

Attachment VII

Construction Quality Assurance Plan

Solid Waste Permit #498
Bristol Integrated Solid Waste Management Facility
2655 Valley Drive
Bristol, VA 24201
(276) 645-7233

SCS ENGINEERS

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15521 Midlothian Turnpike Suite 305
Midlothian, VA 23113
804-378-7440

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1.0 INTRODUCTION

1.1 APPLICABLE UNITS

This Construction Quality Assurance (CQA) Plan is applicable to the Solid Waste Permit (SWP) #498 landfill (SWP498 landfill) at the City of Bristol, Virginia's (City's) Integrated Solid Waste Management Facility (ISWMF). Since no new cells are being constructed and the landfill is moving towards closure, this CQA Plan pertains to closure construction.

The plan covers earth materials and geosynthetics. The plan is intended to supplement, but not supersede, the plans and specifications. Where a conflict arises, the permit documents or approved plans and specifications will govern.

The plan stresses careful documentation during the entire quality assurance process, from the selection of materials through the protection from deleterious environmental conditions.

All parties involved in the project should receive a copy of this plan from the Owner, Project Manager or Engineer. They should also be given any other CQA documents specially prepared for or relevant to the project.

The overall goals of this program are to assure that proper construction techniques and procedures are used and to verify that the materials used meet the specifications. Additionally, the program will identify and define problems that may occur during construction and correct those problems before the construction is complete. At the completion of the work, the program requires certification reports indicating that the facility has been constructed in accordance with design standards and specifications. It is the responsibility of the certifying engineer(s) to prepare these reports.

1.2 KEY PERSONNEL

The organizations involved in the project include the Virginia Department of Environmental Quality, the City of Bristol (the Owner and operator), the Design Engineer, the QA Personnel, and the Contractor and subcontractors. Responsibilities of the principal organizations are described below.

1.2.1 Virginia Department of Environmental Quality

It is the responsibility of the Virginia Department of Environmental Quality (DEQ) to review the permit modification application, including this CQA Plan, for compliance with the regulations of the Commonwealth of Virginia and the United States Environmental Protection Agency. The DEQ will issue a permit modification for the facility upon completion of the review and necessary revisions to comply with the regulations.

1.2.2 City of Bristol

The City of Bristol, Virginia (Bristol), the Owner and Operator, is responsible for the design, construction, operation, and closure of the permitted facility. The Owner has ultimate responsibility for complying with the regulations of the DEQ and assuring that the landfill has been constructed in accordance with the plans and specifications. This is achieved through quality assurance efforts denoted herein, within the technical specifications, and in subsequent documentation.

The Owner is responsible for construction contract administration. The Owner shall be responsible for obtaining construction inspection services for specific construction items, such as soil testing and installation, and shall retain the services of a Consulting Engineer (Consultant) that is independent of other Contractors involved in the construction on the site, including earthwork Contractors and geomembrane installers. The quality assurance efforts performed by the Consultant are in addition to the quality control requirements implemented by others.

Prior to acceptance of wastes in each new cell, the Owner shall submit to the DEQ a certification from a professional engineer that the facility has been constructed in accordance with the approved plans and specifications and the QA report.

1.2.3 Design Engineer (Consultant)

The Design Engineer (also noted as the Engineer or Consultant herein and in the technical specifications), SCS Engineers, is responsible for the design of the landfill. During construction, these design responsibilities will include clarification or interpretation of the plans and changes necessitated by unforeseen site conditions. If the plan revisions are regulated by the DEQ, those revisions shall be subject to approval by the DEQ prior to acceptance by the Owner.

1.2.4 Quality Assurance Engineer

The following items describe the responsibility of the Quality Assurance Engineer (also noted as CQA Engineer in the technical specifications):

The Quality Assurance Engineer (QAE) shall be a registered professional engineer certified in the Commonwealth of Virginia and experienced in landfill construction. He shall be employed by the firm retained as the Consultant by the Owner. He shall have the responsibility to inform the Owner, Engineer, and Contractor of construction that does not meet the design specifications. Parties must agree on the actions needed to bring the construction into compliance with the specifications.

The QAE shall review the design plans and specifications for constructability and clarity. If the design or specifications are unclear to the QAE, he shall request in writing clarification from the Design Engineer.

The QAE shall be responsible for:

- Training the quality assurance officer (QAO) on requirements and procedures
- Scheduling and coordinating quality assurance activities
- Confirming that testing equipment, personnel, and procedures do not change over the length of the project without written documentation
- Confirming that test data are accurately documented
- Notify Owner of construction quality problems
- Recommends testing acceptance or rejection

The QAE shall inspect the site on a periodic basis and review test data and QAO logs in order to maintain control over the QA program. He shall respond promptly to items needing attention or approval in order to expedite work. He shall be responsible for the approval or disapproval of landfill construction work. Approval shall be based on conformance to the design specifications, conformance to the CQA Plan, and sound engineering judgment. In no case shall the QAE change or modify the landfill design prior to notifying the Engineer in writing of the specific changes or modifications.

The final construction documentation report will be prepared, signed and sealed by the Quality Assurance Engineer.

1.2.5 Quality Assurance Officer

The Quality Assurance Officer (QAO) shall be employed by the Consultant and answer directly to the Quality Assurance Engineer. The QAO shall be experienced in earthwork construction, inspection procedures, and be familiar with the tests, processes, and materials involved in the construction of solid waste disposal facilities. He shall provide on-site monitoring of appropriate construction operations and observe that Quality Control sampling, testing and reporting requirements are implemented by the QCO. Appropriate construction operations that will require continuous on-site monitoring include placement of the final cover system components. Other construction operations will require periodic monitoring.

The QAO shall maintain logs and test records and certificates on site in a well- organized, tabulated manner. QAO shall log appropriate construction operations, sampling, and testing. Appropriate construction operations that will require continuous logging include placement of GCL, geomembranes, and vegetative soil layers. Other construction operations will also require periodic logging. Copies of logs, test records and certificates shall be provided to the QAE for review. The QAO shall notify the QCO immediately of non-complying test results and shall be available to verify remediation and retesting of non-complying work. The QAO shall maintain an awareness of the project and detect conditions that may directly or indirectly jeopardize the integrity of the field testing.

The QAO shall verify that the equipment used in the testing meets the specification requirements and that the tests are conducted in accordance with the standard procedures specified.

1.2.6 Contractor and Quality Control Officer

The Contractor has the primary responsibility for ensuring that the landfill is constructed in accordance with the Contract Drawings and Specifications developed by the Engineer and approved by the permitting agency. Other responsibilities include the performance of all construction activities at the site including site facilities, administration, material purchasing, procurement, supervision, construction quality control, installation, construction surveying, and subcontracting. The Contractor is responsible for the protection of completed work until it is accepted by the Owner. The Contractor is also responsible for informing the Owner and Quality Assurance Consultants of the scheduling and occurrence of all construction activities. The Quality Control Officer (QCO), employed by the Contractor, shall be on site as required for representative testing and operational guidance. The QCO shall be responsible for the implementation of the quality control program.

1.2.7 Soils and Geosynthetics QA and QC Laboratories

The soils and geosynthetic QA and QC laboratories are agencies, independent from the Owner, Engineer, Contractor(s), Manufacturer, and Installer, responsible for conducting tests on samples of soils and geosynthetics taken from the site.

1.2.8 Geosynthetic Manufacturers

The geosynthetic manufacturers are responsible for the production of geosynthetic rolls from resin and other source materials.

1.2.9 Geosynthetic Installers

The Geosynthetic Installers are responsible for field handling, sorting, placing, seaming, loading (against wind), and other aspects of the geosynthetics installation, including geomembranes, geotextiles, and drainage geocomposites. The Installers are also responsible for transportation of these materials to the site. In addition, the Installers are responsible for the storage and protection of the materials once they arrive on site, until the final work is accepted.

1.2.10 QA and QC Surveyors

The QC Surveyor is employed by the Contractor and responsible for establishing and maintaining lines and grades and temporary benchmarks throughout all relevant areas of the construction site. The QA Surveyor will be employed by the Consultant and will issue a complete set of Record Drawings certified by a Professional Land Surveyor, licensed in the Commonwealth of Virginia. The Record Drawings will include the results of the confirmation surveying of the liner and final cover components.

2.0 EARTHWORK

2.1 CONSTRUCTION MATERIALS QUALITY CONTROL

2.1.1 Laboratory Testing – Soils

The Contractor shall provide personnel, materials, and equipment to determine field and laboratory density and permeability of soil materials in accordance with the QC program requirements. The Owner is responsible for and will provide Quality Assurance (QA), which will provide independent monitoring and verification of compliance with all construction requirements. See Section 31 00 00 (Earthwork) for additional requirements.

The following tests and minimum testing frequencies are required to be performed on soils being used for construction. Material shall be sampled from the site or taken from stockpiles in an accepted and representative manner.

- Moisture-Density Relationships shall be performed in accordance with ASTM D698 (standard Proctor) or ASTM D1557 (modified Proctor) as specified.
- Soil Classification tests shall include a sieve analysis (ASTM D422), a natural moisture content (ASTM D2216), and an Atterberg Limit determination (ASTM D4318). Soil classifications shall be performed in conjunction with a moisture-density relationship and whenever a change in material occurs.
- The Contractor can, at his own discretion and expense, perform additional ASTM Proctor Tests, with varying efforts, in order to establish a larger acceptable moisture-density region.

The minimum frequency of testing for borrow source and field testing shall be as follows:

Table 1. Soil Borrow Source Testing

Test	ASTM Designation or Other Test Method	Frequency
Grain Size Analysis	D6913 and D1140	1 per 10,000 cy
Natural Moisture Content	D2216	1 per 10,000 cy
Classification	D2487	1 per 10,000 cy
Atterberg Limits	D4318	1 per 10,000 cy
Moisture-Density Relationship	D698 or D1557	1 per 10,000 cy and changes in material
Hydraulic Conductivity*	D5084	1 per source and change in material

* For final cover layers with a permeability/hydraulic conductivity requirement

The CQO shall verify that the laboratory tests have been completed and met the intent of the specifications.

2.1.2 Field Testing – Soils and Road Aggregates

Table 2. Soil Field Testing

Test	ASTM Designation or Other Test Method	Frequency
Compacted Density	D6938, D1556, or D2937	1 per 90' x 90' grid per lift
Compacted Moisture Content	D6938 or D2216	1 per 90' x 90' grid per lift
Classification	D2487	1 per 10,000 cy
Atterberg Limits	D4318	1 per 10,000 cy
Compacted Density - Trench Backfill	D6938, D1556, or D2937	1 per 100 lineal ft per lift
Compacted Moisture Content - Trench Backfill	D6938 or D2216	1 per 100 lineal ft per lift
Backfill Placement	Observation	Continuous
Road Aggregates	D6938 or D2937	1 per 100 lineal feet of road, a minimum of 1 test per lift of select fill
GCL Subgrade/Bedding Layer Thickness	Observation, Field Measurement	200 ft x 200 ft grid
Protective cover/erosion control Layer Thickness	Observation, Field Measurement	Continuous
Vegetative Support Layer Thickness	Observation, Field Measurement	Continuous
Hydraulic Conductivity (For layers with permeability requirement)	ASTM D5084	1 per acre per lift, 3 per test pad

Notes:

- Every fifth sample tested with ASTM D6938 shall be verified by ASTM D1556, Sand Cone or ASTM D2937, Drive Cylinder unless Engineer specifies otherwise.
- Every fifth sample tested with ASTM D6938 shall be verified with ASTM D2216, Laboratory Determination of Water Content of Soil, Rock, and Soil-Aggregate Mixtures unless Engineer specifies otherwise.
- Test locations shall be identified by the Contractor by horizontal and vertical control and presented on drawing or sketch indicating dimensions.
- If a test fails to meet the required compaction level or moisture content, then the area represented by that test shall be reworked and retested at the Contractor's expense. Corrective measures shall be documented in the Quality Control and Quality Assurance reports.
- The Contractor shall plug test locations with a 50% final cover soil, 50% bentonite mixture compacted in 2" lifts to control leakage unless otherwise noted in the technical specifications.

2.2 CONSTRUCTION QUALITY ASSURANCE

2.2.1 Final Cover Foundation

The QAO shall include verification that an appropriate subgrade is established for final cover placement. This may include the placement and compaction of fill. The verification shall include the following:

- For final cover foundations, observations of the daily or intermediate cover layer for proper grading, soft spots, exposed waste or other conditions that could adversely affect the final cover material. Document the condition of the subgrade prior to final cover soil placement in writing. Photographs may be used as needed.
- Observations to verify the quality of compacted fill. Observe and document that Quality Control and Quality Assurance Testing was performed on compacted fill. Compile documentation of locations of QC/QA testing on compacted fill.
- Observations of stripping and excavation to verify that there are no moisture seeps and that soft, organic, or otherwise undesirable materials are removed. Proof-rolling with heavy equipment can be used to detect soft areas likely to cause settlement. Document in written form and photographs removal of undesirable materials.
- Observations to verify the removal of objects such as roots or objects that could penetrate the final cover.
- Observations to verify that the surface is properly compacted, smooth, uniform, and consistent with design grades. Document in written form and with photographs the surface of the final cover foundation.

2.2.2 Bedding Layer

The QAO shall include verification that the final cover bedding layer is placed in accordance with the CQA Plan and specifications. The verification shall include the following:

- Observations to verify the quality of compacted soils. Observe and document that testing was performed. Compile documentation of QC/QA testing including location information.
- Observations to verify the removal of objects such as roots or objects that could penetrate the final cover.
- Observations to verify that the surface is properly compacted, smooth, uniform, and consistent with design grades. Document in written form and with photographs the surface of the bedding layer is acceptable for placement of geosynthetics.

2.2.3 Final Cover Erosion Control and Vegetative Support Layers

The QAO shall include observation and verification that erosion control and vegetative support layers are properly placed on the drainage geocomposite layer for the final cover system. Depths shall be verified. The verification shall include the following:

- Measurements of the depth and slope of the excavation or fill to verify that it meets design requirements.
- Observations to verify the removal of objects such as roots or objects that could penetrate the geosynthetics.
- Observations to verify that the surface is properly compacted, smooth, uniform, and consistent with design grades. Document in written form and photographs the final surface.

2.3 TEST PAD

There is no soil liner proposed as part of landfill closure, therefore no test pad will be constructed.

2.4 SOIL LINER TESTING CERTIFICATION

There is no soil liner proposed as part of landfill closure, therefore no soil liner testing certification is required.

3.0 GEOMEMBRANES

3.1 GEOMEMBRANE MATERIALS QUALITY CONTROL

3.1.1 Manufacturing Quality Control (MQC)

Certification of geomembrane material shall be submitted by manufacturer prior to installation of material. Certification requirements are included in applicable specification sections.

Compound ingredients of the geomembrane materials shall be randomly sampled on delivery to the geomembrane manufacturing plant to verify compliance with specifications. The certification shall certify that the resin used are of the same type and meet the manufacturer's, and this project's, specified performance requirements. The geomembrane shall be manufactured from a first quality resin. Only one type of resin (one manufacturer, one resin classification) shall be used to manufacture geomembrane for this project.

See Section 31 05 19.16 (LLDPE Geomembrane Liner) for additional requirements.

3.1.2 Quality Assurance Observations

The QAO shall verify and document that material is certified by the manufacturer for geomembranes. The QAO shall verify and document that manufacturer's material property characteristics are in accordance with the technical specifications. The QAO shall verify and document that the manufacturer supplies finished product certification.

Manufacturer's certifications shall be compiled and tabulated by the QAO in the final QA documentation.

The QAO shall inspect and verify that the material is delivered, handled, and stored in accordance with the manufacturer's instructions. The QAO shall confirm that the rolls of material, when delivered, are protected with a covering material. Each roll shall be labeled identifying the name of

manufacturer, product type, thickness, length, width, and manufacturer's mark number. The roll shall also indicate the date, lot and batch number of the roll, the square feet in the roll, and the total roll weight as measured after manufacture. The QAO shall prepare a tabulation of roll information and include the tabulation with the manufacturer's data in the final QA report.

3.1.2.1 Frequencies

Perform MQC testing the following at the minimum frequencies specified in the applicable sections of the Technical Specifications:

- Thickness
- Tensile strength and elongation
- Puncture resistance
- Tear resistance
- Ply adhesion

3.1.2.2 Conformance Testing

The QAO shall collect samples of the materials for conformance testing. The QAO shall tabulate the results of the testing. The tabulated results shall be included with the testing data in the final QA report. Alternatively, the QAE may elect to have samples sent directly from the geosynthetics manufacturers to the QA testing laboratory.

3.1.2.2.1 Frequency

Conformance testing shall be performed once every 45,000 square feet, unless otherwise noted in the technical specifications.

3.1.2.3 Sample Collection

Samples shall be collected for conformance testing as follows:

The first three feet on selected rolls shall be used for conformance testing. The sample shall be taken across the entire width of the roll. The QAO shall randomly select the rolls used for conformance testing. If differing lot runs are identified by the manufacturer, the samples shall be taken to represent each lot.

Conformance testing shall include the minimum standards listed in Specification Section 31 05 19.16.

3.2 CONSTRUCTION QUALITY ASSURANCE

The geomembrane installer shall provide for field quality control testing of geomembranes used in the construction of the final cover. The installer shall employ on-site physical nondestructive testing on welds or seams to verify watertight homogeneous welds and strength of seams. Tests must include visual inspection of welds and seams. A detailed test protocol must be submitted for approval prior to installation of the geomembrane.

The installer's quality control technician shall inspect each weld or seam. Areas showing a defect shall be marked and repaired in accordance with applicable repair procedures.

The Owner or its representative reserves the right of access for inspection of this installation.

Contractor shall install geomembrane at a rate that does not exceed his capacity for patching and testing field welds each day. Patches and repairs shall be completed and tested (including visual, air pressure and vacuum) each day on the material installed. Destructive test samples shall be obtained daily on the material installed. The destructive test samples for the geomembrane shall be spaced at a maximum distance of 500 lineal feet.

Geomembrane shall not be installed when wind is great enough to get the geomembrane airborne or the air temperature is less than 33°F, unless otherwise authorized by the QAE.

The installer shall employ on-site physical nondestructive testing on welds to verify watertight homogeneous seams. The methods of testing considered shall be the vacuum box test, the air pressure test and the visual inspection. Tests must include visual inspection of seams. A detailed test protocol must be submitted for approval prior to installation of the final cover.

See Section 31 05 19.16 (LLDPE Geomembrane Liner) for additional requirements.

3.2.1 Quality Control Observations

3.2.2 Non-destructive Testing

3.2.2.1 Vacuum Testing

Vacuum testing shall be performed in accordance with Specification Section 31 05 19.16, LLDPE Geomembrane Liner, unless otherwise approved by the QAE and Engineer.

3.2.2.2 Air Testing

Air testing shall be performed in accordance with Specification Section 31 05 19.16, LLDPE Geomembrane Liner, unless otherwise approved by the QAE and Engineer.

3.2.3 Destructive Testing

Destructive testing shall be performed in accordance with Specification Section 31 05 19.16, LLDPE Geomembrane Liner, unless otherwise approved by the QAE and Engineer.

3.2.4 Inspection Activities

3.2.4.1 Placement

The QAO shall observe the placement of rolls of geomembrane. The QAO shall document placement and location of each roll of geomembrane. Documentation may be through verification of installer daily progress report and tabulation by the QAO of the daily progress reports, or by separate daily progress reports completed by the QAO. The QAO shall document weather conditions (temperature, humidity, precipitation, and wind) to verify that they are acceptable for geomembrane placement and seaming. The QAO shall observe, measure, and document construction of anchor trenches for compliance with plans. The QAO shall verify that trench corners are rounded to reduce stressing the geomembrane. The QAO shall verify backfilling of the anchor trenches as specified.

The QAO shall observe and document tests to confirm that penetrations, if any, and connections are installed as specified. Penetrations, if any, shall be verified for appropriate clamp use, for appropriate material, for good seaming, and for good housekeeping practices.

The QAO shall measure and confirm that required overlaps of adjacent geomembrane panels are achieved. The QAO shall verify that proper temporary anchorage is used (sand bags) and that the panel is placed in a non-stressed state.

The QAO shall visually inspect each panel for tears, punctures, and thin spots. Defects shall be marked on the geomembrane for repair.

3.2.4.2 Geomembrane Seams

The QAO shall inspect and document seaming operations to include:

- Observations to confirm that the geomembrane is free from dirt, dust, and moisture
- Observations to confirm that the seaming materials and equipment are as specified by the manufacturer
- Observations to verify that a firm foundation is available for seaming
- Observations of weather conditions to confirm that they are acceptable for seaming
- Measurements of temperatures, pressures, and speed of seaming, when applicable, to verify that they are as specified (e.g., gauges and dials shall be checked and reading recorded)
- Observations to verify that the geomembrane is not damaged by equipment or personnel during the seaming process.

The QAO shall verify that appropriate destructive and nondestructive tests are performed. The QAO shall verify that trial welds are conducted each day prior to geomembrane seaming. The QAO shall document that 100 percent of applicable seams are tested using nondestructive methods. The QAO shall verify and record that repairs are made in accordance with the specifications and repairs are retested. The QAO shall verify that destructive tests are conducted at the required frequency. The QAO shall require additional destructive tests in areas on contamination, visual variations, or other suspicious observations. The QAO shall document destructive test samples as to location, time, crew, and technique. The QAO shall prepare a tabulation of nondestructive and destructive testing. The tabulation shall be included with the QC testing in the final QA report.

Prior to placement of temporary covers, the QAO shall visually inspect the geomembrane for damage that may have occurred during installation. If damaged areas are located, they shall be marked and patched using approved repair methods. Repairs shall be nondestructively tested. The QAO shall document damaged areas and the repairs. The documentation shall be included in the final QA report.

3.2.4.3 Installer Experience Verification

The QAO shall verify and document that the installer meets the minimum project experience. Project experience listing shall include project name, location, Owner, Owner contact, Engineer, Engineer contact, product installed, amount of material installed, and date of installation.

The QAO shall verify that the installer has submitted a Quality Control Manual (QA) for installation of the material and shall approve the contents of the QA Manual. The QA Manual and the approval by the QAO or Engineer shall be included in the final QA documentation.

The QAO shall verify and approve the submittal by the installer of a proposed panel layout and installation details. The proposed panel layout and details, and the approval by the QAO or the Engineer, shall be included in the final QA documentation.

See Section 31 05 19.16 (LLDPE Geomembrane Liner) for experience requirements.

3.2.4.4 Damage

The QAO shall inspect the material to verify that it is not damaged and to confirm that damage is corrected. Damage may include:

- Puncture from nails or splinters
- Tears from operation of equipment or inadequate packaging
- Exposure to temperature extremes resulting in unusable material
- Blocking: the bonding together of adjacent geomembrane layers, which may be caused by excessive heat
- Crumpling or tearing from inadequate packaging support

When damage to a roll is observed by the QAO, the QAO shall carefully examine the underlying material for damage. If damage is extensive, the QAO shall reject the entire roll.

3.2.4.5 Protection from Weather

On-site storage shall be in a secure area with provisions from adverse weather. Geomembranes, geocomposites, GCL and geotextile materials shall be protected from:

- UV light
- Heavy winds or precipitation
- Temperature extremes
- Vandals

The QAO shall document damage and rejection/replacement of rolls.

3.2.4.6 Final cover Bedding

The QAO shall observe, verify, and document that the bedding layer for geosynthetic materials has been placed, compacted, and tested by the Contractor and has been accepted by the installer's representative. The QAO shall visually inspect the surface to confirm that it is free from clods of soil, rocks, roots, sudden or sharp changes of grade, and standing water.

4.0 GEOSYNTHETIC CLAY LINERS (GCLS)

Installation of geosynthetic clay layers (GCLs) is not intended at this time.

5.0 GEOSYNTHETIC DRAINAGE LAYERS

5.1 MATERIALS QUALITY CONTROL

5.1.1 Geotextile Fabrics

The QAO shall verify and document that material is certified by the manufacturer. The QAO shall verify and document that material property values meet the specifications. Quality control certificates shall be provided at the specified frequency and shall identify the related rolls of geotextile fabric. The QAO shall verify that the rolls are properly labeled.

5.1.2 Geocomposite Drainage Net

The QAO shall verify and document that material is certified by the manufacturer. The QAO shall verify and document that material property values meet the specifications. Quality control certificates shall be provided at the specified frequency and shall identify the related rolls of geocomposite. The QAO shall verify that the rolls are properly labeled.

5.1.3 Manufacturing Quality Control (MQC)

5.1.3.1 Geotextiles

Certification of geotextiles shall be submitted by the manufacturer prior to installation of material. Certification shall demonstrate that the property values of the material meet the project specifications and that adequate quality control measures have been implemented during the manufacturing process.

See Section 31 05 19.13 (Geotextile Fabrics) for additional requirements.

5.1.3.2 Geocomposite Drainage Net

Prior to installation of material, Contractor shall provide the QAO with quality control certifications for the drainage geocomposite. The certification shall demonstrate that the material meets the project specifications and that adequate quality control measures have been implemented during the manufacturing process.

See Section 31 05 19.26 (Drainage Geocomposites) for additional requirements.

5.1.3.3 Conformance Testing

The QAO shall collect samples of the materials for conformance testing. The QAO shall tabulate the results of the testing. The tabulated results shall be included with the testing data in the final QA report. Alternatively, the QAE may elect to have samples sent directly from the geosynthetics manufacturers to the QA testing laboratory.

5.1.3.3.1 Frequency

Conformance testing shall be performed once per 200,000 square feet, unless otherwise noted in the technical specifications.

5.1.3.4 Sample Collection

The first three feet on selected rolls shall be used for conformance testing. The sample shall be taken across the entire width of the roll. Samples shall not be taken from damaged material. The QAO shall randomly select the rolls used for conformance testing. If differing lot runs are identified by the manufacturer, the samples shall be taken to represent each lot.

Conformance testing shall include the minimum standards listed in Specification Section 31 05 19.26.

5.2 CONSTRUCTION QUALITY ASSURANCE

5.2.1 Geocomposite Drainage Net (GDN) Placement

The QAO shall observe the placement of rolls of GDN. The QAO shall document placement and location of the GDN. Documentation may be through verification of installer daily progress report and tabulation by the QAO of the daily progress reports, or by separate daily progress reports completed by the QAO. The QAO shall document weather conditions (temperature, humidity, precipitation, and wind) to verify that they are acceptable for GDN placement and seaming. The QAO shall observe, measure, and document construction of anchor trenches for compliance with plans. The QAO shall verify backfilling of the anchor trenches as specified.

The QAO shall observe and document tests to confirm that penetrations, if any, and connections are installed as specified.

The QAO shall measure and confirm that required overlaps of adjacent GDN panels are achieved. The QAO shall verify that proper temporary anchorage is used (sand bags) and that panel is placed in non-stressed state.

The QAO shall visually inspect each panel for tears, punctures, and thin spots. Defects shall be marked on the GDN for repair.

5.2.2 GDN Seaming

The QAO shall inspect and document seaming operations are conducted in accordance with the technical specifications and manufacturer's recommendations.

Prior to placement of material above the geocomposite, the QAO shall visually inspect the geocomposite for damage that may have occurred during installation. If damaged areas are located, they shall be marked and patched using approved repair methods. The QAO shall document damaged areas and the repairs. The documentation shall be included in the final QA report.

5.2.3 Damage

The QAO shall inspect the material to verify that it is not damaged and to confirm that damage is corrected. Damage may include:

- Puncture from nails or splinters
- Tears from operation of equipment or inadequate packaging
- Exposure to temperature extremes resulting in unusable material
- Blocking: the bonding together of adjacent geomembrane layers, which may be caused by

- excessive heat
- Crumpling or tearing from inadequate packaging support

When damage to a roll is observed by the QAO, the QAO shall carefully examine the underlying material for damage. If damage is extensive, the QAO shall reject the entire roll.

5.2.4 Protection from Weather

On-site storage shall be in a secure area with provisions from adverse weather. Geomembranes, geocomposites, GCL and geotextile materials shall be protected from:

- UV light
- Heavy winds or precipitation
- Temperature extremes
- Vandals

The QAO shall document damage and rejection/replacement of rolls.

6.0 GAS MANAGEMENT COMPONENTS

6.1 MATERIALS QUALITY CONTROL

Contractor shall provide submittals with certifications for piping and aggregates used in the system.

Contractor shall provide submittals for all components for gas collection system for review and acceptance by the Design Engineer.

6.2 CONSTRUCTION QUALITY ASSURANCE

CQA firm shall verify piping and aggregates meet the material specifications.

CQA firm shall observe and document drilling of boreholes and record depths.

CQA firm shall observe and document completion of the landfill gas system installation.

7.0 FINAL COVER SYSTEMS

In addition to the requirements outlined in sections 2.0 through 6.0, this section addresses other requirements of construction of the final cover system.

7.1 QUALITY ASSURANCE

Quality Assurance (QA) is defined as independent qualitative observations, monitoring and documentation to verify that the Quality Control (QC) program is implemented correctly.

The purpose of Quality Assurance is to establish standards that must be followed by the quality assurance personnel in order to confirm that the construction of the containment facility and its components meet the specifications given in the design. The principle objects of an effective Quality Assurance program include:

- Verification of the implementation of the QC program.
- Mitigation of potential long-term problems and failures.
- Documentation of construction and testing.
- Preservation of completed work during subsequent construction activities.

The principle methods with which objectives are achieved are as follows:

- Visual inspection of materials upon delivery to identify damaged materials, cross check lot numbers with manufacturer test data and obtain conformance test samples.
- Conformance testing of delivered materials to verify physical characteristics of material. Conformance testing should be completed prior to installation.
- Construction observation of installation and testing. On-site inspection to observe the QC program such as weld testing (destructive and nondestructive), maintaining record drawings, verifying patches and retests, and preparation of daily reports.
- Accountability of QC personnel. The QA program will require accountability of QC personnel by means of "signing off" on test sections and repaired sections.

7.2 QUALITY CONTROL

The CONTRACTOR is responsible for construction quality control (CQC or QC) and shall establish and maintain an effective quality control system in compliance with the Contract Documents. The construction quality control system shall consist of plans, procedures, tests and observation, and organization necessary to produce an end product which complies with the contract requirements. The system shall cover all construction and manufacturing operations, both on site and off site, and shall be keyed to the proposed construction sequence. The Quality Control Officer (QCO), employed by the Contractor, shall be on site as required for representative testing and operational guidance. The QCO shall be responsible for the implementation of the quality control program.

In accordance with the Specifications and CQA Manual, Contractor will be required, at a minimum, to provide, coordinate, and oversee QC materials testing, operational testing, and construction surveying.

The QC program shall consist of construction and administrative activities related to the Project to control the overall quality of the Project. Quality shall be defined as the level of effort, materials, means or methods used which meet the minimum requirements as specified in the Project Documents. Administrative items included in the QC program include project schedules, project submittals, schedule of values, field logs, and record drawings and surveys.

Minimum testing requirements are included in applicable specification sections. Tests that fail to comply with the minimum requirements shall be retested at the Contractor's expense. The Owner reserves the right to direct additional testing and sampling.

The testing of off-site soils proposed for the project will be the sole responsibility of the Contractor.

A qualified testing laboratory shall perform soils testing. Laboratory shall obtain certificate of calibration in accordance with ASTM E-4 or National Institute for Science and Technology (NIST) Handbook 44 standards for equipment used for soils testing.

A qualified testing laboratory shall perform geosynthetics testing. Laboratory shall obtain certification by the Geosynthetics Accreditation Institute-Lab Accreditation Program (GAI- LAP) by the Geosynthetic Institute (GSI) for appropriate geosynthetics testing procedures and machinery.

Results of analysis shall be submitted to the Engineer as soon as they are available. Should the analyses show that the product tested does not comply with the specifications, the Contractor shall remove, repair or replace the product at no expense to the Owner. The Contractor may, at his option and expense, perform additional testing to substantiate claims that the product complies with the specification requirements.

7.3 RELATED REQUIREMENTS

Material, testing and work execution requirements are provided in the Technical Specifications sections.

7.4 COMMUNICATIONS

7.4.1 Preconstruction Meeting

A preconstruction meeting shall be held prior to initiation of construction.

Present at the preconstruction meeting shall be the Owner, Contractor, the Engineer, and CQA/CQC personnel. The discussion at this meeting shall include, but not be limited to, the following:

- Providing each organization with relevant project documents and supporting information.
- Familiarizing each organization with the CQA Plan and its role relative to the plans and specifications.
- Reviewing the responsibilities of each organization.
- Reviewing lines of authority and communication for each organization. Communications will to be strictly documented. Copies of communications will be distributed in a timely manner to each organization.
- Discussing the established procedures or protocol for observations and tests including sampling strategies.
- Discussing the established procedures or protocol for handling construction deficiencies, repairs, and retesting.
- Reviewing methods for documenting and reporting inspection data.
- Reviewing methods for distributing and storing documents and reports.
- Reviewing work area security and safety protocol.
- Discussing procedures for the location and protection of construction materials and for the prevention of damage of the materials from inclement weather or other adverse events.

- Conducting a site walk-over to review construction material and inspection equipment storage locations.

The QA personnel shall document the Preconstruction Meeting. Copies of the documentation will be forwarded to each organization.

7.4.2 Progress Meetings

Progress Meetings will be held at least every other week at the work area, unless otherwise directed by the Owner. Attending the meeting will be the Owner, Contractor, Engineer (if necessary), and the QA Personnel. The purpose of the meeting is to:

- Review the previous week's activities and accomplishments.
- Review the work location and activities for the upcoming week.
- Identify the Contractor's personnel and equipment assignments for the upcoming week.
- Discuss potential construction problems.

The QA personnel shall document the Progress Meetings. Copies of the documentation will be forwarded to each organization.

7.4.3 Problem or Work Deficiency Meetings

If a problem or deficiency is present, or likely to occur, a special meeting will be held. This meeting will be attended by the Owner, Contractor, QA Personnel, and the Engineer, if necessary.

The purpose of the meeting will be to define and resolve the problem or problems, or recurring work deficiency, in the following manner:

- Define and discuss the problem or deficiency.
- Review alternative solutions.
- Implement a plan to resolve the problem or deficiency.

The QA personnel will document Problem or Work Deficiency Meetings. Copies of the documentation will be forwarded to each organization.

7.4.3.1 Final Cover Bedding

The QAO shall observe, verify, and document that the bedding layer for geosynthetic materials has been placed, compacted, and tested by the Contractor and has been accepted by the installer's representative. The QAO shall visually inspect the surface to confirm that it is free from clods of soil, rocks, roots, sudden or sharp changes of grade, and standing water.

7.5 GENERAL CONSTRUCTION

7.6 GENERAL

The Contractor and QA Personnel shall review the plans and specifications for clarity. If needed, the Engineer will provide further clarification or modification so that the plans and specifications are understandable to involved parties.

The QAO and QAE shall verify that the minimum testing is performed and results documented, and/or certificates provided.

In general, observations shall be documented in the logs maintained by the QAO.

7.7 SITEWORK

The QAE and QAO shall review site investigation information to familiarize themselves with the expected site conditions upon which the designs were based. This will assist with identifying unexpected site conditions that may be encountered during construction.

7.8 FINAL COVER

The QAO shall verify and document that final cover material is certified by the manufacturer for synthetic materials, and that borrow areas are approved for soil components. The QAO shall verify and document that appropriate destructive and nondestructive tests are performed for geomembranes and that horizontal and vertical control is maintained.

In addition to documentation and verification noted in applicable sections above, the QAO shall perform:

- Verification that the vegetative support layer (topsoil) is spread uniformly, layer thickness achieved, that slopes are as specified, and that the soil is not overly compacted.
- Verify that the seeding method is as specified. Verify and document seed mixtures, fertilizer and lime content, and mulch application. Verify that seeding occurs during favorable weather and is not placed during high wind or rain or when the soil is frozen.
- Visually inspect the completed cover to verify that it meets the specified design. Depressions or deficiencies shall be noted and corrected. The perimeter configuration, including drainage conduits, shall be examined for conformance to design specifications. Visually inspect cover until vegetation is established.

7.8.1 Embankments

The QAO shall inspect embankment foundations to verify that an appropriate subgrade is established for embankment construction. This may include the placement and compaction of fill (Section 31.00.00). The QAO shall observe and verify embankment construction to include the following:

- Observations of soil and rock surfaces for adequate filling of rock joints, clay fractures, or depressions, and removal and filling of sand seams.

- Measurements of the depth and slope of the excavation or fill to verify that it meets design requirements. Document measurements.
- Observations to verify the quality of compacted fill. In coordination with the QCO, verify that testing is performed in accordance with the specifications and tabulate testing results. Include tabulation and testing results in the final QA report.
- Observations of stripping and excavation to verify that there are no moisture seeps and that soft, organic, and otherwise undesirable materials are removed. Proof-rolling with heavy equipment can be used to detect soft areas likely to cause settlement.
- Observation of material type, texture, color, and moisture content as placed.
- Observation of scarification and connection between compacted fill lifts.

7.8.2 Miscellaneous

The QAO shall verify and document that fill placement is compacted and tested; that utility trenches are backfilled and tested; that gravity, pressure lines and manholes are leak tested and grades are verified; that subgrades are maintained and pavements constructed as specified; that structures are constructed as specified; that landscaping conforms to the plans and specifications; that fencing, gates, and signs are installed in the locations specified.

8.0 CERTIFICATION

8.1 CERTIFICATION BY CQA OFFICER

The final documentation will be signed by the Quality Assurance Engineer to certify that the CQA Plan has been successfully carried out and that the unit meeting the requirements of 9VAC20-81-130.Q.

8.2 CERTIFICATION BY DESIGN ENGINEER

Since new cells are not being constructed, a separate certification by the Design Engineer in accordance with 9VAC20-81-490.A.1 is not required.

8.3 ACCOMPANYING DOCUMENTATION

8.3.1 Field Documentation

Logs and reports will be prepared by the QAO. Documentation shall include, but are not limited to:

- Date, project name, location, and other identification
- Unique sheet numbering for document control
- Reports on meetings held and their results
- Construction operation and their locations.
- Operations and locations of Quality Control personnel.
- QC tests performed, their designation and location.

- Description of off-site materials received, including quality verification (vendor certification) documentation.
- Locations and designations of samples obtained.
- Meteorological data and conditions.
- Decisions made regarding approval of unit of material or of work, and/or corrective actions to be taken in instances of substandard quality
- Unique identifying sheet numbers of inspection data sheets and/or problem reporting, and corrective measures reports used to substantiate the decisions described in the preceding item.
- General comments and observations.

A copy of logs and reports shall be kept on site or electronically and made available to the Owner, Operator, Engineer, and QAE.

Field and laboratory test data shall be identified and maintained in an easily referenced manner on the site.

Corrective measures taken to bring the unsuitable work into conformance with the design specifications must be documented. This documentation shall describe the non-conformity, the exact location (both horizontal and vertical extent), test designations indicating non-conformity, the corrective action agreed upon, and test results indicating the remedial action is acceptable.

Photographic reports shall also be maintained. These photographs will serve as a pictorial record of work progress, problems, and corrective measures. They will be kept in a permanent protective file or electronically in the order in which they were taken.

8.3.2 Record Drawings

8.3.2.1 Scope

Owner will be responsible for surveying associated with as-builts (record drawings) of final cover construction. Contractor shall plan their work to allow sufficient time for coordination and completion of the as-built surveys. Placement of subsequent layers shall not be conducted until as- built surveys are completed and the Quality Assurance firm has approved.

8.3.2.2 Qualifications

A land surveyor currently licensed by the Commonwealth of Virginia shall prepare record drawings. The land surveyor may be employed by the Quality Assurance firm.

8.3.2.3 Drawings

Provide record drawings as indicated in this section. Drawings shall be submitted in the latest AutoCAD Release format or as otherwise indicated by the Engineer. Submit certification with each record drawing that the elevations and locations of the new work are in conformance or non-conformance with the Contract Documents.

Drawings shall be tied to and include the same horizontal and vertical grid system indicated on the design plans or the State Plane coordinate system.

Information in the AutoCAD files must be at appropriate three-dimensional elevation and coordinates. Entities shall be placed on layer names that describe the entity mapped.

8.3.2.4 Grades and Locations

Grades for each layer comprising the final cover systems shall be contoured on a scaled plan and submitted to the QAO for review upon completion of that portion of the work. The record drawings shall include the following.

8.3.2.4.1 Base Grades

Provide the elevations of the area to be capped prior to placement of final cover materials (i.e., top of subgrade for the bedding layer). The record drawing shall indicate the conditions of the site after vegetation has been stripped from the closure area and the surface prepared.

Provide grid locations that indicate the elevations of the base grades on a maximum 50-foot grid. On slopes, at a minimum the survey points will include top of slope, midpoint, and toe of slope. Survey points shall be obtained at significant grade breaks. The contour interval shall be 2 feet. The scale of the drawing shall be no greater than 1 inch = 50 feet.

Thickness verification tables will be generated for the final cover bedding layer.

8.3.2.4.2 Geomembrane Cover

Provide the horizontal limits of the geomembrane cover. Indicate limits of anchor trenches and tie-in points to previous cells.

8.3.2.4.3 Top of Final cover Systems

Provide horizontal limits and grid point elevations of the top of the vegetative support layer (topsoil). Show points on the grid system used for underlying layers.

During the closure construction, it is likely that the waste will be compressed and that the surveys do not indicate the correct thickness of the installed erosion control and vegetative support layer. If the survey data indicates that the thickness is less than 2.0 feet at the grid locations, the QCO will conduct test pits/auger holes to confirm the actual soil thickness in the presence of the QAO. The confirmation points will be shown by the QAO on a drawing and the information included in the final QA report.

8.3.2.4.4 Surface Features

Provide a record drawing after completion of the project that includes all surface and underground features, which includes, but not limited to, the following items:

- diversion berms
- drainage channels
- culverts (with inverts)
- manholes
- leachate, water or other underground utility lines and valves
- hydrants
- sewer lines

- landfill gas vents/landfill gas wells
- roads
- structures
- ponds
- riprap aprons and outlets
- concrete pads
- utility poles
- cleanouts

8.3.2.4.5 Tolerances

Tolerances are noted in Specification Section 01070. These tolerances are allowable provided the required material thicknesses are maintained.

8.3.2.5 Geomembrane Panel Layout

A record drawing presenting the final geomembrane panel layout shall be prepared by the geomembrane installer and submitted to the Engineer. The panel layout shall present roll and panel identifications, dates of installation, seam identification with welder identified, destructive test locations, and patch locations.

8.3.2.6 Construction Staking

Staking is not allowed within the final cover area once geosynthetics have been placed. The Contractor shall be responsible for maintaining the integrity of construction stakes outside of the area and for providing other means of grade control within the final cover area. The Contractor shall maintain adequate construction staking/control for reference by the QA personnel when locating work elements and test locations. Re-staking shall be the Contractor's expense.

8.3.2.7 Marked-Up Drawings

The Contractor shall be responsible for maintaining an accurate set of marked-up drawings on the construction site. Marked-up drawings shall accurately reflect grades and locations and changes or modifications to the plans. Indicate changes and modifications by colored pencil on a set of project drawings. Upon completion of the project, the marked-up drawings shall be submitted to the Engineer.

8.3.3 Final Documentation

Upon completion of the project, final documentation will be organized and indexed to enable easy access and retrieval of original inspection, testing data sheets, material certification, reports and record drawings. During the construction period, originals of the documents shall be kept by the QAO at the site. At the completion of the project, the QAE will compile the quality assurance data and assemble the certification report.

The final documentation shall include project correspondence pertaining to changes or clarifications to the work.

The final documentation shall include project submittals. Project submittals shall be numbered and tabulated in a submittal log.

The following items will also be included in the documentation to be submitted to the DEQ:

- Photographs
- Gas wells,, gas headers gas probes and groundwater wells:
 - surveyed as-built location drawing(s)
 - boring and construction logs

ACKNOWLEDGEMENTS

Portions of this Quality Assurance Plan were based or excerpted from the EPA Technical Guidance Document: Construction Quality Assurance for Hazardous Waste Land Disposal Facilities, OSWER Report No. EPA/530-SW-86-031.

This plan has been prepared by SCS Engineers. Some portions of the narratives, exhibits, and calculations have been retained from permit documentation prepared by Thompson & Litton, Inc and Draper Aden Associates to maintain consistency of Permit Documents.

END OF CQA PLAN