Tennessee Valley Authority
Kingston Fossil Plant

MATERIAL SPECIFICATIONS AND CONSTRUCTION QUALITY ASSURANCE/QUALITY CONTROL PLAN

COAL COMBUSTION BYPRODUCT DISPOSAL FACILITY - PENINSULA SITE

KIF450

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1 INTRODUCTION

This Material Specifications and Construction Quality Assurance/Quality Control Plan (QA/QC Plan) is prepared for the proposed Coal Combustion Byproduct (CCB) Disposal Facility located at the Tennessee Valley Authority (TVA) Kingston Fossil Plant – Peninsula Site (hereinafter referenced as CCB disposal facility). The CCB disposal facility will be developed in two phases; namely Phase I and II. The purpose of this QA/QC Plan is to outline procedures for verifying that proper materials, construction techniques, and installation procedures are used by the Constructor, and that the design intent is met. This QA/QC plan has been developed to satisfy the requirements of rule 1200-1-7-.04(9)(c)19. In addition, this QA/QC Plan is intended to define problems that may occur during construction and to provide a mechanism for resolving these problems as they occur.

The elements of construction of the CCB disposal facility requiring field monitoring and documentation under this plan include: subgrade/structural fill, soil dike for Phases I and II, geologic buffer, gypsum dikes, and final cover system construction.

The program described by this Plan is independent of the quality control (QC) program conducted by the Constructor. This QA/QC Plan is intended to provide verification that the Constructor has met his obligation in the supply and installation of the specified materials. This plan does not replace the contract documents (design drawings and documents) regarding the selection and installation of materials.

The construction and operation of this facility involves initial facility construction, as well as on-going construction operations. TVA conducts dike inspections at all fossil plants yearly, and will be performed for the CCB Disposal Facility. Because this facility will be raised during the operational phase, certification activities should be an on-going process during operation, but limited to those periods where dikes are being raised. This can be viewed as an extension of the yearly dike inspections. It is anticipated that during dike raising activities, surveillance by technicians to sample and test material and observe construction techniques would also provide assurance that construction activities are in conformance with the drawings. As construction proceeds, the Certification Engineer can adjust the frequency and type of testing and inspection/surveillance as needed.

2. DEFINITIONS AND USE OF TERMS

This section provides definitions for terms used in the QA/QC Plan.

Owner – Tennessee Valley Authority

Constructor – the individual or firm, responsible for disposal facility-related construction and operational activities. This definition applied to any party performing work defined in the construction documents. TVA may use their own construction organization, Heavy Equipment Division (HED), for initial construction activities, and plant operations personnel (TVA Yard Operations) may perform dike raising activities described herein. TVA may also subcontract construction at it's discretion.

Construction Manager – the official representative of the Owner responsible for overseeing construction of the project. If TVA uses the HED for initial construction, and TVA Yard Operations for operation, the Construction Manager and Constructor are one in the same.

Conformance Testing - includes testing that is performed by the Certification Engineer to conform and qualify material prior to their use.

Certification Engineer – individual appointed by the Owner who is responsible for performing tasks outlined in this QA/QC Plan. The Certification Engineer will be selected by TVA FES and shall be a registered Professional Engineer in the state of Tennessee.

Design Engineer – the individual(s) or firm(s) responsible for the preparation of design documents and significant design changes during construction as determined by the Certification Engineer. The design engineer shall be a registered Professional Engineer in the state of Tennessee. TVA Fossil Engineering Services (FES) is the responsible engineering organization for design and certification of this facility.

Earthwork – an activity involving the use of soil or rock materials. It also includes activities involving the use of byproducts in the construction of waste disposal facilities.

Performance Testing – includes those activities that occur during and following material installation including dike raising activities during facility operation.

Project Design Drawings and Documents – all project related drawings and documents, including design modifications and record drawings.

Project Documents – includes Constructor submittals, construction drawings, record drawings, specifications, shop drawings, field inspection reports, and project schedule.

Quality Control (QC) – functions performed by the Constructor and material supplier to verify that work performed conforms to project design drawings and documents.

Quality Assurance (QA) – provides verification that QC functions have been performed in substantial compliance with the project design drawings and documents, this function will normally be provided by a Certification Engineer chosen by TVA.

Record Drawings – drawings recording the locations, elevations, and details of the facility after construction is completed.

Surveyor – the individual responsible for preparation of as-constructed surveys of the completed subgrade, geologic buffer, soil dike fill, final surface of gypsum fill, final cover compacted clay layer, and completed vegetation layer. The surveyor shall be a registered Surveyor in the state of Tennessee.

Testing Laboratory – one or more laboratories capable of conducting the required conformance and performance laboratory testing of soils and geosynthetics required by this QA/QC Plan.

3 CERTIFICATION ENGINEER

The Certification Engineer (or personnel under his direct supervision) will closely monitor construction of the various components of the CCB disposal facility which includes: structural fill, soil dike fill, geologic buffer, gypsum dike construction; and the construction of the soils and geosynthetic components of the final cover system. The Certification Engineer will be a Professional Engineer licensed to practice in the state of Tennessee, who is knowledgeable in the field of soil mechanics and geosynthetics, and will have a good working knowledge of the equipment and procedures generally used in the construction of landfills.

The Certification Engineer has the following duties:

- provide written, certified documentation attesting to conformance with the design requirements and the QA/QC Plan with respect to conditions of structural fill, soil dike fill, geologic buffer, gypsum dike construction, and the construction of the soils and geosynthetic components of the final cover system;
- be present at appropriate intervals during construction of the soil components, perform appropriate tests, and obtain samples for laboratory analyses;
- observe material delivery and unloading;
- use the results of tests and laboratory analyses to document conformance with project requirements;
- provide to TVA and the Constructor the results of observations and test as the work progresses. Coordinate with Constructor when modifications to the plans are necessary to ensure compliance with the design drawings, specifications, and QA/QC Plan;
- schedule and coordinate inspection and testing activities; and
- reject defective work and verify that corrective measures have been implemented.

The Certification Engineer may utilize qualified field technicians to perform testing described and to provide as necessary additional oversight during construction.

4. PROJECT MEETINGS

4.1 Design Review Meeting (Optional)

Following the completion of the design and after review and approval by the State of Tennessee Department of Environment and Conservation (TDEC), Division of Solid Waste Management (DSWM), a design review meeting will be held. The purpose of this meeting, which the Owner, Construction Manager, and the Certification Engineer shall attend, is to accomplish the following activities:

- identify key personnel;
- provide all parties with relevant documents;
- review the project design drawings, documents, and QA/QC Plan;
- confirm responsibilities of each party;
- review reporting and documenting procedures;
- define lines of communication;
- establish work area procedures; and
- review sampling and testing procedures.

The meeting will be documented by the Certification Engineer or person designated by the Construction Manager. Copies of the minutes and relevant documents will be provided to all parties.

4.2 Pre-construction Meeting

A pre-construction meeting will be held at the site prior to the start of construction. The Owner, Construction Manager, Certification Engineer, Constructor, and others designated by the Owner will attend this meeting. In certain cases, many, if not most of these functions may be performed directly by the Owner. The purpose of the meeting is to accomplish the following activities:

- review the construction drawings and documents, QA/QC Plan, work area procedures, construction procedures, and other related issues;
- define lines of communication and authority;
- review the project schedule;
- review best management practices for erosion and sediment control and construction stormwater management during each phase of construction;
- review testing procedures and procedures for correcting and documenting; construction deficiencies, repairs, and retesting;
- review testing and record drawing documentation procedures; and
- conduct a site inspection to discuss work areas, work plans, stockpiling, equipment and material laydown areas, access roads, and related items.

This meeting will be documented by the Construction Manager or authorized representative, and copies of the documentation will be distributed to all parties.

4.3 Progress Meetings

A progress meeting will be held daily just prior to commencement or just following the completion of work. This meeting will be attended by the Construction Manager, and the Constructor's on-site superintendent and the Certification Engineer. The following activities will be discussed during this meeting:

- review the previous days activities and accomplishments;
- review work locations and scheduled work;
- discuss problems; and
- review test data.

This meeting will be documented by the Certification Engineer, and copies of the documentation will be distributed to the Owner, Construction Manager, and Constructor.

4.4 Deficiency Meetings

As required, meetings will be held to discuss problems or deficiencies. At a minimum, these meetings will be attended by the Construction Manager, Certification Engineer, and the Constructor's on-site superintendent. If the problem requires a design modification, the Design Engineer and Constructor's project manager should also be present. The meeting will be documented by the Certification Engineer.

5. BASE GRADE SOIL COMPONENT CONSTRUCTION

5.1 Introduction

This section addresses material specifications and CQA activities associated with preparation and construction of the soil and aggregate components of the base grade system. Details of the soil components of the base grade system are provided in the Drawings Plans. These components include:

- subgrade/structural fill;
- soil dikes;
- geologic buffer; and
- gravel drainage layer.

The soil and aggregate components of the base grade system shall meet requirements related to material characteristics and construction quality. Both field and laboratory tests shall be performed prior to construction to evaluate if the characteristics of soil and aggregate from proposed sources meet the material acceptance requirements of the permit and design specifications. Throughout construction, additional field and laboratory testing shall be performed to evaluate if the placed material meets the requirements of the permit and construction documents with regard to material acceptance and construction quality.

5.2 Test Methods And Sampling Requirements

Tables 1 and 2 present the laboratory and field test methods which shall be used to determine material characteristics and evaluate construction quality for the soil and aggregate components of the base grade system. The tests shall be conducted in accordance with the current versions of the corresponding standard methods given.

Table 3 provides information regarding the minimum test frequencies. The table also includes the locations at which samples shall be collected, the sample size, and the acceptance criteria.

5.3 Subgrade/Structural Fill

Subgrade refers to a surface which is exposed after stripping topsoil, excavating or filling to design grades. The prepared subgrade should conform to the contours shown on the grading plan, as indicated in the Design Drawings and verified by the Surveyor. Vegetation shall be stripped and the surface proof rolled. Potentially deleterious materials such as organics or soft materials shall be removed and the resulting voids filled with acceptable material, appropriately compacted. As required, structural fill will be used to establish design subgrade elevations.

After proof rolling and/or other suitable techniques, visual examination of the subgrade preparation by the Certification Engineer should be sufficient to evaluate its suitability as a foundation for the geologic buffer.

Conformance and performance testing of the subgrade/structural fill shall be accomplished in accordance with Table 3. The subgrade should be accepted by the Certification Engineer if it does not pump or rut excessively. If excessive pumping or rutting occurs, the area should be reworked or removed by undercutting to more suitable material if possible. The surface of the finished subgrade will be surveyed in accordance with Section 11 of this QA/QC Plan to provide as-built documentation prior to placement of the geologic buffer.

5.4 Soil Dikes

Soil dikes refers to the soil material that will be used to construct the perimeter soil dikes shown on the Design Drawings. Soil dike material shall consist of relatively homogenous, silty, and clayey soils which are substantially free of debris, rock, plant materials, frozen materials, foreign objects, and organics. The soil dike geometry should conform to the contours shown on the grading plan, as indicated in the Design Drawings, and verified by the Surveyor.

Conformance and performance testing of the soil dike material shall be accomplished in accordance with Table 3. The surface of the finished subgrade will be surveyed in accordance with Section 11 of this QA/QC Plan to provide as-built documentation prior to placement of the perimeter gypsum dike.

5.5 Geologic Buffer

Geologic buffer material shall consist of relatively homogenous, silty, and clayey soils which are substantially free of debris, rock, plant materials, frozen materials, foreign objects, and organics. The geologic buffer may be constructed from recompacted soils from within the disposal factory footprint (if suitable) or from the borrow area. The borrow area for the geologic buffer material will be identified in the Design Drawings and the material will be tested to provide an Acceptable Permeability Zone (APZ) to meet the required permeability of less than or equal to 1×10^{-7} cm/s. The Certification Engineer shall obtain samples from within the identified borrow area and subject the soils to conformance testing procedures, frequency, and requirements indicated in Table 3 to verify that the APZ that has been developed is acceptable and that the material does meet the project requirements.

Geologic buffer material shall be placed in 8 to 10 in. loose (6 to 8 in. compacted) lifts. The lift depth shall be verified by a manual method (i.e., use of stakes or cones). Soil clods shall be broken down, and moisture conditioning shall be conducted to preserve the homogeneity of the soil and to obtain a relatively uniform moisture content through the soil mass. The moisture content of the geologic buffer soils shall be field tested during processing, placement, and compaction. The action of heavy equipment on the geologic buffer shall be observed for penetration, pumping, and cracking which would indicate that the material is unsuitable and should be re-conditioned. Performance testing shall be accomplished to verify the requirements listed in Table 3 are met.

The finished surface of the geologic buffer shall be firm, uniform, and relatively smooth. Surveying shall be performed to verify that the finished geologic buffer thickness is equal to or greater than 3 ft and that the minimum drainage grade to the central drainage corridor is met.

Perforations created by nuclear density probe, stakes, or any other methods shall be filled with bentonite, a soil-bentonite mixture, or an Engineer approved equal.

5.6 Gravel Drainage Layer

Gravel drainage layer shall be placed around pipes located within the central drainage corridor and the perimeter drainage trenches. The gravel drainage layer shall be composed of aggregates meeting the Conformance testing requirements provided in

Table 3. The gravel drainage aggregate shall be substantially free of organics, frozen material, foreign objects, or other deleterious materials.

5.7 Potential Problems And Deficiencies

During construction, the frequency of testing may be increased at the discretion of Certification Engineer or the Construction Manager when visual observations of construction performance indicate a potential problem. Additional testing for suspected areas will be considered when:

- excessive pumping or cracking of material occurs;
- under adverse weather conditions;
- work is conducted in difficult areas; and
- high frequency of failing tests is observed.

If a defect is discovered in the earthwork product, the Certification Engineer shall immediately determine the extent and nature of the defect. If the defect is indicated by an unsatisfactory test result, the Certification Engineer shall determine the extent of the deficient area by additional tests, observations, a review of records, or other appropriate means and notify the Constructor and Construction Manager.

The Certification Engineer shall schedule appropriate retests after the work deficiency has been corrected. Retests recommended by the Certification Engineer must verify that the defect has been corrected before any additional work is performed in the area of the deficiency

6. GYPSUM DIKE CONSTRUCTION AND PLACEMENT

6.1 Placement

The sequence for the construction and placement of the perimeter and outer gypsum dikes is illustrated in the Design Drawings and described herein. After the soil dikes are constructed, sluiced gypsum will be placed within the disposal area and the perimeter gypsum dike will be constructed from gypsum sedimented within the disposal area. The perimeter gypsum dike is considered an extension to the soil dikes and will provide a platform for the construction of the outer gypsum dikes. Once the perimeter gypsum dikes are constructed, a rim ditch operation will commence and outer gypsum dikes will be constructed using gypsum. Gypsum will continue to be disposed and the outer dikes will be raised progressively using the upstream method of construction.

Gypsum can also be used to divide the disposal area, as required, into smaller subareas areas. This arrangement allows for the sedimentation of gypsum in one subarea while the other subarea is filled with sluiced gypsum. Once rim ditch construction has been completed, and a subarea has been filled, another subarea will begin to receive sluiced gypsum. During the inactive phase of the first subarea, raising of the outer gypsum dikes may begin. Gypsum is excavated from the rim ditch using long-reach trackhoes and placed along the perimeter of the outer gypsum dikes. Leveling, spreading, and compaction will be accomplished using a small dozer. The outer gypsum dikes will generally be raised in five-foot height increments, with individual lift thicknesses being approximately one to two feet thick. The individual lift thicknesses should be such that material can be placed, spread, shaped and compacted to obtain a uniform consistency and be constructed to the lines and grades on the Design Drawings. Perimeter drainage trenches shall be installed as shown on the Design Drawings. It is important that elevations be checked during construction and adjustments made to avoid damage to the drains. The Design Drawings contain instructions and procedures to prevent this from occurring.

6.2 Monitoring and Testing

Monitoring and testing for gypsum dike construction will include the following activities:

- Monitoring of the perimeter gypsum dike construction is required to verify that material has the desired consistency, and is being placed, shaped, and compacted to the proper shape. It is anticipated that surveillance and monitoring activities will be more frequent in the beginning, and will be reduced as successful operation is being demonstrated. The frequency of monitoring will be determined by the Certification Engineer in concert with TVA FES.

- After the completion of perimeter gypsum dike construction, and the area filled with gypsum, outer gypsum dike raising can begin from the second lift. The technician shall take random samples at four locations along the rim ditch along the outer dike at approximate evenly spaced locations. Samples will be tested for grain size to determine variation in material. This information shall be reviewed by the Certification Engineer. Additionally, if considered necessary by the Certification Engineer, strength testing of material at the beginning and end points of the rim ditch along the outer dike may be performed to determine any variation in strength parameters. Operation of the rim ditch may be adjusted at the discretion of the Certification Engineer. This process can be repeated if determined necessary by the Certification Engineer in concert with TVA FES, but it is expected that as stack progression continues, the need for such testing will diminish over time if satisfactory results are obtained. This process may need to be repeated when Phase II construction begins, or if more frequent testing is deemed necessary by the Certification Engineer in concert with TVA FES.

- It is anticipated that quarterly inspections will be performed by the Certification Engineer during dike raising activities as a minimum, and the frequency increased if necessary. The technician should be present to inspect construction of the drains to ensure that the requirements on the Design Drawings are being met. The frequency of these visits shall be determined by the Certification Engineer in concert with TVA FES.

- As stack construction progresses, TVA will perform surveys to determine the remaining life of the facility. These surveys will be reviewed by the Certification Engineer to ensure that grading is being adequately maintained on the side slopes.

7. FINAL COVER SYSTEM SOIL COMPONENT CONSTRUCTION

7.1 Introduction

This section addresses material specifications and CQA activities associated with the construction of the soil components for the final cover system. Details of the soil components of the final cover system are provided in the Design Drawings. These components include:

- intermediate cover;
- compacted clay layer;
- compacted soil Layer; and
- vegetative soil layer.

The soil components of the final cover system shall meet requirements related to material specification and construction quality provided in this QA/QC Plan. Both field and laboratory tests shall be performed prior to construction to evaluate if the characteristics of soil from proposed sources meet the material acceptance requirements.

7.2 Test Methods and Sampling Requirements

Tables 1 and 2 present the laboratory and field test methods which shall be used to determine material characteristics and evaluate construction quality for the soil components of the final cover system. The tests shall be conducted in accordance with the current versions of the corresponding standard methods given.

Table 4 provides information regarding the minimum test frequencies and values. The table also includes the locations at which samples shall be collected, the sample size, and the acceptance criteria.

7.3 Intermediate Cover

Intermediate cover refers to the layer of soil covering the gypsum by-product in the facility to reach the planned grades for the bottom of compacted clay layer material.

Vegetation and other potentially deleterious materials such as organics or soft materials shall be removed and the resulting voids filled with acceptable material and appropriately compacted. The surface shall be proof rolled prior to the placement of subsequent lifts or layers.

After proof rolling and/or other suitable techniques, visual examination of the intermediate cover preparation by the Certification Engineer should be sufficient to evaluate its suitability as a foundation for the compacted soil layer.

The intermediate cover should be accepted by the Certification Engineer if it does not pump or rut excessively. If excessive pumping or rutting occurs, the area should be reworked or removed by undercutting to more suitable material.

The surface of the finished intermediate cover will be surveyed in accordance with Section 11 of this QA/QC Plan to provide for as-built documentation prior to placement of the compacted clay layer or compacted soil layer.

7.4 Compacted Clay Layer

Soils for the compacted clay layer shall consist of relatively homogenous, silty, and clayey soils which are substantially free of debris, rock, plant materials, frozen materials, foreign objects, and organics. If an approved borrow source is not identified in the permit or permit application, the Construction Manager and Constructor shall identify a borrow area for the compacted clay layer. The Certification Engineer shall obtain samples from within the identified borrow area and subject the soils to the Conformance testing requirements indicated in Table 4 to and develop an APZ for the soil to achieve the required permeability of less than or equal to 1×10^{-7} cm/sec.

Based on the results of these laboratory tests, material which may meet the requirements of compacted clay layer material shall be identified. A range of moisture/density values which results in the required permeability should be determined based on the laboratory testing data. This range will then be used as the acceptable range of moisture/density values for field compaction control.

The compacted clay layer material shall be placed in 8 to 10 in. loose (6 to 8 in. compacted) lifts. The lift depth shall be verified by a manual method (i.e., hand auguring). Soil clods shall be broken down, and moisture conditioning shall be conducted to preserve the homogeneity of the soil and to obtain relatively uniform moisture content through the layer. The moisture content of the compacted clay layer may be field tested during processing and placement when requested by the Constructor for verification purposes. The action of heavy equipment shall be observed for penetration, pumping, and cracking of the compacted soil layer surface. Performance testing shall be accomplished in accordance with Table 4.

The finished surface shall be firm, uniform, and relatively smooth. Perforations in the compacted clay layer created by nuclear density probes, stakes, or any other methods shall be filled with bentonite, a soil-bentonite mixture, or an Engineer approved equal.

The surface of the finished compacted soil layer will be surveyed in accordance with Section 11 of this QA/QC Plan to provide for as-built documentation prior to placement of the geomembrane.

7.5 Compacted Soil Layer

Material for the compacted soil layer shall consist of relatively homogenous, silty, and clayey soils which are substantially free of debris, rock, plant materials, frozen materials, foreign objects, and organics. If an approved borrow source is not identified in the permit or permit application, the Construction Manager and Constructor shall identify a borrow area for the compacted soil layer. The Certification Engineer shall obtain samples from within the identified borrow area and subject the soils to the Conformance testing requirements indicated in Table 4. Based on the results of these laboratory tests, material which may meet the requirements of compacted soil layer shall be identified.

The compacted soil layer material shall be placed in 8 to 10 in. loose (6 to 8 in. compacted) lifts. The lift depth shall be verified by a manual method (i.e., hand auguring). Soil clods shall be broken down, and moisture conditioning shall be conducted to preserve the homogeneity of the soil and to obtain relatively uniform moisture content through the layer. The moisture content of the compacted soil layer may be field tested during processing and placement when requested by the Constructor for verification purposes. The action of heavy equipment shall be observed for

penetration, pumping, and cracking of the compacted soil layer surface. Performance testing shall be accomplished in accordance with Table 4.

The finished surface shall be firm, uniform, and relatively smooth. Perforations in the compacted soil layer created by nuclear density probes, stakes, or any other methods shall be filled with bentonite, a soil-bentonite mixture, or an Certification Engineer approved equal.

The surface of the finished compacted soil layer will be surveyed in accordance with Section 11 of this QA/QC Plan to provide for as-built documentation prior to placement of the vegetative cover.

7.6 Vegetative Soil Layer

The soil to be utilized for establishing the vegetative cover shall be capable of sustaining a healthy stand of vegetation, and shall consist of soil reasonably free from subsoil, noxious weeds, stones larger than two inches in diameter, or other deleterious matter that would prevent the formation of a suitable seed bed.

Low ground-pressure equipment shall be used to place the material for the vegetative soil layer over the geosynthetics (if geosynthetics option is used). The equipment shall be operated over the full depth of the layer. In areas traversed by heavy trucks and other non low ground-pressure equipment a minimum material thickness of three (3) feet shall be maintained. Care should be exercised when material is being placed around pipes and other appurtenances to prevent damage to these components. The material shall be placed by pushing the material upslope only. Vegetative soil layer material should not be placed from the top of the slope. The finished surface of the vegetative soil layer shall be roughened to help prevent erosion from occurring, seeded as described in the Vegetation Specification included in Attachment 1 of this QA/QC Plan. The final surface shall be surveyed in accordance with Section 11 of this QA/QC Plan for as-built documentation. Soil thickness verification will be performed by manual methods (i.e., hand auguring and/or thickness markers) due to possible settlement of the gypsum layers during final cover construction activities.

7.7 Potential Problems And Deficiencies

During construction, the frequency of testing may be increased at the discretion of the Certification Engineer or the Construction Manager when visual observations of

construction performance indicate a potential problem. Additional testing for suspected areas will be considered when:

- excessive pumping or cracking of material occurs;
- under adverse weather conditions;
- work is conducted in difficult areas; and
- high frequency of failing tests is observed.

If a defect is discovered in the earthwork product, the Certification Engineer shall immediately determine the extent and nature of the defect. If the defect is indicated by an unsatisfactory test result, the Certification Engineer shall determine the extent of the deficient area by additional tests, observations, a review of records, or other appropriate means. All deficiencies shall be corrected by the Constructor.

The Certification Engineer shall schedule appropriate retests after the work deficiency has been corrected. Retests recommended by the Certification Engineer must verify that the defect has been corrected before any additional work is performed by the Constructor in the area of the deficiency.

8 GEOMEMBRANE

8.1 Manufacture, Shipment, And Storage

The following addresses the activities associated with the manufacture of the geomembrane; the shipment, handling, and delivery of geomembrane to the site; conformance testing of delivered geomembrane; and the storage of the geomembrane prior to installation.

8.1.1 Manufacture of Polyethylene Geomembrane

The Geomembrane Manufacturer shall provide documentation that the material meets the requirements of this section and that adequate quality control measures have been implemented during the manufacturing process.

8.1.1.1 Resin Quality

The raw material shall be first quality polyethylene resin containing no more than 2 percent clean recycled polymer by weight, and meeting the specification outlined in Table 5.

Prior to the shipment of polyethylene geomembrane material, the Geomembrane Manufacturer shall provide the Construction Manager and the Certification Engineer with the following information:

- the origin (Resin Supplier's name and resin production plant), identification (brand name number), and production date of the resin;
- a copy of the quality control certificates issued by the Resin Supplier;
- reports on the tests conducted by the Manufacturer to verify the quality of the resin used to manufacture the geomembrane rolls and extrudate rods meet the requirements in Table 5; and
- a statement that no reclaimed polymer is added to the resin (however, the use of polymer recycled during the manufacturing process may be permitted if

performed with appropriate cleanliness and if recycled polymer does not exceed 2 percent by weight).

At the Owner's discretion and cost, testing may be carried out on the resin by the Geosynthetics QA Laboratory for purposes of verifying conformance. If the results of the Geomembrane Manufacturer and the Geosynthetics QA Laboratory testing differ, the testing will be repeated by Geosynthetics QA Laboratory, and the Geomembrane Manufacturer will be permitted to monitor this testing. The results of this latter series of tests will prevail, provided that the applicable test methods have been followed.

8.1.1.2 Certification of Property Values

In addition to information regarding the raw material, the Geomembrane Manufacturer shall provide the Construction Manager and the Certification Engineer with the following prior to shipment of the geomembrane:

- a properties sheet certification including, at a minimum, guaranteed values for all specified properties presented in Table 5; and
- a list of quantities and descriptions for materials other than the base polymer which comprise the geomembrane.

The Certification Engineer shall verify that the property values certified by the Geomembrane Manufacturer meet the test methods and values shown on Table 5.

8.1.1.3 Quality Control Certificates

Prior to shipment, the Geomembrane Manufacturer shall provide the Construction Manager and the Certification Engineer with quality control certificates for the geomembrane provided. The quality control certificate will be signed by a responsible party employed by the Geomembrane Manufacturer. The quality control certificate will include:

- roll numbers and identification; and
- sampling procedures and results of quality control testing.

The Manufacturer shall be required to perform, at a minimum, the tests presented in Table 5. The Certification Engineer shall:

- verify that the quality control certificates have been provided at the specified frequency or all rolls; and
- review the quality control certificates and verify that the test methods and values meet the requirements presented in Table 5.

8.1.2 Shipment and Handling

Shipment of the geomembrane to the site is the responsibility of the Geomembrane Manufacturer. Handling on-site is the responsibility of the Geosynthetics Installer.

The Certification Engineer shall confirm that:

- handling equipment used on-site poses minimal risk of damage to the geomembrane; and
- the Geosynthetics Installer's personnel handle the geomembrane with care.

Upon delivery at the site, the Geosynthetics Installer and the Certification Engineer shall confirm that roll identification corresponds to quality control certificates issued by the manufacturer.

Rolls without proper identification shall be rejected by the Construction Manager and Certification Engineer.

8.1.3 Conformance Testing of Geomembrane

Upon, or prior to, delivery of the rolls of geomembrane, the Certification Engineer shall verify that samples are removed and forwarded to the Geosynthetics CQA Laboratory for testing to verify conformance with the test methods and values presented in Table 6.

8.1.3.1 Sample Collection

Using the packing list provided by the manufacturer or a sequential inventory list made by the Certification Engineer, rolls shall be selected for sampling. If the material is shipped in identifiable lots or manufacturing runs, sample selection should be adjusted to assure that the minimum frequency is met and that each different lot or manufacturing run is represented by at least one sample.

Samples will be taken across the entire width of the roll and will not include the first 3 linear ft of the roll. Unless otherwise specified, samples will be 3 ft long by the roll width. The Certification Engineer will mark the machine direction on the samples with an arrow.

8.1.3.2 Test Results

The results of the conformance testing shall be evaluated in accordance to the following procedure:

- If the average test values for the sample meet the requirement presented in Tables 5 and 6, the sample passes.
- If the average test value for the sample does not meet one or more of the required values, additional evaluation procedures will be implemented by the Certification Engineer.
- For the failing parameter(s), perform one additional test on the sample. This test may be performed by another Geosynthetics CQA Laboratory at the discretion of the Certification Engineer and the Construction Manager.
- If the test values for the additional tests meet the required values, the roll and adjacent rolls pass and are acceptable.
- If the test value does not meet requirements, reject the roll, collect samples from the closest numerical roll on both sides of the failed roll and test for the failed parameter(s). If one or both of these tests do not meet requirements, those roll(s) will be rejected and the Certification Engineer and Construction Manager shall determine further testing protocol and criteria for identifying the limits of rejected rolls.

8.1.4 Storage

The Geosynthetics Installer and/or Constructor shall be responsible for the storage of the geomembrane on site. Storage space should protect the geomembrane from theft, vandalism, water, weather, or damage.

8.2 Geomembrane Installation

The installation of the geomembrane and anchoring in place is crucial to the performance of the geomembrane. Geomembrane installation activities shall be monitored by the Certification Engineer.

The Certification Engineer shall document that:

- the Surveyor has verified lines and grades of the compacted soil layer; and
- the requirements of Section 7 of this QA/QC Plan are satisfied.

The Geosynthetics Installer shall certify in writing that the surface on which the geomembrane will be installed is acceptable. This subgrade acceptance certificates shall be given by the Geosynthetics Installer to the Certification Engineer prior to commencement of geomembrane installation in the area under consideration. The Certification Engineer will document the acceptance certification for the CQA Final Report.

It is the Geosynthetics Installer's responsibility to protect the compacted soil layer after it has been accepted. After the supporting soil has been accepted by the Geosynthetics Installer, it shall be the responsibility of the Geosynthetics Installer and the Certification Engineer to indicate to the Construction Manager any change in the clay condition that may require repair work.

8.2.1 Geomembrane Placement

The placement of field panels of geomembrane is the responsibility of the Geosynthetics Installer and shall be performed in accordance with the previously submitted panel layout and the following subsections.

8.2.1.1 Panel Layout

At the geosynthetics Pre-Construction Meeting, the Geosynthetics Installer shall provide the Construction Manager and the Certification Engineer with a drawing of the facility to be covered showing expected seam location and layout (Panel Layout Drawing). The Certification Engineer shall review the panel layout drawing and verify it is consistent with the acceptance state of practice and the QA/QC Plan.

The panel layout should be oriented to maximize panel lengths and minimize seams and material waste. In corners and odd-shaped geometric locations, the number of seams should be minimized. Horizontal seams should be greater than 10 ft from the toe of slopes, or areas of potential stress concentration, unless otherwise authorized.

8.2.1.2 Field Panel Identification

The Certification Engineer shall document that the Installer labels each field panel with an "identification code" (number and/or letter) consistent with the panel layout plan. This identification code shall be agreed upon by the Construction Manager, Geosynthetics Installer, and Certification Engineer. It is the responsibility of the Geosynthetics Installer and the Certification Engineer to verify that each field panel placed can be traced to the original manufacturers roll number.

The Certification Engineer shall establish a table or chart showing correspondence between roll numbers and field panel identification codes. The field panel identification code will be used for all quality assurance records.

8.2.1.3 Installation Schedule

Field panels shall be placed one at a time unless otherwise approved by the Certification Engineer and the Construction Manager. Each field panel shall be seamed after its placement to minimize the number of unsealed field panels exposed to weather.

It is usually beneficial to "shingle" overlaps in the downward direction to facilitate drainage in the event of precipitation. It is also beneficial to proceed in the direction of prevailing winds. Scheduling decisions must be made during installation, in accordance with varying conditions. In any event, the Geosynthetics Installer shall be fully responsible for the decision made regarding placement procedures.

The Certification Engineer shall record the identification code, location, date of installation, time of installation, weather conditions and ambient temperature.

8.2.1.4 Weather Conditions

Geomembrane placement shall not proceed when sheet temperature, measured by placing a thermometer on the surface of the sheet, is below 32°F (0°C) for fusion or extrusion welding. Deviations from this temperature criterion shall only occur when authorized by the Construction Manager and with the concurrence of the Certification Engineer. Geomembrane placement shall not be performed during precipitation, fog, snow, in an area of ponded water, or in the presence of excessive winds. Limited exceptions may be granted if the Geosynthetics Installer has established satisfactory installation methods under marginal weather conditions and has submitted an Inclement Weather Placement Plan.

The Certification Engineer shall verify that the above conditions are fulfilled and shall inform the Construction Manager if the conditions are not fulfilled.

8.2.1.5 Anchorage System

Anchor trenches shall be excavated by the Constructor (unless otherwise specified) to the lines and widths shown on the Design Drawings prior to geomembrane placement. The Certification Engineer shall verify that anchor trenches have been constructed according to the plans.

Slightly rounded corners will be provided in trenches where the geomembrane adjoins the trench to avoid sharp bends in the geomembrane. Loose soil shall not underlie the geomembrane in the trenches. Seaming shall continue through the anchor trench.

8.2.1.6 Method of Placement

The following is the responsibility of the Geosynthetics Installer; the Certification Engineer shall document that these conditions are satisfied:

- equipment used does not damage the geomembrane by handling, traffic, excessive heat, leakage of liquids, or other means;

- the prepared surface underlying the geomembrane has not deteriorated since previous acceptance, and is still acceptable immediately prior to geomembrane placement;

- personnel working on the geomembrane do not smoke, wear damaging shoes, or engage in other activities that could damage the geomembrane;

- the method and equipment used to unroll the panels does not cause scratches or crimps in the geomembrane and does not damage the underlying layer;

- the method used to place the panels minimizes wrinkles (especially differential wrinkles between adjacent panels);

- placed geomembrane panels shall extend a minimum of five feet (5 ft) beyond the toe of slope.

- adequate temporary loading and/or anchoring (e.g., sand bags, tires), not likely to damage the geomembrane, has been placed to prevent uplift by wind (in case of high winds, continuous loading, e.g., by adjacent sand bags, is recommended along the edges of panels to minimize the risk of wind flow under the panels).; and

- direct contact with the geomembrane is minimized; i.e., the geomembrane is protected by geotextile, extra geomembrane, or other suitable materials, in areas where excessive traffic may be expected.

The Certification Engineer shall inform the Construction Manager if the above conditions are not fulfilled.

8.2.1.7 Damage

The Certification Engineer shall visually observe each panel, after placement and prior to seaming, for damage. The Certification Engineer shall advise the Construction Manager which panels, or portions of panels, should be rejected, repaired, or accepted. Damaged panels or portions of damaged panels which have been rejected shall be marked and their removal from the work area recorded by the Certification Engineer.

As a minimum, the Certification Engineer shall document that:

- the panel is placed in such a manner that it is unlikely to be further damaged; and

- any tears, punctures, holes, thin spots, etc. are either marked for repair or the panel is rejected.

8.2.2 Field Seaming

Field seaming is the responsibility of the Geosynthetics Installer and shall be performed in accordance with approved methods.

Approved processes for field seaming are extrusion seaming and fusion seaming. Proposed alternate processes shall be documented and submitted to the Certification Engineer for approval. Only seaming equipment which has been specifically approved by make and model by the Certification Engineer shall be used. The Geosynthetics Installer shall submit seaming equipment documentation to the Construction Manager and the Certification Engineer for inclusion into the CQA Final report.

The following is the responsibility of the Geosynthetics Installer; the Certification Engineer shall verify that these conditions are met:

- the Geosynthetics Installer maintains on-site the number of spare operable seaming apparati decided at the Pre-Construction Meeting;

- equipment used for seaming is not likely to damage the geomembrane;

- the extruder is purged prior to beginning a seam and until heat-degraded extrudate has been removed from the barrel;

- for cross seams, the edge of the cross seam is ground to a smooth incline (top and bottom) prior to seaming;

- the electric generator used during geosynthetics installation is placed on a flat smooth base and a rub sheet such that no damage occurs to the geomembrane; and

- a smooth insulating plate or fabric is placed beneath the hot seaming apparatus after usage.

8.2.2.1 Extrusion Seaming

The extrusion seaming apparatus shall be equipped with gauges giving the relevant temperatures of the apparatus such as the temperatures of the extrudate, nozzle, and preheat.

The Geosynthetics Installer shall provide documentation on the extrudate to the Construction Manager and the Certification Engineer, and shall certify that the extrudate is compatible with the design specifications, and is comprised of the same resin as the geomembrane sheeting.

The Certification Engineer shall log apparatus temperatures, ambient temperatures, extrudate temperatures, and sheet temperatures a minimum of every five hours. Apparatus temperatures should be checked randomly during seaming operations to ensure the settings used to complete trial seams are maintained.

8.2.2.2 Fusion Seaming

The fusion seaming apparatus must be automated self-propelled devices, equipped with gauges giving the applicable temperatures. The pressure setting shall be verified by the Geosynthetics Installer prior to each seaming period.

The Certification Engineer shall log ambient temperatures, sheet temperatures, and seaming apparatus temperatures, speeds, and pressures.

8.2.2.3 Seam Preparation

The following is the responsibility of the Geosynthetics Installer; the Certification Engineer shall verify that these conditions are met:

- prior to seaming, the seam area is clean and free of moisture, dust, dirt, oils, greases, debris of any kind, and foreign material; the material to be jointed must be wiped with a clean cloth just prior to seaming;

- a rub sheet must be used to protect the underlying layer while cutting any materials;

- if seam overlap grinding is required, the process is completed according to the Geomembrane Manufacturer's instructions within 1 hour of the seaming operation, and in a way that does not damage the geomembrane;

- as a general guidance, the panels of geomembrane shall have a finished overlap; of a minimum of 3 in. for extrusion seaming and 4 in. for fusion seaming, but in any event sufficient overlap will be provided to allow peel tests to be performed on the seam;

- no solvent or adhesive is used unless the product is approved in writing by the Construction Manager (samples will be submitted to the Construction Manager for testing and evaluation);

- the procedure used to temporarily bond adjacent panels together does not damage the geomembrane (in particular, the temperature of hot air at the nozzle of any seaming apparatus is controlled such that the geomembrane is not damaged).

- no abrading is visible when welding is complete; and

- seams are aligned with the fewest possible number of wrinkle and "fishmouths".

The Certification Engineer shall observe all appropriate temperatures and conditions, and shall log and report to the Construction Manager any deviation.

8.2.2.4 Trial Seams

Trial seams shall be made on fragment pieces of geomembrane to verify that seaming conditions are adequate and in accordance with Table 7. Such trial seams shall be made at least once every 5 hours. A passing trial seam shall be made for each seaming device and technician for each material being welded (i.e., smooth to textured, textured to textured) for each technician. A change in technician or machine on a previously passed trial seam warrants the welding of a new passing trial seam. A trial seam shall also be made in the event that the sheet temperature varies more than 18°F (10°C) since the last passing trial seam. Trial seams shall be made under the same conditions as actual seams. If seaming apparatus is turned off for any reason, a new passing trial seam must be completed for that specific seaming apparatus.

The Geosynthetics Installer shall provide the tensiometer required for shear and peel testing of trial seams in the field. The tensiometer shall be automatic and shall have a direct digital readout. The tensiometer shall be calibrated prior to use at the site. The Geosynthetics Installer shall provide the Certification Engineer with the calibration certification.

The trial seam sample shall be at least 5 ft long by 1 ft wide (after seaming) with the seam centered lengthwise.

Six specimens, each 1 in. wide shall be cut from the trial seam sample by the Geosynthetics Installer. Three specimens shall be tested in shear and three in peel using a field tensiometer. For each fusion specimen, both tracks shall be tested. A passing welded seam is achieved in peel and shear when the specimen meets the criteria of Table 7.

If a specimen fails, the entire operation shall be repeated. If the additional specimen fails, the seaming apparatus and seamer shall not be accepted and shall not be used for seaming until the deficiencies are corrected and two consecutive successful full trial seams are achieved.

The Certification Engineer shall observe trial seam procedures. The remainder of the successful trial seam sample shall be assigned a number and marked accordingly by the Certification Engineer, who will also log the data, hour, ambient temperature, number of seaming unit, name of seamer, and pass or fail description. This portion of the sample shall be retained for the Construction Manager's archives.

8.2.2.5 General Seaming Procedure

Unless otherwise specified, the general seaming procedure used by the Geosynthetics Installer shall be as follows.

- For fusion seaming, a movable protective layer of plastic may be required to be placed directly below each overlap of geomembrane that is to be seamed. This is to help prevent any moisture build-up between the sheets to be seamed. This layer is temporary and shall be removed upon completion of the seam.

- If field conditions necessitate, a firm substrate will be provided by using a flat board or similar hard surface directly under the seam overlap to achieve proper support.

- Wrinkles at the seam overlaps will be cut along the ridge of the wrinkle in order to achieve a flat overlap. The cut wrinkles will be seamed and any portion where the overlap is inadequate will then be patched with an oval or round patch of the same geomembrane extending a minimum of 6 in. beyond the cut in all directions.

- Seaming will extend to the outside edge of panels to be placed in the anchor trench.

- No field seaming shall take place without the Geosynthetics Field Superintendent and representatives of the Certification Engineer being present.

The Certification Engineer shall verify that the above seaming procedures are followed, and shall inform the Construction Manager if they are not.

8.2.2.6 Non-Destructive Seam Continuity Testing

The Geosynthetics Installer shall non-destructively test field seams over their full length using a vacuum test unit (for extrusion or single wedge fusion seams only), air pressure test, or other approved method. The testing shall be carried out to the accepted standards of the industry. The purpose of non-destructive tests is to check the continuity of seams. It does not provide any information on seam strength. Continuity testing shall be carried out as the seaming work progresses (maximum of 3,000 lineal ft of seam to be welded prior to beginning nondestructive testing), not at the completion of all field seaming, unless otherwise approved by the Construction Manager. The Geosynthetics Installer shall complete any required repairs in accordance with this QA/QC Plan. Non-destructive testing shall not be permitted before sunrise or after sunset unless the Geosynthetics Installer demonstrates capabilities to do so.

Air Pressure Testing:

Unless otherwise specified, the general air pressure testing procedure used by the Geosynthetics Installer shall be as follows:

- Inflate the test channel to 30 to 35 psi, close valve, and observe initial pressure after approximately 2 minutes.
- Initial pressure settings are read after a 2 minute "relaxing period". Initial pressure setting shall be between 30 and 35 psi. The purpose of the "relaxing period" is to permit the air temperature and pressure to stabilize.
- Observe and record the air pressure 5 minutes after "relaxing period" ends and initial pressure setting is used. If loss of pressure exceeds 3 psi, or if the pressure does not stabilize, locate the faulty area and repair.
- At the conclusion of the pressure test, the end of the seam opposite the pressure gauge is cut. A decrease in a gauge pressure must be observed or the air channel will be considered "blocked" and the test will have to be repeated after the blockage is located and corrected.
- Remove needle or other approved pressure feed device and seal the resulting hole by extrusion welding.
- Test results will be recorded by the Certification Engineer.

Non-complying Air Pressure Test:

In the event of a non-complying air pressure test, the following procedure shall be followed:

- Check the seam and seals and retest the seam.
- If deviation with specified maximum pressure differential reoccurs cut 1 in. samples from each end of the suspect area.
- Perform destructive peel tests on the samples using the field tensiometer.

- If all samples pass destructive testing, the installer may:
  - Cap-strip the suspect area;
  - When sufficient overlap exists (1.5 in.), heat tack the overlap and extrusion weld the entire seam; or
  - Further isolate the air pressure failure as agreed upon by the Certification Engineer and Construction Manager.
- If one or more samples fail the peel tests, additional samples will be taken. When two passing samples are located, the suspect areas will be considered non-complying. In this section the seam shall be cap stripped, or the overlap left by the wedge welder will be heat tacked in place along the entire length of the seam and will be extrusion welded. Test the entire length of the repaired seam by vacuum testing.
- If the seam is in non-compliance due to air channel blockage, the blockage shall be isolated, as agreed upon by the Certification Engineer and the Construction Manager.
- All sections shall be retested and repaired in accordance with this section.

Vacuum Testing:

Unless otherwise specified, the general vacuum testing procedure used by the Geosynthetics Installer shall be as follows.

- Turn on the vacuum pump to reduce the vacuum box to approximately 5 psi.
- Apply a generous amount of a solution of liquid soap and water to the area to be tested.
- Place the vacuum box over the area to be tested and apply sufficient downward pressure to "seat" the seal strip against the liner.
- Close the bleed valve and open the vacuum valve.

- Ensure that a leak tight seal is created.
- For a period of not less than 15 seconds, examine the geomembrane through the viewing window for the presence of soap bubbles.
- If no bubbles appear after 15 seconds, close the vacuum valve and open the bleed valve, move the box over the next adjoining area with a minimum 3 in. overlap, and repeat the process.

Non-Complying Vacuum Test:

In the event of a non-complying vacuum test, the following procedure shall be followed.

- Mark all areas where soap bubbles appear and repair the marked areas, as specified in this section.

CQA Responsibilities:

The Certification Engineer shall:

- document all continuity testing;
- record location, date, unit number, name of tester, and outcome of all testing; and
- inform the Geosynthetics Installer and Construction Manager of any required repairs.

When defects are located, the Certification Engineer shall:

- observe the repair and retesting of the repair;
- mark on the geomembrane that the repair has been made; and
- document the results.

Non-Testable Areas:

The Geosynthetics Installer shall use the following procedures at locations where seams cannot be non-destructively tested:

- Seams shall be cap-stripped with the same geomembrane material.
- If the seam is accessible to testing equipment prior to final installation, the seam shall be non-destructively tested prior to final installation.
- If the seam cannot be tested prior to final installation, the seaming and cap-stripping operations shall be observed by the Certification Engineer and Geosynthetics Installer for uniformity and completeness.

8.2.2.7 Destructive Seam Testing

The Geosynthetics Installer will not be informed in advance of the locations where the seam samples will be taken.

Sampling Procedure:

Samples shall be cut by the Installer as the seaming progresses to have passing laboratory test results before the geomembrane is covered by another material. The Certification Engineer shall:

- observe sample cutting;
- assign a number to each sample, and mark it accordingly;
- record the sample location on the layout drawing; and
- record the reason for taking the sample at this location (e.g., statistical routine, suspicious feature of the geomembrane).

All holes in the geomembrane resulting from destructive seam sampling shall be immediately repaired in accordance with repair procedures described in Subsection

8.2.3 of this QA/QC Plan. The continuity of the new seams in the repaired area will be tested.

Size of Samples:

At a given sampling location, two types of samples shall be taken by the Geosynthetics Installer.

First, two specimens for field testing shall be taken. Each of these specimens will be 1 in. wide by 12 in. long, with the seam center parallel to the width. The distance between these two specimens will be 42 in. (or 30 in. see below). If both specimens pass the field tests described under the heading entitled "Field Testing," a sample for laboratory testing shall be taken.

The sample for laboratory testing shall be located between the two specimens for field testing. The destructive sample will be 12 in. wide by 42 in. long if the Geomembrane Installer requests a sample; otherwise the destructive samples will be 30 in. with the seam centered lengthwise. The sample shall be cut into three parts and distributed as follows:

- One portion to the Geosynthetics Installer for laboratory testing, 12 in. × 12 in.;
- One portion to the Construction Manager for archive storage, 12 in. × 12 in.;
- One portion for Geosynthetics CQA Laboratory testing, 12 in. × 18 in.

Final determination of the sample sizes shall be made at the Pre-Construction meeting.

Field Testing:

Two 1 in. wide specimens shall be tested in the field with the tensiometer, for peel and shear respectively, and shall meet the minimum requirements presented in Table 7. If any field test sample fails to pass, then the procedures outlined in this section will be followed.

The Certification Engineer shall review field tests and mark all samples and portions with their number. The Certification Engineer shall also log the date and time, ambient temperature, number of seaming unit, name of technician, seaming apparatus temperatures and speeds, and pass or fail description.

Geosynthetics QA Laboratory Testing:

Destructive test samples shall be packaged and shipped, if necessary, by the Certification Engineer in a manner that will not damage the test sample. The Construction Manager shall be responsible for storing the archive samples. Test samples shall be tested by the Geosynthetics CQA Laboratory.

Testing will include shear and peel as shown in Tables 7. At least five specimens will be tested for each test method. A maximum of one non-film tear bond (FTB) failure is acceptable, for each method, provided that strength requirements are met on that sample.

The Geosynthetics CQA Laboratory shall provide test results, in writing, no more than 24 hours after they receive the samples. The Geosynthetic CQA Laboratory shall document the results of seam testing. The Certification Engineer shall review laboratory test results as soon as they become available, and make appropriate recommendations to the Construction Manager.

Destructive Test Failure:

The following procedures shall apply whenever a sample fails a destructive test, whether that test is conducted by the Geosynthetics CQA Laboratory, the Geosynthetics Installer's Laboratory, or by the field tensiometer.

- The Geosynthetics Installer can reconstruct the seam between any two passed destructive seam test locations; or

- The Geosynthetics Installer can trace the seaming path to an intermediate location (at least 10 ft from the point of the failed test in each direction) and take a small sample for an additional field test at each location. If these additional samples pass field tensiometer testing, then full destructive laboratory samples are taken. If these destructive laboratory samples pass the

tests, then the seam shall be reconstructed between these locations by capping for extrusion or fusion welds, by extrusion welding the flap for fusion welds, or by removing and replacing the seam. If either the field tensiometer or the laboratory test sample fails, then the process is repeated to establish the zone in which the seam should be reconstructed.

If a fusion type seam fails destructive testing and the Geosynthetics Installer chooses to cap the seam, only acceptable capping methods will be allowed.

All acceptable seams must be bounded by two locations from which destructive samples passing laboratory tests have been taken. In cases exceeding 150 ft of reconstructed seam, a sample shall be taken from the zone in which the seam has been reconstructed. This sample must pass destructive testing or the procedure outlined here must be repeated.

The Certification Engineer shall document all actions taken in conjunction with destructive test failures.

8.2.3 Defects and Repairs

Seams and non-seam areas of the geomembrane shall be examined by the Certification Engineer for identification of defects, holes, blisters, undispersed raw materials and any sign of contamination by foreign matter. Because light reflected by the geomembrane helps to detect defects, the surface of the geomembrane will be clean at the time of examination. The surface shall be swept or washed by the Geosynthetics Installer if the amount of dust or mud inhibits examination.

8.2.3.1 Repair Procedures

Any portion of the geomembrane exhibiting a flaw, failing a destructive, or failing a non-destructive test, shall be repaired. Several procedures exist for the repair of these areas. The final decision as to the appropriate repair procedure shall be approved by the Construction Manager and the Certification Engineer. The procedures available include:

- Patching - Apply a new piece of geomembrane sheet over, and at least 6 in. beyond the limits of a defect. The patch shall be extrusion seamed to the

underlying geomembrane. This method should be used to repair large holes, tears, destructive test locations, undispersed raw materials, and contamination by foreign matter.

- Spot Seaming - Apply a "bead" of extrudate, maximum length of 6 in., over a defect. Spot seaming should be used only to repair dents, pinholes, pressure test air holes, or other minor, localized flaws.

- Capping - Apply a new strip of geomembrane along the length of a delineated faulty seam. The cap strip shall extend at least 6 in., beyond the limit of the seam and the edges will be extrusion seamed to the underlying geomembrane. This method should be used to repair lengths of extrusion or fusion seamed to the underlying geomembrane.

- Welding Flap - Where an adequate flap exists (i.e., 1.5 in. or more), extrusion weld the flap of a fusion seam. At the ends of this repair, the flap shall be cut to allow the extrusion weld to enclose the failed area.

- Replacement - The faulty seam is removed and replaced.

In addition, the following provisions shall be satisfied:

- Surfaces of the geomembrane which are to be repaired will be abraded no more than one hour prior to the repair;

- All surfaces must be clean and dry at the time of the repair;

- All seaming equipment used in repairing procedures must be approved;

- The repair procedures, materials, and techniques will be approved in advance of the specific repair by the Certification Engineer and Geosynthetics Installer;

- Patches or caps will extend at least 6 in. beyond the edge of the defect, and all corners of patches will be rounded;

- Seam repairs over 150 ft long will require a destructive test to be taken from the repair.

8.2.3.2 Verification of Repairs

Each repair shall be numbered and logged by the Certification Engineer and the Geosynthetics Installer. Each repair shall be non-destructively tested using the methods described in this section as appropriate. Repairs which pass the non-destructive test will be taken as an indication of an adequate repair. However, if the Certification Engineer suspects a repair to be questionable, although it passes non-destructive testing, a destructive test can be requested. Failed tests will require the repair to be redone and retested until a passing test results. The Certification Engineer shall observe non-destructive testing of repairs and shall record the date of the repair and test outcome.

8.2.3.3 Large Wrinkles

When seaming of the geomembrane is completed (or when seaming of a large area of the geomembrane is completed) and prior to placing overlying materials, the Certification Engineer shall observe the geomembrane wrinkles. Wrinkles exceeding six inches in height shall not be permitted. The Certification Engineer will indicate to the Construction Manager which wrinkle should be cut and resealed by the Geosynthetics Installer. The seam thus produced will be tested like any other repair.

8.2.4 Backfilling of Anchor Trench

Anchor trenches will be adequately drained, to prevent ponding or otherwise softening of the adjacent soils while the trench is open. Anchor trenches shall be backfilled and compacted as soon as possible after completion of geosynthetics installation. Care shall be taken when backfilling the trenches to prevent any damage to the geosynthetics.

The Certification Engineer shall observe the backfilling operation and advise the Construction Manager of any problems.

8.2.5 Geomembrane Certification/Acceptance

The Geosynthetics Installer and the Geomembrane Manufacturer shall retain ownership and responsibility for the geosynthetics in the facility until acceptance by the Owner.

The geomembrane shall be accepted by TVA when:

- the installation is completed;
- verification of the adequacy of seams and repairs, including associated testing, is complete;
- Geosynthetics Installer's representative furnishes the Construction Manager with certification that the geomembrane was installed in accordance with the Geomembrane Manufacturer's recommendations as well as the Design Drawings and specifications;
- all documentation of installation is completed including the Certification Engineer final report; and
- certification, including record drawings, sealed by a Professional Engineer has been received by the Construction Manager.

The Certification Engineer shall provide certification that installation has proceeded in accordance with this Plan for the project, except as noted to the Construction Manager.

8.2.6 Materials in Contact with the Geomembrane

The quality assurance procedures indicated in this Subsection are only intended to verify that the installation of these materials does not damage the geomembrane. Additional quality assurance procedures provided in other sections of this QA/QC Plan are necessary to verify that the systems built with these materials are constructed to perform as designed.

8.2.6.1 Geocomposite

Extreme care shall be exercised so as not to damage the geomembrane during placement of the geocomposite and the materials overlying the geocomposite. The Certification Engineer shall verify that the geocomposite is installed in accordance with the procedures described in Section 9 "Geocomposite" of this QA/QC Plan.

8.2.6.2 Appurtenances

The Design Engineer shall provide design specifications for appurtenances to the Construction Manager and the Certification Engineer.

The Certification Engineer shall verify that:

- installation of the geomembrane in appurtenance areas, and connection of geomembrane to appurtenances have been made according to the design specifications;
- extreme care is taken while seaming around appurtenances since neither non-destructive nor destructive testing may be feasible in these areas; and
- the geomembrane has not been visibly damaged while making connections to appurtenances.

The Certification Engineer will inform the Construction Manager if the above conditions are not fulfilled.

9 GEOCOMPOSITE

9.1. Manufacturers Documentation

Prior to delivery, the Geocomposite Manufacturer shall provide documentation which demonstrates that the property values of the material meet the requirements as specified in Table 8. Delivered rolls of geocomposite shall be appropriately labeled.

9.1.1 Certification of Property Values

Prior to shipment the Geocomposite Manufacturer shall provide the Construction Manager and Certification Engineer with a list of guaranteed minimum properties (Table 8) for the type of geocomposite to be supplied. The Geocomposite Manufacturer shall also provide the Construction Manager and Certification Engineer with a written certification signed by a responsible party that the geocomposite actually delivered has properties which meet or exceed the guaranteed properties. Geotextile will be thermally bonded to geonet components of geocomposite.

The Certification Engineer shall examine the Manufacturer's certifications to verify that the property values listed on the certifications meet or exceed the project requirements. Deviations from the project requirements shall be reported to the Construction Manager.

9.1.2 Labeling

The Geocomposite Manufacturer shall identify all rolls of geocomposite. Each geocomposite roll shall have a weatherproof label which contains the following:

- manufacturer's name;
- product identification;
- lot number;
- roll number; and
- roll dimensions.

The Certification Engineer shall examine rolls upon delivery and any deviation from the above requirements shall be reported to the Construction Manager.

9.2 Shipment And Storage

Geocomposite cleanliness is essential to performance; therefore, measures must be taken during shipment and storage to protect the geocomposite from dust and dirt. Geocomposite rolls shall be wrapped in plastic sheets or otherwise protected. Wrappings protecting the geocomposite rolls should be removed less than 1 hour prior to unrolling the geocomposite.

The Certification Engineer shall verify that the geocomposite is free of dirt and dust prior to being installed. If the geocomposite is judged dirty or dusty, it shall be washed by the Geosynthetics Installer prior to installation. Washing operations shall be approved by the Certification Engineer.

The Certification Engineer shall examine rolls prior to installation; any deviation from the above requirements shall be reported to the Construction Manager. Damaged rolls shall be rejected and replaced at no cost to TVA.

9.3 Conformance Testing Of Geocomposite

Upon or prior to delivery of the rolls of geocomposite, the Certification Engineer may remove and forward samples to the Geosynthetics CQA Laboratory for testing to verify conformance with the design specifications listed in Table 9.

9.3.1 Sample Collection

Using the packing list provided by the manufacturer or a sequential inventory list made by the Certification Engineer, rolls may be selected for sampling at a minimum frequency of one sample per 100,000 ft^2 of material. If the material is shipped in identifiable lots or manufacturing runs, sample selection should be adjusted to assure that the minimum frequency is met and that each different lot or manufacturing run is represented by at least one sample. If a roll is not identifiable by roll number, the Certification Engineer shall notify the Construction Manager immediately. If the roll cannot be tracked, the Construction Manager shall reject the roll.

Samples will be taken across the entire width of the roll and will not include the first 3 lineal ft. Unless otherwise specified, samples will be 3 ft long by the roll width. The Certification Engineer will mark the machine direction on the samples with an arrow.

9.3.2 Test Results

The results of the conformance testing shall be evaluated in accordance to the following procedure:

- If the test values for the sample meet all of the values given in Table 8 and the Manufacturer's guaranteed minimum values, the sample passes.
- If the test value for the sample does not meet one or more of the required values, additional evaluation procedures will be implemented by the Certification Engineer.
- For the failing parameter(s), perform one additional test on the sample. This test may be performed by another Geosynthetics CQA Laboratory at the discretion of the Certification Engineer and the Construction Manager.
- If the test values for the additional test meet the required values, the roll and adjacent rolls pass and are acceptable.
- If the test value does not met requirements, reject the roll, collect samples from the closest numerical roll on both sides of the failed roll, and test for the failed parameter(s). If one or both of these tests do not meet requirements, those roll(s) will be rejected and the Certification Engineer and Construction Manager shall determine further testing protocol and criteria for identifying the limits of rejected rolls.

9.4. Handling And Placement

The Geosynthetics Installer shall handle the geocomposite in such a manner as to minimize damage and comply with the following:

- After the wrapping has been removed; the geocomposite shall not be exposed to sunlight for more than the duration specified by the Geotextile Manufacturer.

- On slopes, the geocomposite shall be secured in the anchor trench and then rolled down the slope in such manner as to continually keep the geocomposite sheet in tension. If necessary, the geocomposite shall be positioned by hand after being unrolled to minimize wrinkles. Geocomposite can be placed in the horizontal direction (i.e., across the slope) in some special locations (e.g., at the toe of the slope, or, if an extra layer of geocomposite is required, this extra layer can be placed in the horizontal direction). Such locations shall be identified by the Design Engineer in the Design Drawings.

- The geocomposite shall extend a minimum of 10 feet beyond the toe of slope.

- In the presence of wind, the geocomposite shall be weighted with sandbags or the equivalent. Such sandbags shall be installed during placement and remain until replaced with overlying material.

- Unless otherwise specified, the geocomposite shall not be welded to geomembrane.

- The Geosynthetics Installer shall take necessary precautions to prevent damage to underlying layers during placement of the geocomposite. Care should be taken not to leave tools on or in the geocomposite.

- During placement of the geocomposite, care shall be taken not to entrap dirt or excessive dust that could cause clogging of the drainage system, and/or stones that could damage the adjacent geomembrane. If any dirt, excessive dust, and/or any stones are entrapped in or below the geocomposite, the geocomposite and underlying liner shall be washed or swept prior to placement of material on it.

The Certification Engineer shall note any deviation and report it to the Construction Manager.

9.5 Stacking And Joining

Stacked geocomposite shall be placed in the same direction to prevent the stands of one layer from penetrating the channels of the lower layer, thereby significantly reducing the transmissivity. Geocomposite shall not be laid in direction perpendicular to the underlying geocomposite unless otherwise specified by the Design Engineer.

Adjacent geocomposite panels shall be joined according to the plans and CQA Panel. As a minimum, the following requirements shall be met:

Geonet components:

- Adjacent rolls shall be overlapped by at least 4 in.
- These overlaps shall be secured by tying.
- Tying shall be achieved by nylon cable ties. Tying devices will be white or yellow for easy observation. Metallic devices are not allowed.
- Tying devices shall be placed every 5 ft down the slope, every 2 ft across the slope, and every 6 ft on horizontal surfaces.

Geotextile Components:

- The bottom layers of geotextile shall be overlapped. The top layer of geotextile shall be continuously sewn (i.e., spot sewing is not allowed). Geotextile panels shall be overlapped a minimum of 4 in. prior to sewing.
- No horizontal seams shall be allowed on slopes steeper than 10 horizontal to 1 vertical.
- Polymeric thread, with chemical resistance properties equal to or exceeding those of the geotextile component, shall be used for all sewing. The seams shall be sewn using stitch Type 401. The seam type shall be Federal Standard Type SSN-1.

Geocomposite:

- In the corners of the side slopes of rectangular areas of the disposal areas, where overlaps between perpendicular geocomposite strips are required, and extra layer of geocomposite shall be unrolled along the slope, on top of the previously installed geocomposite, from top to bottom of the slope.

- When more than one layer of geocomposite is installed, joints shall be staggered.

The Certification Engineer shall note any deviation and report it to the Construction Manager.

9.6 Repair

Any holes or tears in the geocomposite shall be repaired by placing a patch extending 2 ft beyond the edges of the hole or tear. The patch shall be secured to the original geocomposite by tying every 6 in. If the hole or tear width across the roll is more than one-half the width of the roll, the damaged area shall be cut out and the two portions of the geocomposite shall be joined.

The Certification Engineer shall observe any repair, note any deviation with the above requirements and report them to the Construction Manager.

9.7 Placement of Materials on Geocomposites

The placement of materials on the geocomposite shall be as soon as possible, such that:

- the geocomposite and underlying geomembrane are not damaged;

- minimal slippage of the geocomposite on the underlying geomembrane occurs; and

- no excess tensile stresses occur in the geocomposite.

If portions of the geocomposite are exposed, the Certification Engineer shall periodically place marks on the geocomposite and the underlying geomembrane and measure the elongation of the geocomposite during the subsequent construction activities. Before a subsequent layer of geosynthetic is placed on the geocomposite the Certification Engineer should observe the geocomposite and underlying liner to determine if any dirt, excessive dust, or any stones are entrapped in, or below, the liner. If so, the geocomposite and geomembrane must be washed or the geocomposite removed so that the liner can be cleaned.

Any deviation shall be noted by the Certification Engineer and reported to the Construction Manager.

10 GEOTEXTILE

10.1 Manufacturers Documentation

Prior to delivery, the Geotextile Manufacturer shall provide documentation to demonstrate that the property values of the material meet requirements as specified in Table 10. Delivered rolls of geotextile shall be appropriately labeled.

10.1.1 Certification of Property Values

The Geotextile Manufacturer shall provide the Construction Manager and Certification Engineer with a list of guaranteed "minimum average roll value" properties (as defined by the Design Engineer) for the type of geotextile to be supplied, as defined in Table 10. The Geotextile Manufacturer shall provide the Construction Manager and Certification Engineer with a written certification signed by a responsible party that the geotextile actually delivered have properties which meet or exceed the guaranteed "minimum average roll values" properties.

The Certification Engineer shall examine the Geotextile Manufacturer's certifications to verify that the property values listed on the certifications meet or exceed requirements listed in this QA/QC Plan. Deviations shall be reported to the Construction Manager.

10.1.2 Labeling

The Geotextile Manufacturer shall identify all rolls of geotextile. Each geotextile roll shall have a weatherproof label which contains the following:

- manufacturer's name;
- product identification;
- lot number;
- roll number;
- roll weight; and

- roll dimensions.

In addition, if any special handling of the geotextile is required, it shall be so marked on the top surface of the geotextile, e.g., "This Side Up". Rolls without proper identification shall be rejected by the Construction Manager.

The Certification Engineer shall examine rolls upon delivery and any deviation form the above requirements shall be reported to the Construction Manager.

10.2 Shipment and Storage

During shipment and storage, the geotextile shall be protected from ultraviolet light exposure, precipitation, snow or other inundation, mud, dirt, dust, puncture, cutting or any other damaging or deleterious conditions. Geotextile rolls shall be wrapped in plastic sheets or otherwise protected. Wrappings protecting the geotextile rolls should be removed less than one hour prior to unrolling the geotextile.

Geotextile shall not be exposed to precipitation prior to being installed. Wet geotextile is heavy which makes it difficult to deploy. During cold weather, the geotextile must be protected from freezing.

The Certification Engineer shall observe rolls upon delivery and prior to installation, any deviation from the above requirements shall be reported to the Construction Manager. Any damaged rolls shall be rejected and replaced at no cost to TVA.

10.3 Conformance Testing of Geotextile

Prior to the deployment of the rolls of geotextile, the Certification Engineer may remove and forward samples to the Geosynthetics CQA Laboratory for testing to verify conformance with the design specifications. Testing shall be accomplished using the parameters listed in Table 11.

10.3.1 Sample Collection

Using the packing list provided by manufacturer or a sequential inventory list made by the Certification Engineer, rolls may be selected for sampling at a minimum

frequency of one sample per 100,000 ft^2 of material. If the material is shipped in identifiable lots or manufacturing runs, sample selection should be adjusted to assure that the minimum frequency is met and that each different lot or manufacturing run is represented by at least one sample. If a roll is not identifiable by roll number, the Certification Engineer shall inform the Construction Manager immediately. If the roll cannot be tracked, the Construction Manager shall reject the roll.

Samples will be taken across the entire width of the roll and will not include the first 3 lineal ft. Unless otherwise specified, samples will be 3 ft long by the roll width. The Certification Engineer will mark the machine direction on the samples with an arrow.

10.3.2 Test Results

The results of the conformance testing shall be evaluated in accordance to the following procedure:

- If the test values for the sample meet all of the required values, the sample passes.
- If the test value for the sample does not meet one or more of the required values, additional evaluation procedures will be implemented by the Certification Engineer.
- For the failing parameter(s), perform one additional test on the sample. This test may be performed by another Geosynthetics CQA Laboratory at the discretion of the Certification Engineer and the Construction Manager.
- If the test values of the additional test meet the required values, the roll and adjacent rolls pass and are acceptable.
- If the test values do not meet requirements listed in Tables 10 and 11, reject the roll, collect samples from the closest numerical roll on both sides of the failed roll and test for the failed parameter(s). If one or both of these tests do not meet requirements, those roll(s) will be rejected and the Certification Engineer and Construction Manager shall determine further testing protocol and criteria for identifying the limits of rejected rolls.

10.4 Handling and Placement

The Geosynthetics Installer shall handle the geotextile in such a manner as to minimize damage and shall comply with the following:

- After the wrapping has been removed; the geotextile shall not be exposed to sunlight for more than the duration specified by the Geotextile Manufacturer.

- In the presence of wind, the geotextile shall be weighted with sandbags or the equivalent. Sandbags shall be installed during the placement and shall remain until replaced with the appropriate overlying material.

- Geotextile shall be kept continually under tension to minimize the presence of wrinkles in the geotextile.

- The geotextile shall be cut using an approved geotextile cutter only. If in-place, special care must be taken to protect other materials from damage which could be caused by the cutting of the geotextile.

- The Geosynthetics Installer shall take necessary precautions to prevent damage to the underlying layers during placement of the geotextile.

- During placement of geotextile, care shall be taken not to entrap stones, excessive dust, or moisture that could damage the geomembrane, generate clogging of drains or filters, or hamper subsequent seaming.

- After installation, the entire surface of the geotextile shall be examined, and harmful foreign objects, such as needles, shall be removed.

- If white geotextile is used, precautions will be taken against "snow blindness" of personnel.

The Certification Engineer shall note any deviation and report it to the Construction Manager.

10.5 Seams and Overlaps

The Geotextile seams shall be continuously sewn using thread, which is at least as chemically resistant and UV resistant as the geotextile. The thread shall be approved by the Certification Engineer and Construction Manager. Spot sewing is not permitted, except for repairs, and thermal bonding shall not be permitted without the written approval of the Construction Manager. The geotextile shall be overlapped a minimum of 4 in. prior to seaming. The Geosynthetics Installer shall pay particular attention that no material is inadvertently inserted beneath the geotextile. Within the Central Drainage Corridor the geotextile panels may be overlapped a minimum of 2 ft. between adjacent panels and the overlap sand bagged, in place of sewing of adjacent panels.

The Certification Engineer shall note any deviation and report it to the Construction Manager.

10.6 Repair

Any holes or tears in the geotextile shall be repaired by the Geosynthetics Installer as follows:

- A patch made from the same geotextile shall be sewn in place with a minimum of 24 in. overlap in all directions.

Care shall be taken to remove any soil or other material which may have penetrated the torn geotextile.

The Certification Engineer shall observe any repair, note any deviation from the above requirements and report them to the Construction Manager.

10.7 Placement of Materials on Geotextiles

The Geosynthetics Installer shall place materials on the geotextile taking the following precautions:

- cause no damage to geotextile;
- allow minimal slippage of the geotextile on underlying layers;

- equipment used for packing the overlying material shall not be driven directly on the geotextile;

- a minimum thickness of 1 ft of soil must be maintained between light, low ground-pressure equipment (such as a wide pad Caterpillar D-6 or lighter) and the geotextile;

- a minimum thickness of 1.5 ft of soil must be maintained between rubber-tired vehicles and the geotextile unless approved by the Design Engineer and Construction Manager; and

- in heavily trafficked areas such as access ramps, soil thickness shall be at least 3 ft.

Any deviation shall be noted by the Certification Engineer and reported to the Construction Manager.

11. SURVEYING AND CONSTRUCTION TOLERANCES

The minimum thickness of the intermediate cover, compacted clay layer, and vegetative layer in the final cover shall be surveyed to verify that the minimum soil thicknesses specified in the Design Drawings are met. Other construction tolerances are as noted on the drawings.

Surveying will be performed under this section to document as-built conditions, and will be the responsibility of the Constructor. The as-built survey will be performed by a Surveyor registered in the state of Tennessee. Intermediate surveying for construction layout, slope staking, etc., may be performed by the Constructor's personnel.

The completed surfaces of subgrade, top of geologic buffer, top of soil dikes and gypsum dikes, completed outer gypsum dikes, top of intermediate cover, and top of vegetative cover will be surveyed. Geomembrane panels shall be surveyed and this survey shall include as-built information of: seam intersections, cross seams, repair locations, destructive sample locations, well or pipe penetration locations, and location of anchor trenches. In applicable cases, surveys will be performed before placement of the overlying drainage layer, to verify that grades and elevations are in accordance with the approved plans. At a minimum, survey points shall be established on a 50 ft. x 50 ft. grid. Survey grid points shall be located such that the same grid can be reused for subsequent as-built surveys as the completion of each layer progresses. Soil layer thickness shall be obtained to the nearest 0.001 ft. and reported to the nearest .01 ft.

The Certification Engineer may request additional survey information as required for certification.

12 REPORTING AND DOCUMENTATION

12.1 Deficiencies

When deficiencies are discovered, the Certification Engineer shall immediately determine the nature and extent of the problem, notify the Constructor, and complete required documentation. In all cases, the Certification Engineer will notify the Constructor within one-half hour of discovering the deficiency. If the deficiency will cause construction delays of more than four hours or will necessitate substantial rework, the Certification Engineer shall also notify the Construction Manager.

The Constructor shall correct the deficiency to the satisfaction of the Certification Engineer. If the Constructor is unable to correct the problem, the Certification Engineer will prepare a nonconformance report and will develop and present suggested solutions to the Construction Manager for approval.

The corrected deficiency shall be re-tested before additional work is performed. All retests, and the steps taken to correct the problem, will be documented by the Certification Engineer.

12.2 Documentation

The QA/QC Plan depends on through monitoring and documentation of construction activities. Therefore, the Certification Engineer shall document that Quality Assurance requirements have been addressed and satisfied. Documentation shall consist of daily record keeping, construction problem resolutions, photographic records, design revisions, weekly progress reports, and a certification and summary report.

12.2.1 Daily Record Keeping

At a minimum, daily records shall consist of field notes, summaries of the daily meetings with the Constructor, observations and data sheets, and construction problems and resolution reports. This information shall be submitted to the Construction Manager for review and approval.

A Daily Meeting Report will be prepared each day, summarizing discussions held with a Constructor. This report will include the following items:

a. date, project name, and location;

b. names of parties involved in discussions;

c. data on weather conditions;

d. listing and location of construction activities underway during the time frame of the Daily Summary Report;

e. equipment present on-site;

f. descriptions of areas and/or activities being inspected and/or tested, and related documentation;

g. description of off-site materials received;

h. scheduled activities;

i. items discussed;

j. signature of the Certification Engineer.

12.2.2 Observation and Test Sheets

Observation and test data sheets shall include the following information:

a. date, project name, and location;

b. weather data;

c. reduced-scale site plan showing work areas, including sample and test locations;

d. description of ongoing construction;

e. summary of test results identified as passing, failing, or in the event of a failed test, retest;

f. calibration of test equipment;

g. summary of decisions regarding acceptance of the work and/or corrective actions taken;

h. signature of the Certification Engineer.

12.2.3 Construction Problem Reports

This report identifies and documents construction problems and resolutions. It is intended to document problems involving significant rework and is not intended to document items easily corrected unless the problems are recurring. At a minimum, this report shall include the following items:

a. detailed description of the problem;

b. location and cause of the problem;

c. how the problem was identified;

d. resolution of the problem;

e. personnel involved;

f. signature of the Certification Engineer and Construction Manager.

12.2.4 Survey Control

The following procedures will be followed with respect to the as-built survey of the components of the CCB disposal facility.

- The subgrade, geologic buffer, soil dikes, perimeter gypsum dikes, outer gypsum dikes, compacted clay and soil layers, and vegetative soil layer will be surveyed to verify that grades and elevations are in accordance with the

approved Design Drawings. A comparison of the pre- and post-component construction surveys will be conducted to verify construction thickness.

- The Surveyor shall promptly submit results of each survey to the Construction Manager. Survey results shall include: copy of any field notes, electronic and hard copy of the survey point file, and electronic and hard copy of survey drawing.

- The Certification Engineer will certify that the components meet the requirements in the Design Drawings and will submit approval to the Construction Manager.

12.2.5 Design Changes

Design changes may be required during construction. In such cases, the Certification Engineer shall notify the Construction Manager, who will then notify the responsible State Agencies. Design changes shall only be made with written agreement of the Construction Manager.

12.2.6 Weekly Progress Reports

The Certification Engineer will prepare weekly progress reports summarizing construction and quality control activities. At a minimum this report, submitted to the Construction Manager, shall contain the following information:

a. date, project name, and location;

b. summary of work activities;

c. summary of deficiencies and/or defects and resolutions;

d. signature of Certification Engineer.

12.2.7 Certification Reports

The Certification Engineer will be required to submit the following certification reports. The first certification report will cover the construction of the base grade

components for the disposal area including: subgrade/structural fill, geologic buffer, soil dikes, gravel drainage layer and will be required prior to disposal of gypsum. A certification report will also be required for final cover system construction.

The final certification report will be required after the gypsum has reached final permitted grades. This report will cover the capping phase of construction and will be required after closure of the facility. This report will address final gypsum-fill slopes, compacted clay layer, geosynthetics, and vegetative layer.

At completion of each phase of construction, the Certification Engineer shall submit a certification report to the Construction Manager. This report shall certify that the work has been performed in substantial compliance with the approved Design Plans. At a minimum, this repot shall contain the following information:

a. summary of all construction activities;

b. testing laboratory test results;

c. observation and test data sheets;

d. sampling and testing location plan;

e. description of significant construction problems and their resolution;

f. list of changes from the approved plans and the justification for these changes;

g. record drawings; and

h. a certification statement signed and sealed by the Certification Engineer.

TABLES

TABLE 1

LABORATORY TEST METHODS
FOR THE EVALUATION OF SOIL AND AGGREGATE

COMMON TEST NAME	PARAMETER DEFINED	STANDARD METHOD
Soil Classification	Unified Soil Classification System	ASTM D 2487
Sieve and Hydrometer Analysis	Particle Size Distribution of Coarse and Fine Grained Soils	ASTM D 422
Sieve Analysis for Aggregates	Particle Size Distribution for Aggregates	ASTM C 136
Atterberg Limits	Liquid and Plastic Limits, Plasticity Index	ASTM D 4318
Standard Proctor Density	Moisture/Density Relationship Using 5.5 lb (2.46 kg) Rammer and 12 in. (305 mm) Drop	ASTM D 698
Moisture Content	Water to Dry Weight Ratio	ASTM D 2216
Permeability: Flex Wall Permeameter	Permeability (Hydraulic Conductivity) on Undisturbed or Remolded Samples of Soil	ASTM D 5084
Permeability: Constant Head	Permeability (Hydraulic Conductivity) of Aggregates	ASTM D 2434
Carbonate Content	Carbonate Content of Aggregate	ASTM D 3042

Notes: 1) Not all tests are required for this site; refer to Tables 3 and 4 in the CQA Plan.

2) Latest version of the applicable ASTM International or USDA testing standards shall be used when conducting tests.

TABLE 2

FIELD TEST METHODS
FOR THE EVALUATION OF SOIL AND AGGREGATE

COMMON TEST NAME	PARAMETER DEFINED	STANDARD METHOD
Visual Classification	Maximum Particle Size, General Material Characteristics	ASTM D 2488
USDA Classification	Classification of Ability to Support Vegetation	USDA Method
Nuclear Densometer	In-Place Density and Moisture Content	ASTM D 2922 and ASTM D 3017
Moisture Content	In-Place Moisture as Check on Nuclear Densometer Measurements	ASTM D 2216
Sand Cone Density	In-Place Density as Check on Nuclear Densometer Measurements	ASTM D 1556
Drive Tube Sample	In-Place Density as Check on Nuclear Densometer Measurements	ASTM D 2937
Lift Depth Check	Thickness of Placed Soils or Aggregates	Visual Confirmation

Notes: (1) Not all tests are required for this site; refer to Tables 3 and 4 in the CQA Plan.

(2) Latest version of applicable ASTM International or USDA testing standards shall be used when conducting tests.

TABLE 3

MINIMUM TEST FREQUENCIES FOR SOIL AND AGGREGATE MATERIALS IN BASE GRADE SYSTEM CONSTRUCTION

LINER COMPONENT	REQUIRED TEST	MINIMUM FREQUENCY	SAMPLE SIZE[a]	ACCEPTANCE CRITERIA
Subgrade/Structural Fill Conformance Testing[c]	Visual Observation	As required	N/A	Substantially free of debris, large rocks, plant materials, or other deleterious material.
	Sieve Analysis	1 per source & 1 per 5,000 yd^3	5-10 lb	Max. 4 in. particle size
	Standard Proctor Density	1 per source & 1 per 10,000 yd^3	50-100 lb	Determination of window of acceptable moisture content given required dry density. Maximum dry unit weight greater than 90 lb/ft^3.
Subgrade/Structural Fill Performance Testing[d]	Visual Observation	As required	N/A	Final surface: firm, smooth, and uniform
	Lift Depth Check	As required		6 to 8 in. compacted lift
	Nuclear Densometer In-place Density and Moisture Content	1 per 100 ft grid per lift	N/A	≥ 95% Standard Proctor maximum dry density, Moisture content -4% +4% of optimum.
	Moisture Content	1 per 10 nuclear densometer tests	Varies	Check nuclear densometer measurements to verify moisture correction.
	Sand Cone Density or Drive Tube Sample	1 per 25 nuclear densometer tests	Varies	Check nuclear densometer measurements to verify moisture correction and density.
Soil Dike Conformance Testing[c]	Visual Observation	As required	N/A	Substantially free of debris, large rocks, plant materials or other deleterious material. Must not pump or rut excessively.
	Sieve Analysis	1 per source & 1 per 5,000 yd^3	5-10 lb	1 inch max. particle size
	Atterberg Limits	1 per source & 1 per 5,000 yd^3	5-10 lb	Plasticity index: 10 or more[b]
	Standard Proctor Density	1 per source & 1 per 5,000 yd^3	50-100 lb	Determination of window of acceptable moisture content given required dry density. Maximum dry unit weight greater than 90 lb/ft^3.
	Moisture Content	1 per 5,000 yd^3	Varies	Determine if adequate moisture is present prior to compaction
	Soil Classification	1 per source & 1 per 5,000 yd^3	5-10 lb	SC, CL, CH, MH, ML, or SM

TABLE 3 (continued)

MINIMUM TEST FREQUENCIES FOR SOIL AND AGGREGATE MATERIALS
IN BASE GRADE SYSTEM CONSTRUCTION

LINER COMPONENT	REQUIRED TEST	MINIMUM FREQUENCY	SAMPLE SIZE[a]	ACCEPTANCE CRITERIA
Soil Dike Performance Testing[d]	Observation			
	Nuclear Densometer In-Place Density and Moisture Content	1 per 100 ft grid per lift	N/A	≥ 95% Standard Proctor maximum dry density. Moisture content -4 to +4% of optimum
	Moisture Content	1 per 5 nuclear densometer tests	Varies	Check nuclear densometer measurements to verify moisture correction.
	Sand Cone Density or Drive Tube Sample	1 per 25 nuclear densometer tests	Varies	Check nuclear densometer measurements to verify moisture correction and density.
	Lift Depth Check	As required	N/A	6 to 8 in. compacted lift
Geologic Buffer Conformance Testing[c]	Visual Observation	As required	N/A	Substantially free of debris, large rocks, plant materials, or other deleterious material.
	Sieve Analysis	1 per source & 1 per 5,000 yd^3	5-10 lb	1 inch max. particle size
	Atterberg Limits	1 per source & 1 per 5,000 yd^3	5-10 lb	Plasticity Index: 10 or more[b]
	Standard Proctor Density	1 per source & 1 per 5,000 yd^3	50-100 lb	Determination of window of acceptable moisture content given required dry density.
	Moisture Content	1 per 5,000 yd^3	Varies	Determine if adequate moisture is present prior to compaction
	Flexible Wall Permeability (remolded)	1 per 10,000 yd^3	50 lb	≤1×10^{-7} cm/sec; Certification Engineer to use approved borrow area specification APZ, but shall verify APZ throughout construction.
	Soil Classification	1 per source & 1 per 5,000 yd^3	5-10 lb	SC, CL, CH, MH, or ML
Geologic Buffer Performance Testing[d]	Visual Observation	As required	N/A	Final surface: firm, smooth, and uniform. Perform lift depth check.
	Nuclear Densometer In-place Density and	1 per 100 ft grid per lift	N/A	≥ 95% Standard Proctor maximum dry density and within the approved APZ

MINIMUM TEST FREQUENCIES FOR SOIL AND AGGREGATE MATERIALS IN BASE GRADE SYSTEM CONSTRUCTION

LINER COMPONENT	REQUIRED TEST	MINIMUM FREQUENCY	SAMPLE SIZE[a]	ACCEPTANCE CRITERIA
	Moisture Content			
Geologic Buffer Performance Testing (continued)[d]	Moisture Content	1 per 5 nuclear densometer tests	Varies	Check nuclear densometer measurements to verify moisture correction.
	Sand Cone Density or Drive Tube Sample	1 per 25 nuclear densometer tests	Varies	Check nuclear densometer measurements to verify moisture correction and density.
	Lift Depth Check	As required	N/A	6 to 8 in. compacted lift
Gravel Drainage Layer Conformance Testing[c]	Visual Observation	As required	N/A	Angular and substantially free of debris, large rocks, plant materials, or other deleterious material.
	Sieve Analysis	1 per source & 1 per 5,000 yd^3	5-10 lb	Max. 5% passing #200 sieve.
	Constant Head Permeability	1 per source & 1 per 5,000 yd^3	50 lb	$\geq 1 \times 10^{-1}$ cm/sec
	Carbonate Content	1 per source	50 lb	<10% by weight

[a] In general, where the symbol "N/A" (not applicable) is used, the test is performed on in-place materials.

[b] Minor variations shall be allowed in acceptance criteria for the geologic buffer in order to maintain permeability less than 1×10^{-7} cm/sec. Under no circumstances shall acceptance criteria be enforced which result in permeability greater than 1×10^{-7} cm/sec

[c] Conformance testing is performed on borrow sources and placed material to ensure the minimum required values are met and the material remains consistent.

[d] Performance testing is performed on materials after placement is complete to ensure that the lift or layer meets design requirements.

TABLE 4

MINIMUM REQUIREMENTS AND TEST FREQUENCIES FOR SOIL COMPONENTS OF THE FINAL COVER SYSTEM

LINER COMPONENT	REQUIRED TEST	MINIMUM FREQUENCY	SAMPLE SIZE[a]	ACCEPTANCE CRITERIA
Compacted Clay Layer Conformance Testing[c]	Visual Observation	As required	N/A	Substantially free of debris, large rocks, plant materials, or other deleterious material.
	Sieve Analysis	1 per source & 1 per 5,000 yd^3	5-10 lb	1 inch max. particle size
	Moisture Content	1 per 5,000 yd^3	Varies	Determine if adequate moisture is present prior to compaction
	Atterberg Limits	1 per source & 1 per 5,000 yd^3	5-10 lb	Plasticity Index: 10 or more[b]
	Standard Proctor Density	1 per source & 1 per 5,000 yd^3	50-100 lb	Determination of window of acceptable moisture content given required dry density.
	Soil Classification	1 per source & 1 per 5,000 yd^3	5-10 lb	SC, CL, CH, ML, or MH
	Flexible Wall Permeability (remolded)	As required to determine acceptable results	50 lb	$\leq 1 \times 10^{-7}$ cm/sec
Compacted Clay Layer Performance Testing[d]	Visual Observation	As required	N/A	Final surface: firm, smooth and uniform.
	Moisture Content	1 per 5 nuclear densometer tests	Varies	Check nuclear densometer measurements to verify moisture correction.
	Nuclear Densometer In-place Density and Moisture	1 per 100 ft grid per lift	N/A	$\geq$ 95% Standard Proctor maximum dry density[b]
	Sand Cone Density or Drive Tube Sample	1 per 25 nuclear densometer is used	Varies	Check nuclear densometer measurements to verify moisture correction and density.
	Lift Depth Check	As required	N/A	6 to 8 in. compacted lift
	Flex Wall Permeability	1 per acre per lift	Thin walled tube	$\leq 1 \times 10^{-7}$ cm/sec

TABLE 4 (continued)

MINIMUM TEST FREQUENCIES FOR SOIL COMPONENTS OF THE FINAL COVER SYSTEM CONSTRUCTION

LINER COMPONENT	REQUIRED TEST	MINIMUM FREQUENCY	SAMPLE SIZE[a]	ACCEPTANCE CRITERIA
Compacted Soil Layer Conformance Testing[c]	Visual Observation	As required	N/A	Substantially free of debris, large rocks, plant materials, or other deleterious material. Must not pump or rut excessively.
	Sieve Analysis	1 per source & 1 per 5,000 yd^3	5-10 lb	Max. 1 in. particle size
	Standard Proctor Density	1 per source & 1 per 10,000 yd^3	50-100 lb	Determination of window of acceptable moisture content given required dry density. Maximum dry unit weight greater than 90 lb/ft^3.
Compacted Soil Layer Performance Testing[d]	Visual Observation	As required	N/A	Final surface: firm, smooth, and uniform
	Lift Depth Check	As required		6 to 8 in. compacted lift
	Nuclear Densometer In-place Density and Moisture Content	1 per 100 ft grid per lift	N/A	≥ 95% Standard Proctor maximum dry density, Moisture content -4% +4% of optimum.
	Moisture Content	1 per 10 nuclear densometer tests	Varies	Check nuclear densometer measurements to verify moisture correction.
	Sand Cone Density or Drive Tube Sample	1 per 25 nuclear densometer tests	Varies	Check nuclear densometer measurements to verify moisture correction and density.

[a] In general, where the symbol "N/A" (not applicable) is used, the test is performed on in-place materials.

[b] Minor variations shall be allowed in acceptance criteria for compacted clay layer in order to maintain permeability less than 1×10^{-7} cm/sec. Under no circumstances shall acceptance criteria be enforced which result in permeability greater than 1×10^{-7} cm/sec

[c] Conformance testing is performed on borrow sources and placed material to ensure the minimum required values are met and the material remains consistent.

[d] Performance testing is performed on materials after placement is complete to ensure that the lift or layer meets design requirements.

Table 5

REQUIRED 40 MIL TEXTURED PE GEOMEMBRANE PROPERTIES

Material Property	Value	Units	Test Method
Resin – Melt Flow Index	≤1.0	g/10 min.	ASTM D1238
Thickness[1]	40	mil	ASTM D5994
Asperity Height [2] (min. avg.)	10	mil	GRI GM12
Specific Gravity (max.)	0.939	g/ml	ASTM D792 or ASTM D1505
Tensile Properties (each direction)			ASTM D6693 Type IV
1. Tensile Strength at Break (min. avg.)	60	lb/in.	
2. Elongation at Break (min. avg.)	250	percent	
Tear Resistance (min. avg.)	22	lb	ASTM D1004, Die C
Puncture Resistance (min. avg.)	44	lb	ASTM D4833
Carbon Black Content	2-3	percent	ASTM D1603
Carbon Black Dispersion	Category 1 or 2	Rating	ASTM D5596

Notes:

(1) Minimum of ten readings must average specified thickness or greater. No single reading may fall more than 15% below the specified value. The lowest individual reading for 8 of the 10 readings shall not fall more than 10% below the specified value.

(2) Minimum of ten readings must average specified height. Eight of the readings must be ≥ 7 mils, and the lowest reading must be ≥ 5 mils.

(3) Manufacturer's Quality Control testing shall be performed at a frequency of one test per every 100,000 ft^2 or one test per resin lot, whichever is more frequent. Thickness testing shall be performed on each roll.

(4) Asperity Height measurements shall be performed on every roll, alternating between measurements for top of sheet and bottom of sheet.

Table 6

REQUIRED 40 MIL TEXTURED PE GEOMEMBRANE PROPERTIES – CONFORMANCE TESTING

Material Property	Value	Units	Test Method	Frequency
Thickness[1]	40	mil	ASTM D5994	100,000 SF
Specific Gravity (max)	0.939	g/ml	ASTM D792 or ASTM D1505	100,000 SF
Asperity Height [2] (min. avg.)	10	mil	GRI GM12	100,000 SF Top and Bottom
Tensile Properties (each direction)			ASTM D6693 Type IV	100,000 SF
1. Tensile Strength at Break (min. avg.)	60	lb/in.		
2. Elongation at Break (min. avg.)	250	percent		
3. Tear Resistance (min. avg.)	22	lb	ASTM D1004, Die C	100,000 SF
4. Puncture Resistance (min. avg.)	44	lb.	ASTM D4833	100,000 SF
Carbon Black Content	2-3	percent	ASTM D1603	100,000 SF
Carbon Black Dispersion	Category 1 or 2	None	ASTM D5596	100,000 SF

(1) Minimum of ten readings must average specified thickness or greater. No single reading may fall more than 15% below the specified value. The lowest individual for 8 of the 10 readings shall not fall more than 10% below the specified value.

(2) Minimum of ten readings must average specified height. Eight of the readings must be $\geq$ 7 mils, and the lowest reading must be $\geq$ 5 mils.

(3) Conformance testing shall be performed by the Certification Engineer or TVA at a minimum frequency of one test per 100,000 ft^2 or one test per resin lot, whichever is more frequent.

Table 7

REQUIRED 40 MIL TEXTURED PE SEAM PROPERTIES

Material Property	Value	Units	Test Method
Shear Strength – Fusion and Extrusion[1]	60	lb/in.	ASTM 6392 Strain rate: 2 in./min. 1 in. strip.
Peel Adhesion			ASTM D6392
Fusion[2]	50	lb/in.	Strain rate: 2 in./min. 1 in.
Extrusion[3]	50	lb/in.	strip.

(1) For Shear Testing of both fusion and extrusion welds, the strength of 4 out of 5 specimens should meet or exceed the given value. The 5th must meet or exceed 48 lb/in.

(2) For Peel Testing of fusion welds the strength of 4 out of 5 specimens should meet or exceed the given value. The fifth must meet or exceed 40 lb/in. All specimens shall fail due to film tear bond or with greater than 25% incursion of the weld (peel).

(3) For Peel Testing of extrusion welds, 1 out of 5 specimens may either achieve <50 lb/in. but be ≥40 lb/in. or exhibit greater than 25% incursion of the weld (peel). The remaining four specimens must meet the specified strength and have a maximum of 25% incursion of the weld (peel).

) Required laboratory seam testing shall be performed by a geosynthetics testing laboratory at a frequency of one test per 1,000 linear feet of seam constructed for both extrusion and fusion welding equipment.

Table 8

REQUIRED GEOCOMPOSITE PROPERTIES

Material Property	Value	Units	Test Method	Manufacturers Frequency
Geonet Component:				
Thickness (min.)	200	mil	ASTM D 5199	1/50,000 SF
Specific Gravity (min. avg.)	0.94	gm/cm^3	ASTM D 792 or ASTM D 505	1/50,000 SF
Carbon Black Content	2-3	percent	ASTM D1603	1/50,000 SF
Tensile Strength, MD (Machine Direction)	45	lb/ft	ASTM D 5035	1/50,000 SF
Geotextile Component:				
Polymer Composition (min.)	95	% polypropylene or polyester by weight		
Mass per Unit Area (min.)	7.5	oz/yd^2	ASTM D 5261	1/90,000 SF
Grab Tensile Strength	≥170	lbs	ASTM D 4632	1/50,000 SF
Grab Elongation (min. avg.)	50	percent	ASTM D 4632	1/50,000 SF
Puncture Strength (min.)	90	lbs	ASTM D 4833	1/90,000 SF
Apparent Opening Size	70 – 120	sieve size	ASTM D 4751	1/540,000 SF
Water Flow Rate (min.)	110	gpm/ft^2	ASTM D 4491	1/540,000 SF
Ultraviolet Resistance (min. avg.)	70	percent	ASTM D 4355 (after 500 hours)	1/per lot
Geocomposite:				
Transmissivity at 10,000 psf[(1)] (min.)	5×10^{-4}	m^2/sec	ASTM D 4716	1/540,000 SF
Peel Strength (min.)	1	lb/in	GR1 GC-7	1/500,000 SF

Notes:

(1) Transmissivity measured using water at 20°C with a gradient of 0.10 and normal stress of 10,000 psf between two steel plates, after one hour.

Table 9

REQUIRED GEOCOMPOSITE PROPERTIES- CONFORMANCE TESTING

Material Property	Value	Units	Test Method
Thickness (min.)	0.20	inch	ASTM D 5199
Resin Density (min. avg.)	0.935	gm/cm^3	ASTM D1505
Geocomposite:			
Peel Strength (min.)	1	lb/in.	GRI GC-7
Tensile Strength (min.)	45	lb/in.	ASTM D 5035

(1) Conformance testing shall be performed by the Certification Engineer or TVA at a minimum frequency of one test per 100,000 ft^2 or one test per resin lot, whichever is more frequent.

Table 10

REQUIRED PROPERTIES FOR 10 OZ/YD^2 GEOTEXTILES (FILTER)

Material Property	Value	Units	Test Method
Polymer Composition	95 (min.)	% polypropylene or polyester by weight	
Mass per Unit Area (min. avg.)	10	oz/yd^2	ASTM D5261
Grab Tensile Strength(min. avg.)	230	lbs	ASTM D4632
Grab Elongation (min. avg.)	50	percent	ASTM D4632
Puncture Strength (min. avg.)	120	lbs	ASTM D4833
Trapezoidal Tear Strength (min. avg.)	95	lbs	ASTM D4533
Apparent Opening Size[(1)] (max. avg.)	70	sieve size	ASTM D4751
Water Permeability	$\geq 5.0 \times 10^{-3}$	cm/sec	ASTM D4491
Ultraviolet Resistance	70 (typical)	percent	ASTM D4355

Notes:

(1) Required only on material which is to be used in filter applications.

(2) Manufacturer's testing for the above properties shall be performed the Certification Engineer or TVA at a frequency of one test per 100,000 ft^2 and each resin lot must be tested.

Table 11

REQUIRED PROPERTIES FOR 10 OZ/YD^2 GEOTEXTILES (FILTER) - CONFORMANCE TESTING

Material Property	Value	Units	Test Method
Mass per Unit Area (min. avg.)	10	oz/yd^2	ASTM D5261
Grab Tensile Strength (min. avg.)	230	lbs	ASTM D4632
Puncture Strength (min. avg.)	120	lbs	ASTM D4833
Trapezoidal Tear Strength (min. avg.)	95	lbs	ASTM D4533
Apparent Opening Size (max. avg.)	70	sieve size	ASTM D4751

Notes:

(1) Conformance testing shall be performed by the Certification Engineer or TVA at a frequency of one test per 100,000 ft^2 and each resin lot must be tested.

Attachment 1 – TVA Vegetation Specification

VEGETATION SPECIFICATIONS

NATIVE GRASSESS - SEEDING AND MULCHING

(SPECIAL FOR WASTE AREAS)

SECTION 582 - Mulching

Refer to FP-96 Section 625. FP-96 Standard Specification for Construction of Roads and Bridges on Federal Highway Projects (US DOT - FHWA)

SECTION 583 - Native Grasses Seeding

583.1 – Description

This specification consists of furnishing and placing native warm season grass seed on waste disposal areas when specified by the plans or the Engineer. The use of these grasses for landfill cover crops is being encouraged by the Tennessee Department of Environment and Conservation Division of Solid Waste Management.

583.2 – Materials

1. Seeds

Seeds shall meet the requirements of applicable seed laws and shall be tested in accordance with the most current edition of the U.S. Department of Agriculture Handbook No. 30, Testing Agricultural and Vegetable Seed. Seeds shall be from the last preceding crop and comply with the requirements outlined below for purity and germination. Each variety of seed shall be furnished in separate, strong bags with each bag being fully tagged or labeled to show the variety, weight, purity, germination, and test data prescribed by law. All test

results shall be fully certified by the vendor or by a recognized seed testing agency. TVA reserves the right to require that samples be furnished, and to inspect and test the seeds after delivery. Seeds found not to comply with specification requirements shall be subject to rejection.

When mixing or forming seed mixtures, the seeds shall be carefully and uniformly mixed. Seeds shall not be mixed until each variety of seed to be used in the mix has been inspected and/or tested separately and approved.

583.2 – Materials (Continued)

Seed Varieties	Purity, Minimum %	Germination Minimum %
Sideoasts Gramma (*Bouteloua curtipendula*)	95	85
Little Bluestem (Schizachyrium scoparium)	95	85
Sand Lovegrass (*Eragrostis trichodes*)	95	85
Annual Rye (lolium multiflorum)	90	90

Seeding materials shall be free from seeds or bulbets of Wild Onion (Allium vineale), Canada Thistle (Cirsium arvense), and Johnson Grass (Sorghum halepense).

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Seed species shall not contain more than six seeds per ounce of the seed of any of the following noxious weeds or the seeds of any other weed specifically listed as noxious:

Bindweed (Convolvulus arvensis)
Buckthorn (Plantago lanceolata)
Corncockle (Agrostemmo githago)
Dodder (Cuscuta species)
Oxeyedaisy (Chrysanthemum leucantheumum)
Quackgrass (Agropyron repens)
Sorrel (Rumex acetosella)

Seed species shall not contain an excess of 2 percent by weight of weed seeds, noxious or otherwise.

2. Seed or seed mixtures, rates, and seasons

Seeding mixtures, rates, and seasons shall be those specified herein. The types to be used for each area or project will be specified by the drawing or by memorandum. Mixtures or rates of application other than those specified shall be used only when specified by the plans or the Engineer. Seeding shall be planted during the season and between the dates specified. Note that the pound rates are PLS (pure live seed).

Type 1: Winter seeding ((Plant between November 1 and December 31)

(1) Sideoats Grama	4 pounds per acre
(2) Little Bluestem	5 pounds per acre
(3) Sand Lovegrass	1 pounds per acre
(4) Annual Rye	60 pounds per acre
	70 pounds per acre

Type 2: Spring seeding (Plant between April 15 and July 1).

Mixture:

(1) Sideoats Grama	4 pounds per acre
(2) Little Bluestem	5 pounds per acre
(3) Sand Lovegrass	1 pounds per acre
	10 pounds per acres

Note: All slopes 3:1 or greater shall be seeded with the winter mixture

e. Temporary Cover

Type 3: Temporary winter seeding (Plant between October 15 and March 15).

Annual Ryegrass	80 pounds per acre

583.3– Soil Chemistry Requirements

Soil pH range: 5.0 - 7.8 S.U.

Soil Fertility: Low-Medium for phosphorous and potassium.

583.4 -- Soil Preparation

Areas to be seeded shall have approved cross sections and grades. Objects such as large roots, stones, stumps, coarse vegetation, debris, or any other items that might impede mechanical mowing shall be removed and disposed of satisfactorily.

Seedbeds shall be plowed, disked, harrowed, scarified, or cultivated to the approved depth. In areas where it is practical, this work shall be done with farm-type equipment. On steep slopes, preparation of seedbeds shall be done with the tools and methods specified by the Engineer. It is strongly recommended that scarifying and preparation on cut and fill slopes be accomplished with tools or equipment specially designed for this purpose. Small furrows or grooves formed in the slopes shall be horizontal or as nearly horizontal as practical. The work shall be performed only when the ground is in a workable and tillable condition as determined by good farming practices.

583.5 -- Special Hydroseeding Equipment

Equipment to be used for the hydraulic application of planting materials shall be a Finn Hydro-Seeder, Bowie Hydro Mulcher, Toro Environmental Control Unit, or an approved equal. The equipment shall have mixing tanks with built-in agitators having operating capacities sufficient to agitate, suspend, and homogeneously mix slurries of water and planting materials. The slurry distribution lines shall be large enough to prevent clogging or stoppage. Discharge lines shall be equipped with sets of different sized hydraulic spray nozzles capable of providing for even distribution of varying slurry mixtures on areas to be seeded.

583.6 -- Seeding Methods

Seeds shall be sown with approved hydroseeding equipment. Rates specified in Section 583.2 shall be maintained in a manner that will guarantee uniform coverage. Seeding operations shall not be performed when drought, high winds, and excessive moisture or other factors may defer satisfactory results. The carrier mix shall be 0-13-13. The area shall be cultipacked immediately after seeding.

583.7 -- Maintenance

Seeded areas shall be maintained until a satisfactory cover of plant material is secured, unless stipulated otherwise. All areas shall be preserved, repaired, and protected as specified for this purpose. Areas having poor stands of plant material shall be seeded again and fertilized at the proper rates.

Watering shall be accomplished during the maintenance period to the extent necessary.

583.8 -- Method of Measurement

Seeded areas will be measured in square yard units and include the seeded areas along slopes.