades and assure a minimum 24-inch thickness in the layer. During the borrow and regrading operations, the CQA Monitor will visually examine the foundation layer material to verify the uniformity of the gradation and that excessive organic material, debris, or other deleterious materials are not present. The CQA Monitor will sample the foundation layer material at a frequency of one

sample per 5,000 cubic yards of material placed, or more frequently if there are indications that the material is not meeting the specification requirements. The samples will be forwarded to the Materials Testing Laboratory where the following tests will be performed:

- Moisture-density relationship test (ASTM D 1557).
- Particle size analysis (ASTM D 422).
- Soil classification (ASTM D 2487).

The CQA Monitor will review the moisture-density relationship test results and will determine the moisture content and soil density that provides 90 percent relative compaction for each grouping or classification of soils. The CQA Monitor will review the particle size analysis results for uniformity and to determine if the results meet the specification requirements. If the requirements are not met, the foundation layer material will be rejected for use in the foundation layer.

During construction, the density and moisture content of the foundation/low permeability layer will be determined in accordance with ASTM D 6938 (Nuclear Method) at a minimum frequency of 1 test per 1,000 CY, with a minimum of 2 test per day. Density test quality assurance will be performed in accordance with ASTM D 1556 (Sand Cone) or tube method at a minimum frequency of one test per 10 density tests, or 1 test per day, whichever is greater. Density tests will be considered as passing if the average of all density is 90 percent of maximum dry density or greater, and no single test is below 88 percent of maximum dry density.

These tests will be scheduled by the CQA Officer and CQA Monitor in consultation with the Contractor in order to minimize disruption of construction.

5.11 VEGETATIVE LAYER TESTING

The Vegetative layer will be tested for consistency, minimum thickness, and final grade. The function of the vegetative layer is to support vegetative growth, protect the geocomposite and geomembrane layers from damage caused by erosion, and provide stormwater runoff control. The vegetative layer on the Landfill 1 top deck areas shall be a minimum thickness of 18-inches.

6 INSPECTION ACTIVITIES

6.1 CAPILLARY BREAK/UNDERDRAIN LAYER

Capillary Break/Underdrain layer inspection activities will be performed by the CQA Monitor during construction of the layer. These activities are divided into pre-construction, construction, and post-construction activities.

The CQA Officer will conduct pre-construction training and information sessions with the CQA Monitor(s) to familiarize them with the specified design, inspection policies, and procedures.

6.1.1 Pre-construction

Pre-construction activities must be performed to provide an understanding of the work activities, design and construction requirements, material properties, and construction methods necessary to meet the design requirements prior to installation of the capillary break/underdrain layer. To accomplish this, a pre-construction meeting(s) will be held between the OWNER, the Design Engineer, the CQA Officer and CQA Monitor, and the Contractor (see Section 4.1). Capillary break/underdrain layer materials will be tested during placement and evaluated for performance properties. Construction procedures will be established with the goal of meeting or exceeding the design requirements.

Pre-construction activities of the CQA Officer and Monitor are:

- Review of all Construction Document sections associated with construction of the capillary break/underdrain layer.
- Review of the Contractor's work schedule.
- Inspection of the as-delivered and/or imported stockpiles for the capillary break/underdrain layer material for uniformity and the presence of unsuitable materials.
- Review of existing laboratory testing reports for the capillary break/underdrain layer materials (if available).
- Review of the construction methods and equipment to be used for placement of the capillary break/underdrain layer.

6.1.2 Construction

The CQA Officer and CQA Monitor will implement a CQA program to verify compliance with the requirements of the Construction Documents for the construction of the capillary break/underdrain layer. This program includes:

- Material testing
- Construction observation
- Construction testing

Activities associated with this program have been broken down into the following categories:

- Material conformance testing
- Capillary break/underdrain layer construction
- Repairs

6.1.2.1 Conformance Testing

The CQA Monitor will obtain one sample per 5,000 cy of capillary break/underdrain layer material placed, or more frequently based on visual material change. The sample size shall be two 5-gallon buckets or the equivalent volume in sample bags. The sample will be forwarded to the Materials Testing Laboratory for the following tests:

- Particle size analysis (ASTM D 422)
- Permeability analysis (ASTM D 2434)

The CQA Monitor will review the particle size analysis results for uniformity and to determine if the results meet the specification requirements. The CQA Monitor will report any nonconformance to the OWNER, the CQA Officer, and the Contractor. The locations and dates of all sampling will be recorded in the CQA Monitor's daily summary report.

6.1.2.2 Capillary Break/Underdrain Layer Construction

During construction of the capillary break/underdrain layer, the CQA Monitor shall:

- Observe all phases of the construction and document the Contractor's compliance or noncompliance with the approved construction procedures and Construction Documents.
- Observe and document that drainage materials are placed to the specified thickness.
- Record any damage to the capillary break/underdrain layer resulting from operation of equipment.

6.1.2.3 Repairs

Any areas of the capillary break/underdrain layer which have not been accepted by the CQA Monitor shall be repaired in accordance with the Construction Documents. The CQA Monitor shall locate and describe all repairs in the daily summary report. All repairs shall be observed by the CQA Monitor and accepted prior to the post-construction inspection of the capillary break/underdrain layer.

6.1.3 Post-construction

Upon completion of the capillary break/underdrain layer a post-construction inspection shall be conducted by the CQA Officer and CQA Monitor. The purpose of this inspection will be to identify those areas that require corrective attention by the Contractor. The CQA Officer and CQA Monitor will inspect the capillary break/underdrain layer for the following:

- Areas that are damaged.

- Areas that have been excessively eroded by rainfall or other means during the construction period or as a result of construction activities.
- Irregularities or protrusions in the capillary break/underdrain layer grade resulting from rocks (other than as specified), sticks, grade stakes, cracks, and excess material placement.
- Areas of drainage material/aggregate placement is less than the specified blanket thickness.
- Review of a construction record survey to verify design grades and slopes.

6.2 LOW-PERMEABILITY COMPACTED SOIL LAYER

Low-permeability compacted soil layer inspection activities will be performed by the CQA Monitor during construction of the layer. These activities are divided into pre-construction, construction, and post-construction activities.

The CQA Officer will conduct pre-construction training and information sessions with the CQA Monitor(s) to familiarize them with the specified design, inspection policies, and procedures.

6.2.1 Pre-construction

Pre-construction activities must be performed to provide an understanding of the work activities, design and construction requirements, material properties, and construction methods necessary to meet the design requirements prior to installation of the low-permeability compacted soil layer. To accomplish this, a pre-construction meeting(s) will be held between the OWNER, the Design Engineer, the CQA Officer and CQA Monitor, and the Contractor (see Section 4.1). Low-permeability compacted layer materials will be tested during placement and evaluated for performance properties. Construction procedures will be established with the goal of meeting or exceeding the design requirements.

Pre-construction activities of the CQA Officer and Monitor are:

- Review of all Construction Document sections associated with construction of the low-permeability compacted soil layer.
- Review of the Contractor's work schedule.
- Inspection of the stockpiles or borrow site of the low-permeability compacted soil layer material for uniformity and the presence of unsuitable materials.
- Review of existing laboratory testing reports for the low-permeability compacted soil layer materials (if available).
- Review of the construction methods and equipment to be used for placement of the low-permeability compacted soil layer.

6.2.2 Construction

The CQA Officer and CQA Monitor will implement a CQA program to verify compliance with the requirements of the Construction Documents for the construction of the low-permeability compacted soil layer. This program includes:

- Material testing
- Construction observation
- Construction testing

Activities associated with this program have been broken down into the following categories:

- Material conformance testing
- Low-permeability compacted soil layer construction
- Repairs

During construction of the low-permeability compacted soil layer, the CQA Monitor shall:

- Observe all phases of the construction and document the Contractor's compliance or noncompliance with the approved construction procedures and Construction Documents.
- Perform testing of the relative compaction and moisture content of lifts of the low-permeability soil that can be practically compacted over synthetic geomembrane and geotextile layers. Field density and moisture content tests by nuclear methods (ASTM D 6938) will be performed at a minimum frequency of one test per 250 cy of low-permeability compacted soil layer material placed, with a minimum of 2 tests per day being performed. The CQA Monitor will be required to pass or fail the compacted lift based on relative compaction percentage obtained by testing compared to the Specification requirements. For quality assurance of the density testing, an additional density test (Sand Cone, ASTM D 1556) will be performed at a minimum frequency of 1 test per day or 1 test per 10 density tests, whichever is greater. Low-permeability compacted soil layer density tests shall be identified as LPL-1, LPL-2, etc., with retests at failed locations identified as LPL-1A, LPL-1B, etc. Locations of all test locations shall be noted on the CQA Monitors daily summary report and on a master test location map. If the CQA Monitor cannot provide the necessary documentation to determine that the low-permeability compacted soil layer compaction is acceptable, the CQA personnel may require that the area(s) in question are proof rolled.

Record any damage to the low-permeability compacted soil layer or geosynthetic material layers resulting from operation of equipment.

6.2.2.1 Conformance Testing

The CQA Monitor will obtain one sample per 5,000 cubic yards (cy) of low-permeability compacted soil layer material placed, or more frequently based on visual soil change. The sample size shall be two 5-gallon buckets or the equivalent volume in sample bags. The sample will be forwarded to the Materials Testing Laboratory for the following tests:

- Particle size analysis (ASTM D 422)
- Soil classification (ASTM D 2487)
- Moisture-density relationship (compaction curve, ASTM D 1557)
- Hydraulic conductivity (ASTM D 5084)
- Adderberg limits (ASTM 4318)
- Permeability analysis (ASTM D 2434)

The CQA Monitor will review the moisture-density relationship test results and will determine the moisture content and soil density that provides 90 percent relative compaction for each grouping or classification of soils. The CQA Monitor will also review the particle size analysis results for uniformity and to determine if the results meet the specification requirements. The CQA monitor will also review relevant testing results to ensure that the material used in the low-permeability compacted soil layer meets all design requirements. The CQA Monitor will report any nonconformance to the County, the CQA Officer, and the Contractor. The locations and dates of all sampling will be recorded in the CQA Monitor's daily summary report.

6.2.2.2 Low-Permeability Compacted Soil Layer Construction

During construction of the low-permeability compacted soil layer, the CQA Monitor shall:

- Observe all phases of the construction and document the Contractor's compliance or noncompliance with the approved construction procedures and Construction Documents.
- Record any damage to the low-permeability compacted clay liner and geosynthetic layers resulting from operation of equipment.

6.2.2.3 Repairs

Any areas of the low-permeability compacted soil layer which have not been accepted by the CQA Monitor shall be repaired in accordance with the Construction Documents. The CQA Monitor shall locate and describe all repairs in the daily summary report. Repair procedures include:

- Proof rolling

All repairs shall be observed by the CQA Monitor and accepted prior to the post-construction inspection of the low-permeability compacted soil layer. Any area(s) that have been repaired will be retested by compaction testing, or other warranted testing methods, prior to acceptance by the CQA Monitor.

6.2.3 Post-construction

Upon completion of the low-permeability compacted soil layer a post-construction inspection shall be conducted by the CQA Officer and CQA Monitor. The purpose of this inspection will be to identify those areas that require corrective attention by the Contractor. The CQA Officer and CQA Monitor will inspect the low-permeability compacted soil layer for the following:

- Areas that are damaged.

- Areas that have been excessively eroded by rainfall or other means during the construction period or as a result of construction activities.
- Areas that may result in ponding.
- Irregularities or protrusions in the low-permeability compacted soil layer grade resulting from rocks, sticks, grade stakes, cracks, and excess material placement.
- Review of a construction record survey to verify design grades, low-permeability layer material thickness and slopes.

6.3 GEOSYNTHETIC CLAY LINER

GCL inspection activities will be performed by the CQA Monitor during construction of the layer. These activities are divided into pre-construction, construction, and post-construction activities.

The CQA Officer will conduct pre-construction training and information sessions with the CQA Monitor(s) to familiarize them with the specified design, inspection policies, and procedures.

6.3.1 Pre-construction

Pre-construction activities must be performed to provide an understanding of the work activities, design and construction requirements, material properties, and construction methods necessary to meet the design requirements prior to installation of the GCL. To accomplish this, a pre-construction meeting(s) will be held between the OWNER, the Design Engineer, the CQA Officer and CQA Monitor, and the Contractor (see Section 4.1). GCL materials will be tested prior to placement and evaluated for performance properties. Construction procedures will be established with the goal of meeting or exceeding the design requirements.

Pre-construction activities of the CQA Officer and Monitor are:

- Review Contractor Roll Deployment Plan.
- Review of all Construction Document sections associated with construction of the GCL liner layer.
- Review of the Contractor's work schedule.
- Review of existing laboratory testing reports for the GCL materials (if available).
- Review of the construction methods and equipment to be used for placement of the GCL.

6.3.2 Construction

The CQA Officer and CQA Monitor will implement a CQA program to verify compliance with the requirements of the Construction Documents for the construction of the GCL layer. This program includes:

- Material testing
- Construction observation
- Construction testing

Activities associated with this program have been broken down into the following categories:

- Material conformance testing
- GCL installation
- Repairs

6.3.2.1 Conformance Testing

The CQA Monitor will obtain one sample per 100,000 square feet (sf) of GCL material placed. The sample size shall be three feet for the width of the roll. The sample will be forwarded to the Materials Testing Laboratory for the following tests:

- ASTM D5890 – Swell Index
- ASTM D5261 – Mass/Area
- ASTM D5887 – Index Flux

The CQA Monitor will review the conformance test results to determine if the material meets the specifications. The CQA Monitor will report any nonconformance to the OWNER, the CQA Officer, and the Contractor.

6.3.2.2 GCL Construction

During construction of the GCL layer, the CQA Monitor shall:

- Observe all phases of the construction and document the Contractor's compliance or noncompliance with the approved construction procedures and Construction Documents.
- Record any damage to the GCL layer resulting from operation of equipment.
- Observe and document that panel overlap follows Construction Documents. Overlap is occurring in the proper direction and of proper length.

6.3.2.3 Repairs

Any areas of the GCL layer which have not been accepted by the CQA Monitor shall be repaired in accordance with the Construction Documents. The CQA Monitor shall locate and describe all repairs in the daily summary report. Repair procedures include:

- Place a piece of GCL over damaged areas that extends a minimum of 1-foot beyond the limit of damage.
- Add a bead of granular bentonite between the layers around the repair area.

All repairs shall be observed by the CQA Monitor and accepted prior to the post-construction inspection of the GCL.

6.3.3 Post-construction

Upon completion of the GCL layer a post-construction inspection shall be conducted by the CQA Officer and CQA Monitor. The purpose of this inspection will be to identify those areas that

require corrective attention by the Contractor. This will occur prior to placement of the geomembrane over the GCL layer. The CQA Officer and CQA Monitor will inspect the GCL layer for the following:

- Low spots or depressions that would cause water to pond on the landfill.
- Areas that are damaged or improperly placed.
- Areas that have been excessively eroded by rainfall or other means during the construction period or as a result of construction activities.
- Irregularities or protrusions in the GCL layer grade resulting from rocks, sticks, grade stakes, cracks beneath the layer.
- Review of a construction record survey to verify design grades and slopes.

6.4 GEOMEMBRANE LINER

The geomembrane installation will be performed by the OWNER'S third party Installer and inspection activities will be performed by the CQA Officer and Monitor for the duration of the installation of the geomembrane. In the Landfill 1 and Landfill 2 floor area containment systems, primary and secondary geomembrane liners will be installed above and below the geocomposite drainage layer, respectively. The geomembrane will be installed above the foundation layer in the Landfill 1 partial final cover system. These activities are divided into pre-construction and post-construction activities.

The CQA Officer will conduct pre-construction training and information sessions with the CQA Monitor(s) to familiarize them with the specified design, inspection policies, and procedures.

6.4.1 Pre-construction

Pre-construction activities for the geomembrane installation will be performed to provide an understanding of the work activities, design and construction requirements, material properties, and installation methods that will meet the design requirements prior to installation of the geomembrane installation. To accomplish this, a pre-construction meeting(s) will be held between the OWNER, the Design Engineer, the CQA Officer and Monitor, and the Installer (see Section 4.1). Geomembrane quality control submittals will be reviewed for conformance of the specifications. Construction details will be discussed and methods of deployment, seaming, and testing will be finalized.

Pre-construction activities of the CQA Officer and Monitor include:

- Review all design criteria, construction plans, and specifications associated with installation of the geomembrane.
- Review Installer's work schedule.
- Look for inconsistencies in the construction plans, specification, and construction methods.
- Become familiar with the site and materials which are to be used in installation of the geomembrane.

- Review and approve the installation methods and equipment to be used for placement and seaming of the geomembrane.
- Review and approval of Installer's quality control submittals for conformance to the specifications requirements.
- Review and approval of Installer's Quality Assurance Manual for conformance to the specification requirements and accepted industry practices.
- Review and approval of the Panel Deployment Plan, panel and seam numbers, location of field seams, boot details, etc.

6.4.2 Construction

The CQA Officer and Monitor will implement a CQA program to verify compliance with the requirements of the specifications and construction plan for the testing of the geomembrane. This program includes:

- Material conformance testing
- Construction testing
- Construction observation

Activities associated with this program have been broken down into the following categories:

- Delivery
- Conformance testing
- Geomembrane installation
- Geomembrane seaming
- Nondestructive seam testing
- Destructive seam testing
- Repairs

6.4.2.1 Delivery

The CQA Monitor shall verify the following:

- Equipment used to unload the rolls will not damage the geomembrane.
- Care is used to unload the rolls.
- All documentation required by the specification has been received.
- Receipt of the geomembrane has been documented.

At the CQA Monitor's discretion damaged rolls may be rejected and shall be removed from the site or stored at a location, separate from accepted rolls, designated by the OWNER. All rolls which do not have proper manufacturer's documentation shall also be stored at a separate location until all documentation has been received and approved.

6.4.2.2 Conformance Testing

After delivery, unless otherwise specified, the CQA Monitor shall obtain one geomembrane sample per 100,000 square feet of geomembrane delivered, or one sample per lot, whichever

results in the greater number of conformance tests. The sample shall be forwarded to the Materials Testing Laboratory for the following tests:

- Specific Gravity (ASTM D 792 Method A)
- Carbon black content (ASTM D 1603)
- Thickness (ASTM D 1593)
- Tensile characteristics (ASTM D 638)

Where optional procedures are noted in the test method, the specification requirements shall prevail. The CQA Monitor will review all test results and shall report any nonconformance to the OWNER, CQA Officer, Installer, and to the Contractor.

The sample shall be taken across the entire roll width and shall not include the first 3 feet. Unless otherwise specified, samples shall be 3 feet long by the roll width. The CQA Monitor shall mark the machine direction, the manufacturer's roll identification number, and the date the sample was obtained.

6.4.2.3 Geomembrane Installation

Prior to geomembrane installation, the CQA Monitor shall verify that:

- All lines and grades have been verified by a qualified surveyor.
- The underlying soil, GCL, or geocomposite drainage layer has been prepared in accordance with the construction plans and specifications.
- The surface has been rolled and compacted to be free of surface irregularities, loose soil, and protrusions.
- The underlying soil, GCL, or geocomposite drainage layer surface does not contain stones which could damage the geomembrane.
- There are no excessively soft areas which could result in geomembrane damage.
- All construction stakes and hubs have been removed and the underlying layer repaired as necessary.
- The Contractor has certified, in writing, that the surface on which the geomembrane will be installed is acceptable.

The Installer shall give each panel an identification number which shall be agreed to and used by the OWNER, the CQA Monitor, and the Contractor. The CQA Monitor shall establish a chart showing correspondence between roll numbers, certification reports, and panel numbers. The Monitor shall document the panel number, roll number, date placed, panel dimensions, and other pertinent information.

During panel placement, the CQA Monitor shall:

- Observe the panel surface as it is deployed and record all panel defects and disposition of the defects (panel rejected, patch installed, extrudate placed over the defect, etc.) All repairs are to be made in accordance with the specifications.

- Verify that equipment used does not damage the panel by handling, trafficking, leakage of hydrocarbons, or by other means.
- Verify that the surface beneath the panel has not deteriorated since previous acceptance.
- Verify there are not stones, construction debris, or other items beneath the panel which could cause damage.
- Observe that the panel is not dragged across an unprotected surface. If the panel is dragged across an unprotected surface, the panel shall be inspected for scratches and repaired or rejected, if necessary.
- Record weather conditions including temperature, wind, and humidity. The panel shall not be deployed in the presence of excess moisture (fog, dew, mist, etc.)
- Verify that people working on or near the panel do not smoke, wear shoes which could damage the panel, or engage in activities which could damage the panel.
- Verify that the method used to deploy the panel minimizes wrinkles and that the panels are anchored to prevent movement by the wind. Do not specify anchorage methods (the Installer is responsible for any damage resulting to the panel from improper anchoring).

The CQA Monitor shall inform the OWNER, CQA Officer, Installer, and the Contractor if the above conditions are not met.

The Installer shall provide the OWNER and CQA Monitor with a seam and panel layout drawing, and is responsible for updating this drawing daily as the job proceeds. No panel shall be seamed until the panel layout drawing has been approved by the CQA Officer. A seam numbering system shall be agreed to by the CQA Monitor, OWNER, and Installer prior to the start of seaming operations. One procedure is to identify the seam by adjacent panels (i.e., the seam located between panel 55 and 110 would be Seam No. 55/110).

Prior to seaming, each welder and seaming apparatus shall be tested in accordance with specification to determine if the equipment is functioning properly. The CQA Monitor shall observe all seaming operations, quantitatively test each trial weld, and document the results. It is very important that the weld be completed under conditions similar to those under which the panels will be seamed. If at any time the CQA Monitor believes that an OWNER or seaming apparatus is not functioning properly, a weld test shall be performed. If there are large changes in temperature, humidity, or wind speed, the test should be repeated.

During seaming operations the CQA Monitor shall verify:

- The Installer has the number of seamers and spare parts agreed to in the pre-construction meeting.
- Equipment used for seaming does not damage the geomembrane.
- The extruder is purged prior to beginning a seam until all the heat-degraded extrudate is removed (extrusion welding only).

- Seam grinding has been completed less than 1 hour before seam welding (extrusion welding only).
- Seam edges are beveled and grind marks are perpendicular to the seam (extrusion welding only).
- Grind marks do not extend more than 1/4 inch from the edge of the panel to be seamed.
- The ambient temperature measured within 6 inches of the geomembrane surface is between 40 and 104 degrees Fahrenheit, unless otherwise approved in writing by the CQA Officer.
- The end of old welds (more than 5 minutes old) are ground to expose new material before restarting a weld (extrusion welding only).
- The weld is free of dust and other debris.
- The cross seams, the seam is ground to a smooth incline prior to welding (fusion welding only).
- The seams are overlapped a minimum of 3 inches for extrusion welding and 4 inches for fusion welding.
- No solvents or adhesives are present in the seam area unless written approval has been received from the CQA Officer.
- The procedure used to temporarily hold the panels together does not damage the panels and does not preclude nondestructive or destructive testing.
- The panels are being seamed in accordance with the construction plans and specifications.

6.4.2.4 Non-destructive Seam Testing

The Installer will test all seams non-destructively over their full length using a vacuum test unit. Double fusion seams will be non-destructively tested using an air pressure test or other approved method. The non-destructive tests will be completed to verify the continuity of the seams. Non-destructive testing will be conducted concurrently with the seaming scope of work and will not be completed at the completion of field seaming activities. Non-destructive testing will only occur between sunrise and sunset, unless the Installer demonstrates the ability to complete the testing outside of this timeframe with CQA Officer approval. Non-destructive seam testing will conform the following method:

- Geomembrane seam evaluation by vacuum chamber (ASTM D 5641).

During nondestructive test operations, the CQA Monitor shall:

- Record and observe all continuity testing
- Record the location, date, test number, technician name, and results of all testing.
- Mark the location of any defects requiring repairs.

- Mark the failed areas with a waterproof marker compatible with the liner (spray painting should not be used), and inform the Installer and the OWNER of any required repairs.
- Verify that all testing is completed in accordance with the specifications.
- Verify that all repairs are completed and tested in accordance with the specifications.

6.4.2.5 Destructive Seam Testing

Destructive seam tests will be performed at selected intervals, at least one test per 500 lineal feet. However, the CQA Monitor shall perform additional tests if he or she suspects the seam may not meet specification requirements. Reasons for performing additional tests may include:

- Wrinkling in seam area.
- Suspect seaming equipment.
- Adverse weather conditions (wind, temperature, moisture).
- Possibility of dirt in the seam.
- Failing tests.

Destructive tests are performed to evaluate seam strength and to estimate long-term performance. Destructive testing shall be performed concurrently with seaming operations, not at the completion of the installation.

There are two types of destructive tests completed during the liner installation: 1) peel and shear; and 2) microtomes. The purpose of the peel and shear tests, which are required, is to evaluate seam strength and to evaluate long-term performance. Microtome testing consists of analyzing a thin-slice section of the seam to be analyzed under a microscope for holes, cracks, or other types of voids in material. The microtomes are performed, if necessary, to aid in evaluating potential seam defects or high seam tests failure rates.

The CQA Monitor shall select locations where seam samples will be cut for laboratory testing. These locations shall be established as follows:

- A minimum of one test per 500 lineal feet of seam length. This is an average frequency for the entire installation; individual samples may be taken at greater or lesser intervals.
- A maximum frequency shall be agreed to by the Contractor, Installer, CQA Officer and Monitor, and the OWNER at the pre-construction meeting. However, if the number of failed samples exceeds 5 percent of the tested samples, this frequency may be increased at the discretion of the CQA Officer. The testing frequency may also be increased at the CQA Monitor's discretion if seam test values are marginal and there is reason to suspect seaming related problems. Samples taken as the result of failed tests do not count toward meeting the minimum frequency requirements for seam testing.
- Test locations shall be determined at the CQA Monitor's discretion. Locations shall not be selected prior to welding. Locations selected may be prompted by liner distortion due to overheating, weld contamination, or any potential cause of poor welds.

The Installer shall not be informed in advance of the destructive sample locations. Samples shall be removed by the Installer at locations identified by the CQA Monitor.

The CQA Monitor shall:

- Observe sample cutting.
- Mark each sample with an identifying number which contains the seam number.
- Record the sample location, sample number, and date sample was taken, weather conditions, and reason sample was taken (e.g.; random sample, visual appearance, result of a previous failure, etc.).

Two types of samples shall be taken at each location. First, 2 seam samples, 1 inch wide by 12 inches long with the seam centered across the length shall be taken 42 inches apart. These samples shall be tested in the field by the CQA Monitor using a tensiometer capable of quantitatively measuring shear and peel strengths. If one or both of the samples fails, the Installer can, at his or her discretion: (1) reconstruct the seam between passed test locations; or (2) take another test sample 10 feet from the point of the failed test in each direction and repeat this procedure. If the second test passes, the Installer can either reconstruct or cap strip the seam between the two passed test locations¹. If subsequent tests fail, the procedure is repeated until the length of the poor quality seam is established. Repeated failures indicate that either the seaming equipment and/or operator is not performing properly, and appropriate action should be taken.

Once the field tests have passed, a sample shall be recovered from between passing field sample locations for Material Testing Laboratory testing. The sample shall be 42 inches long by 12 inches wide, with the seam centered along the length. The recovered sample shall be divided into three parts: one 12-inch by 12-inch section shall be given to the Installer, one 12-inch by 18-inch sample shall be sent to the Material Testing Laboratory for testing, and one 12-inch by 12-inch sample shall be given to the OWNER for archive storage.

If the laboratory test fails in either peel or shear, the Installer may either reconstruct the entire seam or additional samples may be recovered at least 10 feet from either side of the failed sample location for Material Testing Laboratory testing. Sample size and disposition shall be as described in the preceding paragraph. This process shall be repeated until passed tests bracket the failed seam section. All seams shall be bounded by locations from which passing Material Testing Laboratory tests have been taken. In cases involving more than 50 feet of reconstructed or cap stripped seam, the reconstructed or cap stripped seam must also be tested. Ultimate acceptance of seams shall be based on test results from the Materials Testing Laboratory. In no case shall field testing of installed seams be used for final acceptance.

Destructive samples shall be shipped by the CQA Monitor to the Materials Testing Laboratory on the same day the sample is recovered. Testing shall include seam strength (ASTM D 3083) and peel (ASTM D 41). At least 5 specimens shall be tested in peel and 5 specimens in shear. At

¹ When a wedge welder is used and (1) there is at least a 1-inch-wide strip outside the wedge weld, (2) there is no evidence of overheating of the wedge weld, and (3) the wedge weld passes the shear test, the Installer may extrusion weld the flap left from the fusion weld, thus creating a new seam. The extrusion weld must conform to the specifications. CQA should include vacuum testing and may include destruction testing.

least 4 of the 5 specimens tested by each method must meet the minimum test values presented in the specification. The Material Testing Laboratory shall provide test results within 24 hours in writing or via telephone conversation with the CQA Monitor. Certified test results are to be provided within 3 days. The CQA Monitor shall immediately notify the Installer in the event of a failed test. Higher than normal failure rates (in excess of 5 percent of tested samples or successive test failures) shall be reported to the CQA Officer. No area, except as necessary to provide wind protection or to prevent water from getting under the geomembrane, are to be covered prior to receiving test results.

6.4.2.6 Electronic Leak Detection

Electronic leak detection will be performed at across all layers of geomembrane liner. Electronic leak detection testing is to be performed to evaluate proper liner construction and liner integrity.

Prior to commencement of the leak location survey, the leak detection consultant shall submit a Work Plan to the CONTRACTOR. The Work Plan shall include the qualifications of the proposed leak detection consultant including the number of years the leak detection consultant has performed the proposed survey method. The Leak Location Survey Work plan will also include a description of the proposed survey method, procedures, site preparations, estimated duration of survey, and quality control and field calibration procedures.

The leak detection shall be completed by a consultant with qualifications and experience in conducting geoelectric surveys including having tested a minimum of 10,000,000 square feet of geomembrane liner and a minimum of 5,000,000 square feet of the proposed survey method on at least five projects. In addition, the leak location survey shall be supervised by a professional or technician with a minimum of 2,000,000 square feet of liner testing experience using the proposed method on at least three projects.

6.4.2.7 Repairs

Any portion of the geomembrane with a flaw or which fails a nondestructive or destructive test shall be repaired in accordance with the Specifications. The CQA Monitor shall locate and describe all repairs. Repair procedures include:

- Patching - used to repair large holes, tears, large panel defects, and destructive sample locations.
- Extrusion - used to repair small defects in the panels and seams where welds cannot be nondestructively tested.
- Capping - used to repair failed welds or to cover seams where welds cannot be nondestructively tested.
- Removal - used to replace areas with large defects where the preceding methods are not appropriate. Also used to remove excess material (wrinkles) from the installed geomembrane.

Placement of cover materials over the geomembrane, temperature changes, or creep may cause wrinkles to develop in the geomembrane. Any wrinkles which can fold over shall be repaired either by cutting out excess material or, if possible, allowing the liner to contract due to

temperature reduction. In no case shall material be placed over the geomembrane which could result in the geomembrane folding.

6.4.3 Post-construction

Upon completion of the geomembrane installation, a post-construction inspection will be conducted of the completed geomembrane liner by the CQA Officer and Monitor to identify those areas that require corrective attention by the Installer. The CQA Officer and Monitor will inspect the geomembrane liner for the following:

- Low spots or depressions that would cause water to pond.
- Areas that are damaged or have wrinkles or folded material.

6.5 GEOCOMPOSITE LAYER

Geocomposite is a layer comprised of geotextile-geonet-geotextile. Geocomposite installation will be performed by the Contractor and the inspection activities will be performed by the CQA Officer and Monitor during the installation of the geocomposite. These activities have been divided into pre-construction, construction, and post-construction activities.

The CQA Officer will co-conduct pre-construction training and information sessions with the CQA Monitor to familiarize them with the specific design, inspection policies, and procedures.

6.5.1 Pre-construction

Pre-construction activities for the geocomposite must be performed to provide an understanding of the work activities, design and construction requirements, material properties, and installation methods that will meet the design requirement prior to full production of the geocomposite installation. To accomplish this, a pre-construction meeting(s) will be held between the OWNER, the Design Engineer, CQA Officer and Monitor, and the Contractor (see Section 4.1). Geocomposite quality control submittals will be reviewed for conformance to the specifications. Construction details will be discussed and methods of deployment, seaming, and repairs will be finalized.

Pre-construction activities of the CQA Officer and Monitor include:

- Review all design criteria, construction plans, and specifications associated with the geocomposite installation.
- Review Contractor's work schedule.
- Look for inconsistencies in the construction plans, specifications, and construction methods.
- Become familiar with the site and materials which are to be used in the installation of geocomposite.
- Review and approve the installation method and equipment to be used for placement and seaming of the geocomposite.

- Review and approval of the Contractor's quality control submittals for conformance to the specification requirements.

6.5.2 Construction

The CQA Officer and Monitor will implement a CQA program to verify compliance with the requirements of the specification and construction plans for the installation, seaming and repair of the geocomposite. This program includes:

- Material conformance testing.
- Construction observation.

Activities associated with this program have been broken down into the following categories:

- Delivery.
- Conformance testing.
- Geocomposite installation.
- Repairs.

6.5.2.1 Delivery

The CQA Monitor shall verify the following:

- Equipment is used to unload the rolls will not damage the geocomposite.
- Care is used to unload the rolls.
- All documentation required by the specification has been received.
- Receipt of the geocomposite has been documented.

Any damaged rolls shall be rejected and removed from the site or stored at a location, separate from accepted rolls, designated by the OWNER. All rolls which do not have proper manufacturer's documentation shall also be stored at a separate location until all documentation has been received and approved.

6.5.2.2 Conformance Testing

After delivery, the CQA Monitor shall obtain one geocomposite sample per 50,000 square feet of geocomposite (geotextile and geonet) delivered, or one sample per lot, whichever results in the greater number of conformance tests. The geotextile portion of the sample shall be forwarded to the Materials Testing Laboratory for the following tests:

- Thickness (ASTM D1777).
- Puncture resistance (ASTM D3738).
- Weight (ASTM D3766).

The geonet portion of the sample shall be forwarded to the Materials Testing Laboratory for the following tests:

- Tensile characteristics (ASTM D638).

Where optional procedures are noted in the test method, the specification requirements shall prevail. The CQA Monitor will review all test results and shall report any nonconformance to the OWNER, CQA Officer, and to the Contractor.

Samples shall be taken across the entire roll width and shall not include the first 3 feet. Unless otherwise specified, samples shall be 3 feet long by the roll width. The CQA Monitor shall mark the manufacturer's roll identification number, machine direction, and date sampled on the sample.

6.5.2.3 Geocomposite Installation

Prior to geocomposite installation, the CQA Monitor shall verify that:

- All lines and grades used have been verified by a qualified surveyor.
- The geocomposite has been installed in accordance with the specification and all portions of the geocomposite installation, including all required documentation, has been completed.
- The geocomposite surface does not contain stones which could damage the geotextile, GCL, or the geomembrane.

During geocomposite placement, the CQA Monitor shall:

- Observe the geocomposite as it is deployed and record all defects and disposition of the defects (panel rejected, patch installed, etc.). All repairs are to be made in accordance with the specifications.
- Verify that equipment used does not damage the geocomposite by handling, trafficking, leakage of hydrocarbons, or by other means.
- Verify that people working on the geocomposite do not smoke or wear shoes that could damage the geocomposite.
- Verify that the geocomposite is anchored to prevent movement by the wind (the Contractor is responsible for any damage resulting to the geocomposite from improper anchoring).

The CQA Monitor shall inform the OWNER, CQA Officer and the Contractor if the above conditions are not met.

During geocomposite placement, the Monitor shall verify:

- The geonet and geotextile seams are overlapped a minimum of 6 inches.
- The geonet will be secured by tying with nylon cable ties, metallic devices will not be used. Tying will occur every 5 feet or less along the slope, every 1 foot or less across the slope, and every 6 inches or less in any anchor trench, or at the minimum frequencies described in the specification
- The panels are being joined in accordance with the plans and specifications.
- The sewing apparatus used to sew the geotextile panels together does not damage the underlying geomembrane.

6.5.2.4 Repairs

Repair procedures include:

- Patching - used to repair holes, tears, and defects.
- Removal - used to replace areas with large defects where the preceding method is not appropriate.

Specific repair procedures shall be outlined in the Project Specifications, and will be specific to the geocomposite materials to be employed. .

6.5.3 Post-construction

Upon completion of the geocomposite installation, a post-construction inspection will be conducted of the completed geocomposite layer by the CQA Officer and Monitor to identify those areas that require corrective attention by the Contractor. The CQA Officer and Monitor will inspect the geocomposite layer for the following:

- Areas that are damaged or have wrinkles or folded material.
- Presence of any protruding objects that may tear the geocomposite or underlying geomembrane.
- Presence of dirt or construction debris beneath the geocomposite.
- Areas that have loose seams.

6.6 GEOTEXTILE LAYER

Geotextile installation will be performed by the Contractor and the inspection activities will be performed by the CQA Officer and Monitor during the installation of the geotextile layers. These activities have been divided into pre-construction, construction, and post-construction activities.

The CQA Officer will co-conduct pre-construction training and information sessions with the CQA Monitor to familiarize them with the specific design, inspection policies, and procedures.

6.6.1 Pre-construction

Pre-construction activities for the geotextile must be performed to provide an understanding of the work activities, design and construction requirements, material properties, and installation methods that will meet the design requirement prior to full production of the geotextile installation. To accomplish this, a pre-construction meeting(s) will be held between the OWNER, the Design Engineer, and CQA Officer and Monitor, and the Contractor (see Section 4.1). Geotextile quality control submittals will be reviewed for conformance to the specifications. Construction details will be discussed and methods of deployment, seaming, and repairs will be finalized.

Pre-construction activities of the CQA Officer and Monitor include:

- Review all design criteria, construction plans, and specifications associated with the geotextile.
- Review Contractor's work schedule.
- Look for inconsistencies in the construction plans, specifications, and construction methods.
- Become familiar with the site and materials which are to be used in the installation of geotextile layers.
- Review and approve the installation method and equipment to be used for placement and seaming of the geotextile layers.
- Review and approval of the Contractor's quality control submittals for conformance to the specification requirements.

6.6.2 Construction

The CQA Office and Monitor will implement a CQA program to verify compliance with the requirements of the specification and construction plans for the installation, seaming and repair of the geotextile. This program includes:

- Material conformance testing.
- Construction observation.

Activities associated with this program have been broken down into the following categories:

- Delivery.
- Conformance testing.
- Geotextile installation.
- Repairs.

6.6.2.1 Delivery

The CQA Monitor shall verify the following:

- Equipment is used to unload the rolls will not damage the geotextile.
- Care is used to unload the rolls.
- All documentation required by the specification has been received.
- Receipt of the geotextile has been documented.

Any damaged rolls shall be rejected and removed from the site or stored at a location, separate from accepted rolls, designated by the OWNER. All rolls which do not have proper manufacturer's documentation shall also be stored at a separate location until all documentation has been received and approved.

6.6.2.2 Conformance Testing

After delivery, the CQA Monitor shall obtain one geotextile sample per 50,000 square feet of geotextile delivered, or one sample per lot, whichever results in the greater number of conformance tests. The sample shall be forwarded to the Materials Testing Laboratory for the following tests:

- Thickness (ASTM D1777).
- Puncture resistance (ASTM D3738).
- Weight (ASTM D3766).

Where optional procedures are noted in the test method, the specification requirements shall prevail. The CQA Monitor will review all test results and shall report any nonconformance to the OWNER, CQA Officer, and to the Contractor.

Samples shall be taken across the entire roll width and shall not include the first 3 feet. Unless otherwise specified, samples shall be 3 feet long by the roll width. The CQA Monitor shall mark the manufacturer's roll identification number, machine direction, and date sampled on the sample.

6.6.2.3 Geotextile Installation

Prior to geotextile installation, the CQA Monitor shall verify that:

- All lines and grades used have been verified by a qualified surveyor.
- The geotextile has been installed in accordance with the specification and all portions of the geotextile installation, including all required documentation, has been completed.
- The geotextile surface does not contain stones which could damage the geotextile or the geomembrane.

During geotextile placement, the CQA Monitor shall:

- Observe the geotextile as it is deployed and record all defects and disposition of the defects (panel rejected, patch installed, etc.). All repairs are to be made in accordance with the specifications.
- Verify that equipment used does not damage the geotextile by handling, trafficking, leakage of hydrocarbons, or by other means.
- Verify that people working on the geotextile do not smoke, or wear shoes that could damage the geotextile or underlying geomembrane materials.
- Verify that the geotextile is anchored to prevent movement by the wind (the Contractor is responsible for any damage resulting to the geotextile from improper anchoring).

The CQA Monitor shall inform the OWNER, CQA Officer and the Contractor if the above conditions are not met.

During geotextile placement, the Monitor shall verify:

- The seams are overlapped a minimum of 6 inches.
- The panels are being joined in accordance with the plans and specifications.
- The sewing apparatus used to sew the panels together does not damage the underlying geomembrane.

6.6.2.4 Repairs

Repair procedures include:

- Patching - used to repair holes, tears, and defects.
- Removal - used to replace areas with large defects where the preceding method is not appropriate.

Specific repair procedures shall be outlined in the Project Specifications.

6.6.3 Post-construction

Upon completion of the geotextile installation, a post-construction inspection will be conducted of the completed geotextile layer by the CQA Officer and Monitor to identify those areas that require corrective attention by the Contractor. The CQA Officer and Monitor will inspect the geotextile layer for the following:

- Areas that are damaged or have wrinkles or folded material.
- Presence of any protruding objects that may tear the geotextile or underlying geomembrane.
- Presence of dirt of construction debris beneath the geotextile.
- Areas that have loose seams.

6.7 LEAK DETECTION LAYER

Leak detection layer inspection activities will be performed by the CQA Monitor during construction of the layer. These activities are divided into pre-construction, construction, and post-construction activities.

The CQA Officer will conduct pre-construction training and information sessions with the CQA Monitor(s) to familiarize them with the specified design, inspection policies, and procedures.

6.7.1 Pre-construction

Pre-construction activities must be performed to provide an understanding of the work activities, design and construction requirements, material properties, and construction methods necessary to meet the design requirements prior to installation of the Leak Detection layer. To accomplish this, a pre-construction meeting(s) will be held between the OWNER, the Design Engineer, the CQA Officer and CQA Monitor, and the Contractor (see Section 4.1). Leak Detection layer

materials will be tested during placement and evaluated for performance properties. Construction procedures will be established with the goal of meeting or exceeding the design requirements.

Pre-construction activities of the CQA Officer and Monitor are:

- Review of all Construction Document sections associated with construction of the Leak Detection layer.
- Review of the Contractor's work schedule.
- Inspection of the imported stockpiles for the Leak Detection layer material for uniformity and the presence of unsuitable materials.
- Review of existing laboratory testing reports for the Leak Detection layer materials (if available).
- Review of the construction methods and equipment to be used for placement of the Leak Detection layer.

6.7.2 Construction

The CQA Officer and CQA Monitor will implement a CQA program to verify compliance with the requirements of the Construction Documents for the construction of the Leak Detection layer. This program includes:

- Material testing
- Construction observation
- Construction testing

Activities associated with this program have been broken down into the following categories:

- Material conformance testing
- Leak Detection layer construction
- Repairs

6.7.2.1 Conformance Testing

The CQA Monitor will obtain one sample per 2,500 cy of Leak Detection layer material placed, or more frequently based on visual material change. The sample size shall be two 5-gallon buckets or the equivalent volume in sample bags. The sample will be forwarded to the Materials Testing Laboratory for the following tests:

- Particle size analysis (ASTM D 422)
- Soil classification (ASTM D 2487)

The CQA Monitor will review the particle size analysis results for uniformity and to determine if the results meet the specification requirements. The CQA Monitor will report any nonconformance to the OWNER, the CQA Officer, and the Contractor. The locations and dates of all sampling will be recorded in the CQA Monitor's daily summary report.

6.7.2.2 Leak Detection Layer Construction

During construction of the Leak Detection layer, the CQA Monitor shall:

- Observe all phases of the construction and document the Contractor's compliance or noncompliance with the approved construction procedures and Construction Documents.
- Observe and document that the aggregate material thickness and drain piping are
- Observe that equipment and materials do not damage the underlying geomembrane liner during placement of aggregate.
- Record any damage to the Leak Detection layer resulting from operation of equipment.

6.7.2.3 Repairs

Any areas of the Leak Detection layer which have not been accepted by the CQA Monitor shall be repaired in accordance with the Construction Documents. The CQA Monitor shall locate and describe all repairs in the daily summary report. All repairs shall be observed by the CQA Monitor and accepted prior to the post-construction inspection of the Leak Detection layer.

6.7.3 Post-construction

Upon completion of the Leak Detection layer a post-construction inspection shall be conducted by the CQA Officer and CQA Monitor. The purpose of this inspection will be to identify those areas that require corrective attention by the Contractor. The CQA Officer and CQA Monitor will inspect the Leak Detection layer for the following:

- Areas that are damaged.
- Areas that have been excessively eroded by rainfall or other means during the construction period or as a result of construction activities.
- Irregularities or protrusions in the Leak Detection layer grade resulting from rocks (other than as specified), sticks, grade stakes, cracks, and excess material placement.
- Review of a construction record survey to verify design grades and slopes.

6.8 LEACHATE COLLECTION AND RECOVERY SYSTEM LAYER

LCRS layer inspection activities will be performed by the CQA Monitor during construction of the layer. These activities are divided into pre-construction, construction, and post-construction activities.

The CQA Officer will conduct pre-construction training and information sessions with the CQA Monitor(s) to familiarize them with the specified design, inspection policies, and procedures.

6.8.1 Pre-construction

Pre-construction activities must be performed to provide an understanding of the work activities, design and construction requirements, material properties, and construction methods necessary to

meet the design requirements prior to installation of the LCRS layer. To accomplish this, a pre-construction meeting(s) will be held between the OWNER, the Design Engineer, the CQA Officer and CQA Monitor, and the Contractor (see Section 4.1). LCRS layer materials will be tested during placement and evaluated for performance properties. Construction procedures will be established with the goal of meeting or exceeding the design requirements.

Pre-construction activities of the CQA Officer and Monitor are:

- Review of all Construction Document sections associated with construction of the LCRS layer.
- Review of the Contractor's work schedule.
- Inspection of the imported stockpiles for the LCRS layer material for uniformity and the presence of unsuitable materials.
- Review of existing laboratory testing reports for the LCRS layer materials (if available).
- Review of the construction methods and equipment to be used for placement of the LCRS layer.

6.8.2 Construction

The CQA Officer and CQA Monitor will implement a CQA program to verify compliance with the requirements of the Construction Documents for the construction of the LCRS layer. This program includes:

- Material testing
- Construction observation
- Construction testing

Activities associated with this program have been broken down into the following categories:

- Material conformance testing
- LCRS layer construction
- Repairs

6.8.2.1 Conformance Testing

The CQA Monitor will obtain one sample per 2,500 cy of LCRS layer material placed, or more frequently based on visual material change. The sample size shall be two 5-gallon buckets or the equivalent volume in sample bags. The sample will be forwarded to the Materials Testing Laboratory for the following tests:

- Particle size analysis (ASTM D 422)
- Soil classification (ASTM D 2487)

The CQA Monitor will review the particle size analysis results for uniformity and to determine if the results meet the specification requirements. The CQA Monitor will report any

nonconformance to the OWNER, the CQA Officer, and the Contractor. The locations and dates of all sampling will be recorded in the CQA Monitor's daily summary report.

6.8.2.2 LCRS Layer Construction

During construction of the LCRS layer, the CQA Monitor shall:

- Observe all phases of the construction and document the Contractor's compliance or noncompliance with the approved construction procedures and Construction Documents.
- Observe and document that the aggregate material thickness and drain piping are
- Observe that equipment and materials do not damage the underlying geomembrane liner during placement of aggregate.
- Record any damage to the LCRS layer resulting from operation of equipment.

6.8.2.3 Repairs

Any areas of the LCRS layer which have not been accepted by the CQA Monitor shall be repaired in accordance with the Construction Documents. The CQA Monitor shall locate and describe all repairs in the daily summary report. All repairs shall be observed by the CQA Monitor and accepted prior to the post-construction inspection of the LCRS layer.

6.8.3 Post-construction

Upon completion of the LCRS layer a post-construction inspection shall be conducted by the CQA Officer and CQA Monitor. The purpose of this inspection will be to identify those areas that require corrective attention by the Contractor. The CQA Officer and CQA Monitor will inspect the LCRS layer for the following:

- Areas that are damaged.
- Areas that have been excessively eroded by rainfall or other means during the construction period or as a result of construction activities.
- Irregularities or protrusions in the LCRS layer grade resulting from rocks (other than as specified), sticks, grade stakes, cracks, and excess material placement.
- Review of a construction record survey to verify design grades and slopes.

6.9 OPERATIONS LAYER

Operations layer inspection activities will be performed by the CQA Monitor during construction of the layer. These activities are divided into pre-construction, construction, and post-construction activities.

The CQA Officer will conduct pre-construction training and information sessions with the CQA Monitor(s) to familiarize them with the specified design, inspection policies, and procedures.

6.9.1 Pre-construction

Pre-construction activities must be performed to provide an understanding of the work activities, design and construction requirements, material properties, and construction methods necessary to meet the design requirements prior to installation of the operations layer. Special precautions will be undertaken to document that underlying geomembrane liner components are not damaged during operations layer construction. To accomplish this, a pre-construction meeting(s) will be held between the OWNER, the Design Engineer, the CQA Officer and CQA Monitor, and the Contractor (see Section 4.1). Operations layer materials will be tested during placement and evaluated for performance properties. Construction procedures will be established with the goal of meeting or exceeding the design requirements.

Pre-construction activities of the CQA Officer and Monitor are:

- Review of all Construction Document sections associated with construction of the Operations layer.
- Review of the Contractor's work schedule.
- Inspection of the stockpiles or borrow site of the operations layer material for uniformity and the presence of unsuitable materials.
- Review of existing laboratory testing reports for the operations layer materials (if available).
- Review of the construction methods and equipment to be used for placement of the operations layer.

6.9.2 Construction

The CQA Officer and CQA Monitor will implement a CQA program to verify compliance with the requirements of the Construction Documents for the construction of the operations layer. This program includes:

- Material testing
- Construction observation
- Construction testing
-

Activities associated with this program have been broken down into the following categories:

- Material conformance testing
- Operations layer construction
- Repairs

6.9.2.1 Conformance Testing

The CQA Monitor will obtain one sample per 5,000 cubic yards (cy) of operations layer material placed, or more frequently based on visual soil change. The sample size shall be two 5-gallon buckets or the equivalent volume in sample bags. The sample will be forwarded to the Materials Testing Laboratory for the following tests:

- Particle size analysis (ASTM D 422)
- Soil classification (ASTM D 2487)

The CQA Monitor will also review the particle size analysis results for uniformity and to determine if the results meet the specification requirements. The CQA Monitor will report any nonconformance to the OWNER, the CQA Officer, and the Contractor. The locations and dates of all sampling will be recorded in the CQA Monitor's daily summary report.

6.9.2.2 Operations Layer Construction

During construction of the operations layer, the CQA Monitor shall:

- Observe all phases of the construction and document the Contractor's compliance or noncompliance with the approved construction procedures and Construction Documents.
- Verify that equipment used for compaction is capable of achieving required compaction rates.
- Verify that material lift thicknesses adhere to Construction Documents.
- Observe operation of equipment and placement of material to ensure protection of underlying layer.
- Record any damage to the geotextile or LCRS layers resulting from operation of equipment.

6.9.2.3 Repairs

Any areas of the operations layer which have not been accepted by the CQA Monitor shall be repaired in accordance with the Construction Documents. The CQA Monitor shall locate and describe all repairs in the daily summary report. Repair procedures include:

- Proof rolling

All repairs shall be observed by the CQA Monitor and accepted prior to the post-construction inspection of the operation layer.

6.9.3 Post-construction

Upon completion of the operations layer a post-construction inspection shall be conducted by the CQA Officer and CQA Monitor. The purpose of this inspection will be to identify those areas that require corrective attention by the Contractor. The CQA Officer and CQA Monitor will inspect the operations layer for the following:

- Areas that are damaged.
- Areas that have been excessively eroded by rainfall or other means during the construction period or as a result of construction activities.
- Irregularities or protrusions in the operations layer grade resulting from rocks, sticks, grade stakes, cracks, and excess material placement.

- Review of a construction record survey to verify design grades, operations layer material thickness and slopes.

6.10 FOUNDATION LAYER

Foundation layer inspection activities will be performed by the CQA Monitor during construction of the foundation layer for both the barrier layer (refuse placement over slopes and decks) and Landfill 1 partial final cover. These activities are divided into pre-construction, construction, and post-construction activities.

The CQA Officer will conduct pre-construction training and information sessions with the CQA Monitor(s) to familiarize them with the specified design, inspection policies, and procedures.

6.10.1 Pre-construction

Pre-construction activities must be performed to provide an understanding of the work activities, design and construction requirements, material properties, and construction methods necessary to meet the design requirements prior to installation of the foundation layer. To accomplish this, a pre-construction meeting(s) will be held between the County, the Design Engineer, the CQA Officer and CQA Monitor, and the Contractor (see Section 4.1). Foundation layer materials will be tested during placement and evaluated for performance properties. Construction procedures will be established with the goal of meeting or exceeding the design requirements.

Pre-construction activities of the CQA Officer and Monitor are:

- Review of all Construction Document sections associated with construction of the foundation layer.
- Review of the Contractor's work schedule.
- Inspection of the stockpiles or borrow site of the foundation layer material for uniformity and the presence of unsuitable materials.
- Review of existing laboratory testing reports for the foundation layer materials (if available).
- Review of the construction methods and equipment to be used for placement of the foundation layer.

6.10.2 Construction

The CQA Officer and CQA Monitor will implement a CQA program to verify compliance with the requirements of the Construction Documents for the construction of the foundation layer. This program includes:

- Material testing
- Construction observation
- Construction testing

Activities associated with this program have been broken down into the following categories:

- Material conformance testing
- Foundation/bedding layer construction
- Repairs

6.10.2.1 Conformance Testing

The CQA Monitor will obtain one sample per 5,000 cubic yards (cy) of foundation layer material placed, or more frequently based on visual soil change. The sample size shall be two 5-gallon buckets or the equivalent volume in sample bags. The sample will be forwarded to the Materials Testing Laboratory for the following tests:

- Moisture-density relationship (compaction curve, ASTM D 1557)
- Particle size analysis (ASTM D 422)
- Soil classification (ASTM D 2487)

The CQA Monitor will review the moisture-density relationship test results and will determine the moisture content and soil density that provides 90 percent relative compaction for each grouping or classification of soils. The CQA Monitor will also review the particle size analysis results for uniformity and to determine if the results meet the specification requirements. The CQA Monitor will report any nonconformance to the County, the CQA Officer, and the Contractor. The locations and dates of all sampling will be recorded in the CQA Monitor's daily summary report.

6.10.2.2 Foundation Layer Construction

During construction of the foundation layer, the CQA Monitor shall:

- Observe all phases of the construction and document the Contractor's compliance or noncompliance with the approved construction procedures and Construction Documents.
- Perform testing of the relative compaction and moisture content of each lift of the compacted foundation/bedding layer. Field density and moisture content tests by nuclear methods (ASTM D 6938) will be performed at a minimum frequency of one test per 250 cy of foundation/bedding layer material placed, with a minimum of 2 tests per day being performed. The CQA Monitor will be required to pass or fail the compacted lift based on relative compaction percentage obtained by testing compared to the Specification requirements. For quality assurance of the density testing, an additional density test (Sand Cone, ASTM D 1556) will be performed at a minimum frequency of 1 test per day or 1 test per 10 density tests, whichever is greater. Foundation density tests shall be identified as FL-1, FL-2, etc., with retests at failed locations identified as FL-1A, FL-1B, etc. Locations of all test locations shall be noted on the CQA Monitors daily summary report and on a master test location map. If the CQA Monitor cannot provide the necessary documentation to determine that the foundation/bedding layer compaction is acceptable, the CQA personnel may require that the area(s) in question are proof rolled.
- Record any damage to the compacted foundation layer resulting from operation of equipment.

6.10.2.3 Repairs

Any areas of the foundation layer which have not been accepted by the CQA Monitor shall be repaired in accordance with the Construction Documents. The CQA Monitor shall locate and describe all repairs in the daily summary report. Repair procedures include:

- Excavation and recompaction of the area
- Proof rolling or overcompacting
- Placement of additional material to meet minimum thickness specifications.

All repairs shall be observed by the CQA Monitor and accepted prior to the post-construction inspection of the foundation layer.

6.10.3 Post-construction

Upon completion of the foundation layer a post-construction inspection shall be conducted by the CQA Officer and CQA Monitor. The purpose of this inspection will be to identify those areas that require corrective attention by the Contractor. This will occur prior to placement of the geomembrane over the foundation/bedding layer. The CQA Officer and CQA Monitor will inspect the foundation layer for the following:

- Low spots or depressions that would cause water to pond on the landfill.
- Areas that are damaged or improperly compacted.
- Areas that have been excessively eroded by rainfall or other means during the construction period or as a result of construction activities.
- Large irregularities or protrusions in the foundation/bedding layer grade resulting from rocks, sticks, grade stakes, cracks, and excess material placement.
- Review of a construction record survey to verify design grades and slopes.

The CQA Officer or CQA Monitor will also verify the foundation layer thickness for the areas of Landfill 1 where the foundation layer is placed over existing waste. The thickness in these areas will be verified by either coring or augering to the required depth.

6.11 VEGETATIVE LAYER

Vegetative layer inspection activities will be performed by the CQA Monitor during construction of that layer in the partial final cover system. These activities are divided into pre-construction, construction, and post-construction activities.

The CQA Officer will conduct pre-construction training and information sessions with the CQA Monitor(s) to familiarize them with the specified design, inspection policies, and procedures.

6.11.1 Pre-construction

Pre-construction activities must be performed to provide an understanding of the work activities, design and construction requirements, material properties, and construction methods necessary to meet the design requirements prior to installation of the vegetative layer. To accomplish this, a

pre-construction meeting(s) will be held between the OWNER, the Design Engineer, the CQA Officer and CQA Monitor, and the Contractor (see Section 4.1). Vegetative layer materials will be tested during placement and evaluated for performance properties. Construction procedures will be established with the goal of meeting or exceeding the design requirements.

Pre-construction activities of the CQA Officer and Monitor are:

- Review of all Construction Document sections associated with construction of the Vegetative layer.
- Review of the Contractor's work schedule.
- Inspection of the stockpiles, compost windrows, and/or borrow site of the vegetative layer material for uniformity and the presence of unsuitable materials.
- Review of existing laboratory testing reports for the vegetative layer materials (if available).
- Review of the construction methods and equipment to be used for placement of the vegetative layer.

6.11.2 Construction

The CQA Officer and CQA Monitor will implement a CQA program to verify compliance with the requirements of the Construction Documents for the construction of the vegetative layer. This program includes:

- Material testing
- Construction observation
- Construction testing

Activities associated with this program have been broken down into the following categories:

- Material conformance testing
- Vegetative layer construction
- Repairs

During construction of the vegetative layer, the CQA Monitor shall:

- Observe all phases of the construction and document the Contractor's compliance or noncompliance with the approved construction procedures and Construction Documents.
- Perform testing of the relative compaction and moisture content of each lift of the compacted vegetative layer. Field density and moisture content tests by nuclear methods (ASTM D 6938) will be performed at a minimum frequency of one test per 250 cy of vegetative layer material placed, with a minimum of 2 tests per day being performed. 85 percent relative compaction will be required for the vegetative layer. The CQA Monitor will be required to pass or fail the compacted lift based on relative compaction percentage obtained by testing compared to the Specification requirements. For quality assurance of the density testing, an additional density test

(Sand Cone, ASTM D 1556) will be performed at a minimum frequency of 1 test per day or 1 test per 10 density tests, whichever is greater. Vegetative layer density tests shall be identified as VL-1, VL-2, etc., with retests at failed locations identified as VL-1A, VL-1B, etc. Locations of all test locations shall be noted on the CQA Monitor's daily summary report and on a master test location map. If the CQA Monitor cannot provide the necessary documentation to determine that the vegetative layer compaction is acceptable, the CQA personnel may require that the area(s) in question are proof rolled.

- Record any damage to the compacted vegetative layer resulting from operation of equipment.

6.11.2.1 Conformance Testing--

The CQA Monitor will obtain one sample per 5,000 cubic yards (cy) of vegetative layer material placed, or more frequently based on visual material change. The sample size shall be two 5-gallon buckets or the equivalent volume in sample bags. The sample will be forwarded to the Materials Testing Laboratory for the following tests:

- Particle size analysis (ASTM D 422)
- Soil classification (ASTM D 2487)

The CQA Monitor will also review the particle size analysis results for uniformity and to determine if the results meet the specification requirements. The CQA Monitor will report any nonconformance to the OWNER, the CQA Officer, and the Contractor. The locations and dates of all sampling will be recorded in the CQA Monitor's daily summary report.

6.11.2.2 Vegetative Layer Construction

During construction of the vegetative layer, the CQA Monitor shall:

- Observe all phases of the construction and document the Contractor's compliance or noncompliance with the approved construction procedures and Construction Documents.
- Record any damage to the geocomposite or geomembrane layers resulting from operation of equipment.
- Observe disking of soil amendments and/or compost material to verify adequate mixing and sufficient depth.

6.11.2.3 Repairs

Any areas of the vegetative layer which have not been accepted by the CQA Monitor shall be repaired in accordance with the Construction Documents. The CQA Monitor shall locate and describe all repairs in the daily summary report. Repair procedures include:

- Proof rolling

All repairs shall be observed by the CQA Monitor and accepted prior to the post-construction inspection of the vegetative layer.

6.11.3 Post-construction

Upon completion of the vegetative layer a post-construction inspection shall be conducted by the CQA Officer and CQA Monitor. The purpose of this inspection will be to identify those areas that require corrective attention by the Contractor. The CQA Officer and CQA Monitor will inspect the vegetative layer for the following:

- Areas that are damaged.
- Areas that have been excessively eroded by rainfall or other means during the construction period or as a result of construction activities.
- Irregularities or protrusions in the vegetative layer resulting from unsuitable materials such as rocks, sticks, grade stakes, cracks, and excess material placement.
- Review of a construction record survey to verify design grades, material thickness and slopes.
- Proper use and application of any necessary soil amendments and/or compost material.

6.12 FINAL INSPECTION

After completion of all construction activities, a final inspection will be performed by the OWNER, the CQA Officer and CQA Monitor, and the Contractor. This inspection will review the previous construction activities and will address all repairs that were required and were completed. The final condition of the operations layer will be reviewed and a punchlist developed. Once all punchlist repairs are completed and all construction record documents are received and approved, each capital improvement project for Landfill 1 and Landfill 2, respectively, will be completed. A Final Report will be prepared using the construction reports, checklists, and test results as described in Section 7, Documentation, for submittal to the Contracting Officer and subsequent submittal to the regulatory agencies for review and approval.

7 DOCUMENTATION

Documentation of CQA activities will follow the same procedure for the capillary break/underdrain layer, low-permeability compacted soil layer, GCL layer, HDPE geomembranes, geocomposite layer, geotextile layers, LCRS layer, operations layer, foundation layer, and vegetative layer.

7.1 DAILY RECORD KEEPING AND REPORTING

A daily summary report will be prepared with supporting inspection data sheets and records of any problems that occur or corrective measure implemented throughout the day. The CQA Monitor will prepare a chronological daily summary report that includes the following:

- Date, name of project, and location;
- Weather and site conditions;
- Summary of any meetings conducted and the results of the meetings;
- Location of daily construction activities and progress;
- Record of equipment and personnel working in particular area;
- Location of work being tested and areas passing final inspection;
- Description of any materials received at the site and the condition in which they were received;
- Record of equipment calibrations or recalibrations of test equipment and any actions taken as a result of recalibration;
- Record of site visits by non-project persons with names and affiliations;
- Identification of construction problems and their solution or disposition; and
- Signature of CQA Monitor.

7.2 INSPECTION DATA SHEETS

All field observations and field testing will be recorded on the inspection data sheet. These sheets will be used to formulate the daily summary reports. All field testing will follow ASTM standardized test procedures and methods of data recording unless otherwise indicated in the specifications or construction plans. Observations in the field may take the form of notes, charts, drawings or sketches, photographs, or any combination of the above. The inspection data sheets will have the following information:

- Description and title of the inspection activity;
- Location of the inspection activity;
- Recorded observation and/or test data, having all calculations completed and checked;
- Comparison of test results and observations with specification requirements;
- Names and titles of all persons involved in the inspection activity;

- The recording of any material or workmanship which does not meet specified designs. All corrective action measures and the results will be recorded; and
- Signature of the CQA Monitor.

7.3 PHOTOGRAPHIC REPORTING DATA SHEETS

Color photographs will be taken during various stages of construction to help document field testing, construction activities and progress, and general inspection observations. Each photograph will have the following documentation:

- A document control number or identification which may be cross-referenced to inspection data sheets;
- The date, time, and location the photograph was taken;
- The size, scale, and orientation of the subject matter photographed, including the type of camera and lens size;
- Purpose of the photograph and a description of the work or subject matter seen. All photographs will be kept in chronological order in a protective file. The negatives or electronic disks will be stored in a separate file from the photographs.

The CQA Officer and/or CQA Monitor may supplement still photography with videos. The videos may be made on a routine basis and a narrative provided on the tape with the video. The video will serve as a pictorial record of work progress, problems, and corrective measures. The video tapes should be documented and stored in the same manner as the still photography.

7.4 ACCEPTANCE OF COMPLETED COMPONENTS

Daily inspection reports, inspection data sheets, and inspection still photographs and videos will be reviewed by the CQA Officer. All reports will be evaluated for internal consistency, accuracy, and completeness. These reports will be reviewed in a timely manner.

The above daily reports will be summarized into periodic acceptance reports. The reports will indicate that work has been completed and approved according to the specified design. These reports will be included in the project files and be available to the regulatory agencies, if requested.

7.5 FINAL DOCUMENTATION

At the completion of the construction activities, a Final Construction Report will be sent to the OWNER for submittal to the regulatory agencies. This report will include the following:

- Narrative, including, but not limited to:
 - Project description;
 - Project design team;
 - CQA personnel;
 - Contractor;
 - Installer;

Description of field inspection operations;
Unusual conditions;
Final quantities; and
Weather data (climatological data for the area as published by NOAA);

- Daily inspection summary reports;
- Inspection data sheets;
- Photographic reporting data sheets;
- Test results and locations;
- Acceptance reports;
- Deviations from design and material specifications (with justifying documentation);
- Construction record survey.

The CQA Officer will certify in writing that the capillary break/underdrain layer, low-permeability compacted soil layer, GCL, geomembrane layers, geocomposite layers, geotextile layers, LCRS layer, operations layer, foundation layer for the barrier and partial final cover systems, and vegetative layer were built or installed according to the Construction Documents, and approved modifications of the Specification as described in the Final Construction Report. This certification will be included in the final documentation sent to the OWNER for submittal to the regulatory agencies.

7.6 DOCUMENT CONTROL AND STORAGE

During construction the CQA Officer will be responsible for all CQA documents and organization of the documents for easy access. The CQA Officer will be responsible for keeping duplicate records for all documentation in another location. Furthermore, the CQA Officer will be responsible for incorporating any revisions to the CQA plan and distributing revised copies to the Contractors and all other relevant parties.

Upon completion of the construction, the Contracting Officer will store all original documents. These documents will be stored in such a manner that they are protected from damage yet easily accessed. All documentation will be maintained through the operating life and the postclosure monitoring periods of the facility.

EXHIBIT

GEOSYNTHETICS RECEIVED LOG

Project No. _____

Facility _____

Project _____

Date Rec'd	Roll #	Lot/ Batch	Roll	Size	Weight (Oz/Cu yd)	QC Docs Rec'd (Date)	QA Sample Sent (Date)	QA Test Rec'd P/F (Date)	Remarks
			L/W	Sq. Ft.					
Manufacturer: _____				Notes:				Prepared By: _____	
P=Pass F=Fail								Checked By: _____	