CITY OF EDINBURG SOLID WASTE MANAGEMENT

PERMIT AMENDMENT APPLICATION

Part III, Attachment 7

CLOSURE PLAN

Edinburg Regional Disposal Facility

Edinburg, Hidalgo County, Texas

TCEQ Permit MSW-956C

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Golder Associates

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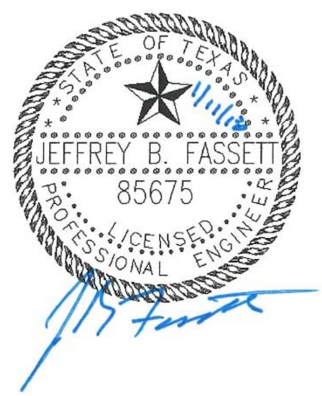

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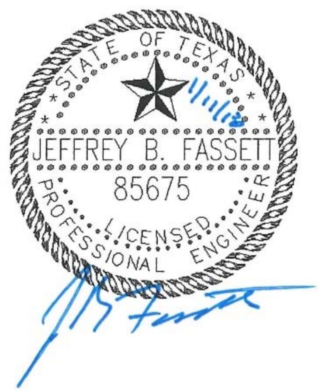

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EXECUTIVE SUMMARY

30 TAC §330.457(e)(1)

This Closure Plan has been developed to addresses the requirements of Title 30 of the Texas Administrative Code (TAC) §§330.63(h) and 330.457 (Subchapter K), Closure Requirements for Municipal Solid Waste Landfill Units that Receive Waste on or after October 9, 1993. This plan includes a description of the final cover systems, a description of the steps that will be undertaken to close each filled disposal area, and the methods used to install the final cover.

1.0 FINAL COVER DESIGN

1.1 Final Contour Map

30 TAC §§330.63(h) & 330.457(e)(5)

A contour map showing the final constructed contour of the entire landfill is provided Figure III7-1, Final Contour Map. The final contours consist of 4 horizontal to 1 vertical (4H:1V) sideslopes and the upper portions of the final cover are sloped at a minimum 5-percent grade to a maximum elevation of approximately 398 ft-msl. Drainage features including on the final cover are add-on berms designed to intercept run-off from the top surface and along the sideslopes and direct it to downchutes. The downchutes convey stormwater run-off to the perimeter channels and stormwater ponds. These drainage structures as well as the drainage entering and departing the facility are shown on Figure III7-1, Final Contour Map. A perimeter berm protects the facility from flooding due to a 100-year frequency storm as depicted in Part IIC, Floodplains. Details of the surface water management features are included in Part III2, Surface Water Drainage Report. Cross-sections of the final filled condition are included as Figures III7-2A – III7-2E.

1.2 Final Cover System

The City shall install a final cover system for the unit that is constructed to minimize infiltration and erosion. The final cover system at the facility will consist of a conventional composite system meeting the requirements of 30 TAC §330.457(a)(1) or alternative final cover systems meeting the requirements of 30 TAC §330.457(d). The final cover systems will provide a low maintenance cover, protect against erosion, reduce rainfall percolation through the cover system and minimize leachate generation within the landfill.

1.2.1 Conventional Composite System

30 TAC §330.457(a)

The conventional composite final cover will consist of the following from top to bottom:

- Erosion layer consisting of 24 inches of protective soil cover, of which the uppermost 6 inches will be capable of supporting native vegetation.
- Double-sided geocomposite (geotextile/geonet/geotextile) drainage layer.
- 40-mil linear low-density polyethylene (LLDPE) textured geomembrane that has a permeability less than or equal to the permeability of the bottom liner system.
- 18-inch thick compacted clay rich earthen material with a hydraulic conductivity of $1x10^{-5}$ cm/sec or less.

Figure III7-3A, Conventional Composite Final Cover Details includes final cover and drainage feature installation details.

The erosion layer shall be composed of no less than two feet of soil where the first 18 inches shall be of clayey soil and the uppermost 6 inches shall be of suitable topsoil that is capable of sustaining native plant growth and shall be seeded or sodded immediately following the application of the final cover in order to minimize erosion.

Double-sided geocomposite (geotextile/geonet/geotextile) drainage layer shall be installed top of the geomembrane to prevent the buildup of excess pore water pressure at the on the geomembrane interface. Calculations are provided in Part III, Waste Management Unit Design Report.

A 40-mil linear low-density polyethylene (LLDPE) textured geomembrane that has a permeability less than or equal to the permeability of any bottom liner system shall be installed on top of an 18-inch thick compacted clay rich earthen material with a hydraulic conductivity of $1x10^{-5}$ cm/sec or less. The thickness of the 40-mil LLDPE textured geomembrane is of adequate thickness to ensure proper seaming.

1.2.2 Alternative Composite System

30 TAC §330.457(d)

The alternative composite final cover varies from the conventional composite system by substituting a geosynthetic clay liner for the 18-inch thick compacted clay rich earthen material and will consist of the following from top to bottom:

- Erosion layer consisting of 24 inches of protective soil cover, of which the uppermost 6 inches will be capable of supporting native vegetation.
- Double-sided geocomposite (geotextile/geonet/geotextile) drainage layer.
- 40-mil linear low-density polyethylene (LLDPE) textured geomembrane that has a permeability less than or equal to the permeability of the bottom liner system.
- Geosynthetic Clay Liner.

Figure III7-3B, Alternative Composite Final Cover Details includes final cover and drainage feature installation details.

Appendix III7A, Alternative Composite Final Cover Demonstration shows that use of geosynthetic clay liner achieves a greater or equal to reduction in infiltration in comparison to 18-inch thick compacted clay rich earthen material.

2.0 CLOSURE

Waste disposal areas designated as units in this application do not have discrete individual final cover systems but share one final cover; therefore, for the purposes of closure, they will be collectively referred to as the MSW landfill unit. Final cover installation will be done in installments as areas of the

MSW landfill unit attain permitted elevation. Part II, Facility Layout of this application describes the anticipated schedule of development for the facility. Figures II-20 – II-25, Operational Sequence I – VI show areas of final cover placement as waste is filled to permitted elevation.

2.1 Maximum Closure Area

30 TAC §330.457(e)(2)

Based on the Figure II-20A, Operational Fill Sequence I of site development discussed in Part II, Facility Layout of this application, the maximum closure area or estimate of the largest area of the MSW landfill unit ever requiring final cover at any time during the active life is approximately 159.1 acres. Figure III7-4, Maximum Closure Area includes the active face and areas with daily or intermediate cover in place.

2.2 Maximum Inventory of Wastes

30 TAC §330.457(e)(3)

The maximum inventory of waste ever on-site over the active life of the facility is both the capacity of MSW landfill unit and storage or processing areas. Waste in storage or processing areas at final facility closure will either be disposed in the landfill or transported to an authorized facility, therefore the maximum inventory of waste is the capacity of the MSW landfill unit.

2.2.1 Facility

The maximum inventory of waste ever on-site over the active life of the facility is 87,301,156 cubic yards as demonstrated in Part III3A-1, Volume Calculations of this application. The volume represents the total volume available for in-place solid waste and daily and intermediate cover soils. Wastes accepted for disposal in accordance with Part II, Waste Acceptance Plan are typically compacted in place at the working face as they are received.

2.2.2 Storage or Processing Areas

Waste in storage or processing areas at final facility closure will either be disposed in the landfill or transported to an authorized facility. Closure for the storage and processing areas at the site is addressed as follows:

- Mulch area: Brush will be mulched used for erosion control applications.
- Liquid waste stabilization area: Upon closure, the waste remaining in the stabilization basin will be properly stabilized and disposed of in the landfill. The stabilization basin will be disposed of within the landfill.
- Whole tire staging area: At time of closure, tires in the staging area will be processed by grinding or other means to reduce size to quartered or split and disposed of in the landfill or another authorized facility.

- Large Item/White Goods Storage Area: Large items/white goods stored on-site at time of closure will be either transported offsite for recycling or disposed of at an authorized facility.
- Reusable materials staging area: Reusable materials will transported off-site for to reusable material end user locations.

2.3 MSW Landfill Unit Closure Implementation

30 TAC §330.457(e)(4)

A schedule for completing all activities necessary to satisfy the closure criteria for the MSW landfill unit is as follows in accordance with 30 TAC §330.457(f). The closure process will follow the procedures listed in Appendix III7B, TCEQ Closure Plan Form.

2.3.1 Closure Plan Placed in Operating Record by Initial Receipt of Waste

30 TAC §330.457(f)(1)

Because waste is currently received by the facility under TCEQ Permit MSW-956B, the City shall place a copy of this closure plan in the operating record upon issuance of TCEQ Permit MSW-956C.

2.3.2 Closure Notice to TCEQ

30 TAC §330.457(f)(2)

No later than 45 days prior to the initiation of closure activities for the MSW landfill unit, the City shall provide written notification to the TCEQ of the intent to close the unit and place this notice of intent in the operating record.

2.3.3 Begin Closure Activities

30 TAC §330.457(f)(3)

The City shall begin closure activities for the MSW landfill unit no later than 30 days after the date on which the unit receives the known final receipt of wastes or, if the unit has remaining capacity and there is a reasonable likelihood that the unit will receive additional wastes, no later than one year after the most recent receipt of wastes. A request for an extension beyond the one-year deadline for the initiation of closure may be submitted to the TCEQ for review and approval and shall include all applicable documentation necessary to demonstrate that the unit has the capacity to receive additional waste and that the City has taken and will continue to take all steps necessary to prevent threats to human health and the environment from the MSW landfill unit.

2.3.4 Complete Closure Activities

30 TAC §330.457(f)(4)

The City shall complete closure activities for the MSW landfill unit within 180 days following the initiation of closure activities. These activities include placing all the final cover components to design grades and elevations over the waste mass utilizing methods, procedures, and specifications described in the Final Cover Quality Control Plan and installation of any outstanding or replacement of any damaged post-closure monitoring devices such as monitoring wells, gas probes, and the gas collection system. A request for an extension for the completion of closure activities may be submitted to the TCEQ for review and approval and shall include all applicable documentation necessary to demonstrate that closure will, of necessity, take longer than 180 days and all steps have been taken and will continue to be taken to prevent threats to human health and the environment from the unclosed MSW landfill unit.

2.3.5 Following Completion of Closure Activities

30 TAC §330.457(f)(5)

Following completion of all closure activities for the MSW landfill unit, the City shall comply with the post-closure care requirements specified in Part III8, Post-Closure Plan. The City shall submit to the TCEQ by registered mail for review and approval a certification, signed by an independent licensed professional engineer, verifying that closure has been completed in accordance with this closure plan. The submittal to the executive director shall include all applicable documentation necessary for certification of closure. Once approved, this certification shall be placed in the operating record.

2.3.6 TCEQ Closure Acknowledgement

30 TAC §330.457(f)(6)

Following receipt of the required closure documents, as applicable, and an inspection report from the TCEQ's regional office verifying proper closure of the MSW landfill unit according to this closure plan, the TCEQ may acknowledge the termination of operation and closure of the unit and deem it properly closed.

2.4 Final Facility Closure

Certification of final facility closure will be accomplished in accordance with 30 TAC §330.461.

2.4.1 Public Notice

30 TAC §330.461(a)

No later than 90 days prior to the initiation of a final facility closure, the City shall, through a public notice in the newspaper(s) of largest circulation in the vicinity of the facility, provide public notice for final facility closure. This notice shall provide the name, address, and physical location of the facility; the permit, registration, or notification number, as appropriate; and the last date of intended receipt of waste. The City shall also make available an adequate number of copies of the approved final closure and post-closure plans for public access and review.

2.4.2 Written Notification to TCEQ

30 TAC §330.461(a)

No later than 90 days prior to the initiation of a final facility closure, the City shall provide written notification to the TCEQ of the intent to close the facility and place this notice of intent in the operating record.

2.4.3 Facility Closure Sign Posting

30 TAC §330.461(b)

Upon written notification to the TCEQ, the City shall post a minimum of one sign at the main entrance and all other frequently used points of access for the facility notifying all persons who may utilize the facility of the date of closing for the entire facility and the prohibition against further receipt of waste materials after the stated date.

2.4.4 Access Barriers

30 TAC §330.461(b)

Upon written notification to the TCEQ, suitable barriers shall be installed at all gates or access points to adequately prevent the unauthorized dumping of solid waste at the closed facility.

2.4.5 Deed Recordation

30 TAC §330.457(g) & §330.461(c)(1)

Within ten days after closure of the MSW landfill unit, the City shall submit to the TCEQ by registered mail a certified copy of an "affidavit to the public" in accordance with the requirements of 30 TAC §330.19, Deed Recordation and place a copy of the affidavit in the operating record. In addition, the City shall record a certified notation of the deed to the facility property, or on some other instrument that is normally examined during title search, that will in perpetuity notify any potential purchaser of the property that the land has been used as a landfill facility and use of the land is restricted according to the provisions specified in 30 TAC §330.465 Certification of Post-Closure Care. The City shall submit a certified copy of the modified deed to the TCEQ and place a copy of the modified deed in the operating record.

2.4.6 Certification

30 TAC §330.461(c)(2)

Within ten days after completion of final closure activities, a certification, signed by an independent licensed professional engineer, verifying that final facility closure has been completed in accordance with this closure plan. The submittal to the TCEQ shall include all applicable documentation necessary for certification of final facility closure. Once approved, the certification will be placed in the site's operating record.

Following receipt of the required final closure documents and an inspection report from the TCEQ's regional office verifying proper closure of the facility according to this closure plan, the TCEQ may acknowledge the termination of operation and closure of the facility and deem it properly closed. Post-closure care maintenance will begin immediately upon the date of final closure as approved by the TCEQ. All post-closure land use will comply with 30 TAC §330.463, as indicated in the Post-Closure Plan. Appendix III7B, TCEQ Closure Plan Form, provides guidance to detail the plan for closure of a landfill unit, closure of associated storage or processing areas, and final closure of the facility to meet the requirements in 30 TAC Chapter 330, §330.63(h) and 30 TAC Chapter 330 Subchapter K for a MSW Type I facility.

3.0 FINAL COVER QUALITY CONTROL PLAN

30 TAC §330.457(c)

Appendix III7C, Final Cover Quality Control Plan (FCQCP) describes the final cover system design, construction, and evaluation protocol and processes, including the personnel, materials, methods, sampling and testing standards, procedures, and practices to be used in procuring, handling, installing, and evaluating all elements of the final cover system. It establishes the material requirements; personnel qualifications and roles; installation requirements; quality control and quality assurance monitoring, testing, documentation, and reporting programs to be used during construction of each component of the final cover system to assure and to verify that the final cover system is constructed as designed and in accordance with applicable rules and technical standards.

APPENDIX III7B

TCEQ CLOSURE PLAN FORM

APPENDIX III7C

FINAL COVER QUALITY CONTROL PLAN

PERMIT AMENDMENT APPLICATION

Part III, Attachment 7, Appendix C

FINAL COVER QUALITY CONTROL PLAN

CONVENTIONAL COMPOSITE AND ALTERNATIVE COMPOSITE FINAL COVER

Edinburg Regional Disposal Facility

Edinburg, Hidalgo County, Texas

TCEQ Permit MSW-956C

Submitted To: City of Edinburg
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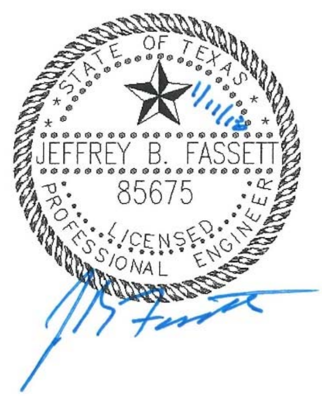

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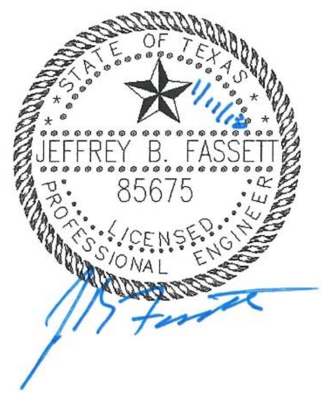

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1.0 PURPOSE

1.1 Purpose

This Final Cover Quality Control Plan (FCQCP), is prepared under the direction of a licensed professional engineer, and it is the basis for the type and rate of quality control testing performance and reported in the final cover system evaluation report (FCSER) as required in 30 TAC §330.457. The plan provides operating personnel adequate procedural guidance for assuring continuous compliance with applicable rules and technical standards. The plan specifies construction methods employing good engineering practices for installation and testing of components of the conventional composite and alternative composite final cover system including infiltration layer, geosynthetic clay liner (GCL), geomembrane (GM), drainage layer, and erosion layer.

1.2 Final Cover Quality Control Testing Procedures

The liner quality control testing procedures, including sampling frequency, are provided in this FCQCP. All field sampling and testing, both during construction and after completion, shall be performed by a person acting in compliance with the provisions of the Texas Engineering Practice Act and other applicable state laws and regulations. The professional of record (POR) who signs the FCSER or his representative should be on site during all liner construction. Quality control of construction and quality assurance of sampling and testing procedures should follow the latest technical guidelines of the TCEQ.

2.0 FINAL COVER SYSTEM COMPONENTS

The final cover system options at the facility includes a conventional composite final cover system meeting the requirements of §330.457(a)(1) and an alternative composite final cover system meeting the requirements of §330.457(d). This FCQCP applies to both the conventional composite final cover system as well as an alternative composite final cover system with a GCL component for the infiltration layer. FCQCPs for other alternative final cover systems are presented separately.

The conventional composite final cover consist of (from top to bottom):

- Erosion layer consisting of 24 inches of protective soil cover, of which the uppermost 6 inches will be capable of supporting native vegetation.
- Double-sided geocomposite (geotextile/geonet/geotextile) drainage layer.
- 40-mil linear low-density polyethylene (LLDPE) textured geomembrane that has a permeability less than or equal to the permeability of the bottom liner system.
- 18-inch thick compacted clay rich earthen material with a hydraulic conductivity of $1x10^{-5}$ cm/sec or less (infiltration layer).

The alternative composite final cover will consist of (from top to bottom):

- Erosion layer consisting of 24 inches of protective soil cover, of which the uppermost 6 inches will be capable of supporting native vegetation.
- Double-sided geocomposite (geotextile/geonet/geotextile) drainage layer.
- 40-mil LLDPE textured geomembrane that has a permeability less than or equal to the permeability of the bottom liner system.
- Reinforced GCL (infiltration layer).

The construction and testing requirements for the conventional composite final cover system infiltration layer are described in §2.0, Final Cover System Components of this FCQCP. The construction and testing requirements of the GCL infiltration layer in the alternative composite final cover system is described in §3.0, Cohesive Soil Cover of this FCQCP.

3.0 COHESIVE SOIL COVER (INFILTRATION LAYER)

This section outlines generally acceptable construction practices and specifications and the minimum quality control testing requirements for cohesive soil covers, serving as the infiltration layer in the final cover system.

3.1 Pre-construction Material Evaluation

The first step in constructing a cohesive soil cover is to pre-qualify the soil materials that are selected for final cover construction. Cohesive soil cover material may be obtained from in situ soil strata that will be excavated as the final cover is constructed or from a select borrow source. Representative samples from either source shall be subject to the minimum pre-construction testing program shown in Table III7C-1, Cohesive Soil Cover Materials Pre-construction Testing Schedule. Each soil type shall undergo the series of tests listed in Table III7C-1.

Table III7C-1: Cohesive Soil Cover Materials Pre-construction Testing Schedule

TEST	METHOD USED	FREQUENCY(1)
Soil Classification	ASTM D2487	1 per soil type
Particle-Size Analysis	ASTM D422 or D1140	1 per soil type
Atterberg Limits	ASTM D4318	1 per soil type
Hydraulic Conductivity(2)	ASTM D5084(3)	1 per soil type
Conventional Proctor Test	ASTM D698	1 per soil type
Moisture Content	ASTM D2216	1 per soil type

NOTES:

(1) If either the liquid limit (LL) or plastic limit (PI) varies by more than 10 points from other samples, the soil is considered a different soil type.

(2) Conduct this test on a remolded sample that is compacted at or less than 95% of the maximum dry density and at the optimum moisture content as determined from the conventional Proctor test or compacted at or less than 90% for modified Proctor test at one percent dry of the optimum. If pre-construction samples are compacted at higher

or lower densities and/or respective moisture contents, then these values will govern for field control. Pre-construction tests should represent the "worst-case" condition in the field concerning hydraulic conductivity results.

(3) Testing procedures in Appendix VII of the US Army Corps of Engineers Manual EM 1110-2-1906, November 30, 1970, Laboratory Soils Testing, may be used as an alternative method. Permeability tests will be conducted using tap water or 0.05N calcium sulfate solution as the permeant fluid. Distilled or deionized water is not acceptable.

Where soil types vary substantially and are not segregated, representative blends of those soil types anticipated to be utilized for cohesive soil cover construction should also be sampled and tested. The material tested shall comply with the following minimum material specifications:

- Plasticity Index ≥ 15
- Liquid Limit ≥ 30
- Percent Passing No. 200 Sieve ≥ 30
- Particle Size ≤ 1 inch
- Hydraulic Conductivity ≤ 1 x 10^{-5} cm/sec

The Proctor moisture-density curves shall be developed for each type of soil determined suitable as cohesive soil cover material and shall be used during the construction phase as a performance reference for compaction and moisture control.

The POR should consider the potential adverse effects on and/or inconsistencies of results due to laboratory drying procedures, as some materials may exhibit variation in results for Proctor and Atterberg limits tests. Samples should not be oven-dried nor dried back more than 2 to 3 percent below the lowest anticipated moisture content needed to develop the Proctor moisture-density relationship. The zero air voids line shall be computed and included along with the Proctor curves, indicating the specific gravity value used.

Pre-construction samples to be run for hydraulic conductivity testing shall be molded at or less than the optimum moisture content and at or less than 95 percent of the maximum dry density according to the conventional Proctor test (ASTM D698). These points should represent reasonable worst-case conditions for hydraulic conductivity results on appropriately compacted soils. If higher moisture contents or dry densities are used for the hydraulic conductivity tests, then the higher values will be used for field control during placement. However, if lower moisture or density values are used and confirmed to achieve acceptable hydraulic conductivities, field control will still be based on the minimum compaction requirements in §3.2.4, Minimum Compaction Requirements of this FCQCP. .

A minimum of one series of pre-construction tests will be performed on each soil type and, a general rule for every 15,000 to 20,000 cubic yards (CY) of soil to be used in cohesive soil cover construction, unless soil types are limited and easily distinguished. As soil is usually made available subsequent to excavation during final cover construction, additional pre-construction samples should be taken and tests performed when soils vary or as soon as the initial pre-construction test results appear inappropriate or questionable.

If and when the same borrow source is utilized for the soil supply of more than one final cover area, and the soil type is the same, results from previous tests may be used to supplement the pre-construction data.

3.2 Soil Cover Construction Specifications and Practices

The cohesive soil cover shall be constructed in accordance with the requirements included in this section. Also, certain construction practices shall be utilized as described herein when appropriate.

3.2.1 Working Surface Preparation

Subgrade preparation prior to receiving final cover will include compacting the near surface waste or intermediate cover to prepare the working surface. Depressions in the surface where ponded water is observed will be prepared by removing the water and filling the depression with additional intermediate cover to maintain an adequate slope.

Stability of the working surface prior to placement of the final cover shall be determined by the POR by visual inspection to confirm that deflection and pumping characteristics are minimized and the strength of the surface material is adequate. The lines and grades shall be determined by survey methods prior to subsequent final cohesive soil cover construction.

The prepared subgrade shall be tied into the first cohesive soil cover lift in a manner deemed suitable by the POR such that the integrity of the first lift will be maintained.

3.2.2 Work Area Selection and Sizing

Work areas for cohesive soil cover construction should be selected, sized, and sequenced so that work on each lift can begin and be completed in the same day. The area worked at any one time should be of such size that placement, processing, and compaction will be uniform, with minimal variation caused by weather conditions. It is critical that completed lifts be tested and covered with the next loose lift before that completed lift dries out in the sun or becomes damaged by heavy precipitation. Furthermore, the selection of size and shape of work areas shall be consistent, so that uniform construction techniques and equipment can be selected. Adequate numbers of quality control personnel will be provided to suit the pace of construction so proper monitoring and documentation is performed.

3.2.3 Lift Placement and Processing

Reduction of soil clods, uniform moisture distribution, and consistent placement thickness are key elements to achieving uniform compaction of cohesive soil covers. Cohesive soil cover material shall be placed in loose lifts, generally not exceeding 8 inches after spreading and leveling and/or processing, with the expectation that the finished lift, following compaction, will be about 6 inches or less. In no case will the loose lift thickness, after spreading and leveling, be greater than the length of the compactor feet. The intent of limiting the loose thickness is to achieve good interlift bonding and to minimize bridging or layering effects.

The loose lift of soil shall be mechanically processed, either in-place or in a separate processing area, to break down the original soil structure and to reduce clod size. Additional processing, if necessary, will be used to blend variable soil types within the loose lift and incorporate additional water. The goal of processing is to yield a relatively uniform mass of soil that is devoid of original structure that may contribute to excess hydraulic conductivity. Processing may be achieved by discing, grading, compacting, or pulverizing. Pneumatic-tired or tracked equipment will not generally be acceptable to provide processing action, although this equipment may be used to pull the other acceptable implements.

Moisture adjustment may be required, particularly during dry seasons, and reasonable practices shall be used to distribute added water uniformly within the lift. Care shall be taken to prevent over-watering and ponding of water within the loose lift, as this excess water is difficult to redistribute. Drying back of overly wet soils during processing can result in clods having dry, crusting surfaces, which may not bond together adequately. If such drying is allowed, then additional effort will be necessary to assure even moisture distribution and hydration. Hydration times shall be evaluated and determined if acceptable by the POR.

3.2.4 Minimum Compaction Requirements

Processed loose lifts shall be leveled prior to compaction to provide uniform compaction effort over the lift. Each lift shall be compacted to the moisture and density requirements established for the project and as set forth in the provisions of this FCQCP. Lifts shall be compacted to at least 95 percent of the maximum dry density with a corresponding moisture content at or up to 5 percent above optimum determined by conventional Proctor test results (ASTM D698) conducted on similar representative material. The above criteria shall be utilized, unless pre-construction hydraulic conductivity tests were performed at higher or lower densities or moisture contents, in which case these density and moisture values will be used as field compaction minimums. The soil liner density must be expressed as a percentage of the maximum dry density and at the corresponding optimum moisture content as discussed in this section.

In the event that subsequent laboratory testing of samples from an area of constructed cohesive soil cover indicate an alternate moisture density curve is appropriate for the soil type, the CQA monitor will switch to the appropriate curve as necessary. It is recognized that laboratory test results become available often several days after construction of an area of cohesive soil cover. If the laboratory testing data indicates that the area constructed using the incorrect moisture-density curve meets the permeability requirements (i.e., less than or equal to 1×10^{-5} cm/sec), the area will be considered acceptable as cohesive soil cover.

Cohesive soil covers shall not be compacted with a bulldozer or any track-mobilized equipment unless it is used to pull a footed roller; however, this practice is not encouraged. All cohesive soil covers shall be compacted with a pad-footed or prong-footed roller only. Bulldozers, pneumatic rollers or scrapers, and flat-wheeled rollers will not be permitted for compaction.

Construction survey control should be conducted routinely during lift placement to verify that loose and finished lifts are of the proper thickness to ensure uniform compaction.

3.2.5 Lift Bonding and Cohesive Soil Cover Tie-in

Interlift bonding shall be accomplished prior to placing the subsequent loose lift. Compactors shall be of sufficient weight and foot length to penetrate the current lift when loose and provide bonding to the previous lift.

When lifts of the cohesive soil cover are not constructed continuously, a vertical construction joint may occur. To remove the vertical construction joint(s), the edge of the adjoining section shall be cut back or flattened to permit offsetting of the tie-in for subsequent lifts. For each 6-inch lift, the edge should be cut back at least 2.5 feet or graded to a maximum slope of 5H:1V, and then the corresponding adjoining lift should be placed against the existing finished lift. The new loose lift and at least 2 feet of the adjoining existing lift will be processed together, and then recompacted, so that the existing cohesive soil cover edge is tied to new construction without superimposed vertical construction joints. This tie-in procedure shall be repeated lift-by-lift until all corresponding adjacent lifts are constructed to the required elevation. The cut back edge of the existing cohesive soil cover may be done all at once or one lift at a time.

3.3 Construction Monitoring and Conformance Testing

Quality assurance of recompacted cohesive soil covers shall consist of monitoring the work as cohesive soil cover construction proceeds and laboratory and field testing to assure that material conformance and construction performance specifications are achieved.

3.3.1 Monitoring and Observations

Full-time quality assurance monitoring and testing will be performed during the course of cohesive soil cover construction. The work will be performed by a POR described in §1.2, Final Cover Quality Control Testing Procedures of this FCQCP or by a CQA monitor working under the general supervision of the POR. The CQA monitor will be on-site at all times when cover construction is ongoing, so that all relevant activities can be observed and documented. The POR will visit the site periodically as construction progress warrants. Such visits will be frequent enough so that the POR is fully knowledgeable of the construction methods and performance, so that the POR can determine that quality control monitoring and testing activities are adequate to meet the terms and intent of this FCQCP.

Visual observation shall include, but not be limited to, the following:

- Moisture content and distribution, particle size, and other physical properties of the soil during processing, placement, and compaction.
- Type and level of compaction effort, including roller type and weight, drum size, foot length and face area, and number of passes.
- Action of compaction equipment on soil surface (i.e., foot penetration, rolling, pumping, or shearing).
- Maximum clod size and breakdown of soil structure.
- Method of bonding lifts together and making cohesive soil cover tie-ins.
- Stones or other inclusions, which may damage overlying geosynthetic components or adversely affect compaction, lift bonding, and in-place testing/sampling.
- Areas where damage due to excess moisture, insufficient moisture, or freezing may have occurred.

3.3.2 Construction Testing

30 TAC §330.457(c)

During cohesive soil cover construction, the minimum testing and sampling program presented in Table III7C-2, Cohesive Soil Cover Construction Testing Schedule shall be conducted to determine that adequate compaction and material conformance are being achieved.

Table III7C-2: Cohesive Soil Cover Construction Testing Schedule

TEST	METHOD	MINIMUM FREQUENCY(2)(3)
Field Moisture/Density Test	ASTM D6938, D2937, or D1556	1 per 8,000 ft^2, per 6-inch lift
Percent Finer Than No. 200 Sieve	ASTM D1140 or D422	1 per 100,000 ft^2, per 6-inch lift
Atterberg Limits	ASTM D4318	1 per 100,000 ft^2, per 6-inch lift
Hydraulic Conductivity(1)	ASTM D5084	1 per acre (evenly distributed through all lifts), per 6-inch lift

NOTES:

(1) Testing shall be conducted on undisturbed samples. Testing procedures in Appendix VII of the US Army Corps of Engineers Manual EM 1110-2-1906, November 30, 1970, Laboratory Soils Testing, may be used as an alternative.
(2) A voluntary increase in the number of any tests performed does not in turn require a commensurate increase in the other testing requirements to meet the above program.
(3) A minimum of one of each of the designated tests must be conducted for each lift of cohesive soil cover regardless of surface area.

Typically, field moisture-density tests will be performed using a nuclear density gage (ASTM D6938). Other acceptable test methods include the Sand Cone Method (ASTM D1556) or Drive Cylinder Test (ASTM D2937). Questions concerning the accuracy of any single field moisture-density test shall be addressed by retesting in the same general location. Periodic checks using the various test methods may be performed to verify the field moisture-density test results. Alternatively, field moisture-density checks may be performed using laboratory measurements of tube samples obtained adjacent to the field test locations.

Hydraulic conductivity tests will be performed on samples obtained with a thin-walled tube sampler. The percent finer than No. 200 sieve and Atterberg limits will be performed on the thin-walled tube sample or on a grab sample obtained adjacent to the thin-walled tube. These construction test samples will be obtained from the recently completed lift, taken one lift at a time, so that sample penetrations only go through one lift and do not penetrate from one lift into the next. Hydraulic conductivity samples will be sent to the geotechnical laboratory in the sampling tube, which will be properly sealed to preserve the moisture content and integrity of the sample.

3.3.3 Failure Repairs

3.3.3.1 Field Density Testing

Sections of cohesive soil cover that do not pass either the density or moisture requirements in the field shall be reworked and retested until the section in question does pass. All field density results shall be reported in the Final Cover System Evaluation Report (FCSER), whether they indicate passing or failing values.

In the event of a failed moisture-density test, additional tests will be performed between the failed test and the nearest adjacent passing test locations. If those additional tests pass, then the area between the failed test and the additional passing tests will be reworked and retested until passing. If the additional tests fail, then additional tests will be performed halfway between the initial additional tests and the adjacent passing tests to further define the failing area. This procedure will be repeated until the failing area is defined, reworked, and retested with passing results.

3.3.3.2 Laboratory Testing

Sections of cohesive soil cover that do not pass hydraulic conductivity testing shall be reworked and retested until the section in question does pass. All hydraulic conductivity testing results shall be reported in the Final Cover System Evaluation Report (FCSER), whether they indicate passing or failing values.

In the event of a failed hydraulic conductivity test, additional tests will be performed between the failed test and the nearest adjacent passing test locations. If those additional tests pass, then the area between the failed test and the additional passing tests will be reworked and retested until passing. If the additional tests fail, then additional tests will be performed halfway between the initial additional tests and the adjacent passing tests to further define the failing area. This procedure will be repeated until the failing area is defined, reworked, and retested with passing results.

3.3.4 Cohesive Soil Cover Perforations

When taking field densities and undisturbed samples, all holes dug or created in the cohesive soil cover for density probes or samples must be backfilled with bentonite or a bentonite-rich soil material. This backfill will be tamped in the hole to remove pockets of air or loose soil, and to assure a tight compact seal.

3.3.5 Cover Thickness Verification

Cohesive soil cover thickness verification shall be determined by survey methods. The verification points for record purposes shall be on a grid not exceeding 10,000 square feet per grid. If the area under evaluation is less than 10,000 square feet, a minimum of two grid points is required for verification. The selected grid shall be the same for both beginning and finished elevations of the cohesive soil cover, so that minimum thicknesses can be calculated and verified.

3.3.6 Post-Construction Care of Cohesive Soil Cover

The integrity of the cohesive soil cover shall be maintained by moistening to prevent the material from desiccating. Conversely, the cohesive soil cover shall be kept free of standing water. Damage caused by rain shall be repaired, and if the lift must be reworked, as determined by the POR, then appropriate retesting (including field moisture-density and permeability tests) shall be performed.

4.0 GEOSYNTHETIC CLAY LINER

This section presents general procedures, quality control testing requirements, and installation procedures for the geosynthetic clay liner (GCL) used in the alternative composite final cover to replace the cohesive soil (infiltration) layer. The GCL approved for use at the site consists of sodium bentonite encapsulated between two geotextile layers, needle-punched or stitched-bonded together.

4.1 Pre-Installation Material Evaluation

4.1.1 Manufacturer’s Quality Control Certificates

Prior to the installation of the GCL, the manufacturer or installer shall provide the POR with quality control certificates signed by a responsible party employed by the manufacturer. The manufacturer must provide documentation certifying the material was continuously inspected for broken needles, and is needle free. Each quality control certificate shall include roll identification numbers, testing procedures, and results of quality control tests. The quality control tests shall be performed in accordance with project-specific testing methods and subject to the minimum testing frequency shown in Table III7C-3, GCL OC Submittal Frequency & Material Specifications. The owner may require more frequent testing at his discretion.

The quality control testing may be performed in the manufacturing plant. The POR shall review the test results prior to accepting the GCL to ensure that the certified minimum properties meet the values presented in Table III7C-3, GCL OC Submittal Frequency & Material Specifications.

4.1.2 Conformance Testing

In addition to the manufacturer's quality control certificates, samples of rolls of GCL will be obtained for conformance testing. The samples shall be tested by an independent third party laboratory in accordance with Table III7C-4, GCL Conformance Test Schedule. The POR shall review the test results to ensure that they meet the values presented in Table III7C-3, GCL QC Submittal Frequency & Material Specifications.

The POR shall compare measured shear strength values to those used in the stability analyses included in Part III3B-2E, Final Cover System Stability. If the measured interface shear strength is less than the values used in the analyses, the stability of the final cover system shall be reassessed and revised calculations shall be included in the Final Cover System Evaluation Report (FCSER).

4.1.3 Shipping and Unloading

In order to prevent premature hydration, the GCL rolls shall be shipped in plastic wrapping that shall remain intact until material installation. Rolls shall be labeled with the manufacturers name, product identification, roll and lot number, roll dimensions, weight and any other information to trace the quality assurance documentation. Upon delivery of the GCL, storage and handling procedures shall be documented. The rolls will be stacked, stored above ground, covered, and handled in accordance with ASTM D5888 or manufacturer's recommendations. If any rolls is damaged during shipping, unloading or storage or if the outer portion becomes partially hydrated, the damaged portion shall be removed before the roll is deployed.

Table III7C-3: GCL QC Submittal Frequency & Material Specifications

Bentonite					
Property	**Qualifier**	**Unit**	**Value**	**Test Method(1)**	**Frequency**
Fluid Loss	max.	ml	18	ASTM D5891	1 per 50 tons or every truck or railcar
Free Swell	min.	ml	24	ASTM D5890	
Geotextile					
Property	**Qualifier**	**Unit**	**Value**	**Test Method(1)**	**Frequency**
Mass per Unit Area	—	g/cc	—	ASTM D5261	1 per 200,000 ft^2
Tensile Properties:	—	lb	—	ASTM D4632	
GCL Product					
Property	**Qualifier**	**Unit**	**Value**	**Test Method(1)**	**Frequency**
Bentonite Mass	min.	lb/ft^2	0.8	ASTM D5993	1 per 40,000 ft^2

Bentonite Moisture Content	—	%	—	ASTM D5993	
Grab Tensile Strength	—	lb	—	ASTM D6768	1 per 200,000 ft^2
Hydraulic Flux	max.	m^3/m^2-s	1 x 10^{-8}	ASTM D5887	1 per week for each production line$^{(2)}$
Lap Joint Permeability	Max	cm/sec	1 x 10-8	Flow Box or other suitable device	1 per material and lap type

Notes:
1. Updated methods may be implemented based on a review by the POR.
2. Report last 20 test values, ending on production date of supplied GCL.
3. For those properties that do not indicate a value, the GCL material must meet the manufacturer's minimum specification.

Table III7C-4: GCL Conformance Test Schedule

TEST	METHOD$^{(1)}$	FREQUENCY
Bentonite Mass/Unit Area	ASTM D5993	Not less than 1 test per 100,000 ft^2
Hydraulic Flux	ASTM D5887	
Direct Shear	ASTM D6243	1 test per GM/adjoining materials

Notes:
1. Updated methods may be implemented based on a review by the POR.

4.2 Installation Procedures

4.2.1 GCL Subgrade Preparation

Surfaces to be lined should be smooth and free of all rocks greater than 0.75-inch diameter (or as recommended by the manufacturer, if less than 0.75 inches), sharp/angular objects, sticks, roots, or debris of any kind. The surface should provide a firm, unyielding foundation for the GCL with no sudden, sharp, or abrupt changes or break in grade. The subgrade surface shall be prepared by rolling with a smooth-drum roller to minimize the roughness and press down protruding soil or rock particles prior to GCL deployment. Loose rocks and/or dry soil particles that could damage the GCL shall be removed. Excessive voids or dimples shall be filled with soil.

The GCL subgrade should be moisture conditioned prior to placing the GCL in final covers. Research has shown that the subgrades with water contents above 10%, or greater than the optimum water content, promotes hydration and osmotic swell in GCLs. These conditions result in GCLs that maintain their low hydraulic conductivities regardless of the amount cation exchange that occurs (Scalia and Benson 2011).

Although the subgrade shall be moist, standing water will not be allowed.

4.2.2 GCL Deployment

Equipment used to deploy GCL must not cause excessive rutting of the subgrade. Deployed GCL panels should contain no folds or excessive slack. Installation personnel must not smoke or wear damaging shoes on GCL. GCL should not be placed during excessive winds. Sand bags should be used to anchor deployed GCL when necessary. In general, only low ground pressure rubber-tired support equipment approved by the POR may be allowed on the GCL. If the POR or CQA monitor observes any potential damage done to the liner by the support equipment, use of the equipment will cease and the damage will be repaired. Generators, gasoline or solvent cans, tools, or supplies must not be stored directly on the GCL. GCL must be rolled into position, not drug across the subgrade. Deployed GCL must not be used as a work area without adequate protection such as a rub sheet.

Panels should be overlapped and seamed, as recommended by the manufacturer. End-to-end seams on sideslopes are not allowed. Care must be taken to assure the GCL is installed with the proper side up.

GCL deployment shall be limited to the amount that can be covered with the overlying geomembrane liner the same day. GCL deployment shall not be undertaken during precipitation or when there is an impending threat of precipitation. GCL deployed on 5H:IV or steeper slopes shall be rolled down the slopes, not cross slope.

Following deployment, the CQA monitor shall visually examine the entire surface of the GCL for even bentonite distribution, thin spots, or other panel defects. All defects will be recorded and repaired in accordance with this FCQCP. The QA/QC representative shall also verify the following:

- Adequately moist subgrade
- Proper overlap during deployment
- Seams between GCL panels are constructed per manufacturer's recommendations
- Defects are patched and overlapped properly
- The bentonite has not become excessively hydrated
- No stones, tools, cutting blades or other objects that could damage the GCL are present on the GCL.

Excessively hydrated GCL shall be removed and replaced. Geomembrane shall not be placed on excessively hydrated GCL.

GCL panels shall be given an identification code, mapped, and logged to record relevant installation information.

4.2.3 GCL Repairs

Torn or otherwise damaged geosynthetic facing must be patched with the same type of geosynthetic. The geosynthetic patch must extend at least 12 inches beyond the damaged area and must be heat bonded, or otherwise attached to the main GCL to avoid shifting during placement of overlying geosynthetics. If the GCL damage includes loss of bentonite, the patch must consist of full GCL extending at least 12 inches beyond the damaged area. Lapping procedures must be the same as specified for original laps of GCL panels.

4.2.4 GCL Protection

The overlying geosynthetics and soil layers shall be deployed in such a manner as to ensure that the GCL is not damaged. Textured geomembranes shall not be dragged across previously installed GCL. A smooth rubsheet shall be placed between the GCL and textured geomembrane to prevent damage. The rubsheet will be removed when the geomembrane is in position. Other methods may be employed at the POR's discretion.

To avoid local bentonite displacement, and the possible impact on the hydraulic performance of a GCL, the soil cover material should be placed over the geomembrane and geocomposite overlying the GCL as soon as practicable following completion of the geomembrane and drainage system construction.

5.0 GEOMEMBRANE LINER

This section presents general procedures, quality control testing requirements, and construction specifications for geomembrane liner construction. Both the conventional composite final cover system and the alternative composite final cover system will include the following components:

- 40-mil, textured LLDPE geomembrane;
- A geocomposite drainage layer composed of a geonet and filter geotextiles heat-bonded to both sides; and
- 18-inch protective cover soil. The upper 6 inches is an erosion control layer and must be capable of sustaining native plant growth.

5.1 Pre-installation Material Evaluation

5.1.1 Manufacturer's Quality Control Certificates

Prior to installing any geomembrane, the manufacturer or installer shall provide the POR with quality control certificates signed by a responsible party employed by the manufacturer. Each quality control certificate shall include roll identification numbers, testing procedures, and results of quality control tests. The quality control tests shall be performed in the manufacturing plant using the test methods and frequencies listed in the most recent version of the Geosynthetic Research Institute (GRI) test method GM17, "Test Methods, Test Properties and Testing Frequency for Linear Low Density Polyethylene (LLDPE) Smooth and Textured Geomembranes," included in Attachment 1. The owner may require more frequent testing at his/her discretion.

The POR shall review the test results prior to accepting the geomembrane to assure that the certified minimum properties meet the minimum values for geomembranes, as determined by the most recent GRI test method GM17.

The rolls delivered to the site shall be inventoried, recording the manufacturer's name and product identification, and the roll thickness, number and dimensions. Manufacturer's certificates should be cross-referenced to rolls delivered on-site.

Resumes of the installer's supervisor(s) or Master Seamer(s) shall be obtained to verify that adequate seaming experience will be utilized on the project. The installer's supervisor or Master Seamer shall have had experience totaling a minimum of 2,000,000 square feet of geomembrane installation.

Upon delivery of geosynthetic materials, storage and handling procedures shall also be documented. Rolls of geosynthetic materials shall be handled and stored in such a way as not to damage the material. As a general rule, rolls of geosynthetic materials should not be stacked more than four rolls high.

5.1.2 Conformance Testing

In addition to the manufacturer's quality control certificates, samples of the delivered rolls of geomembrane will be obtained either at the manufacturing facility or upon delivery to the site for conformance testing. If collected at the manufacturing facility, samples collection shall be observed by a third party who shall record the roll number(s) sampled. The test samples shall be conformance tested by a third party laboratory in accordance with the testing schedule shown in Table III7C-5, Geomembrane Conformance Test Schedule.

Table III7C-5: Geomembrane Conformance Test Schedule

TEST	METHOD(1)	FREQUENCY
Thickness (laboratory measurement)	ASTM D5994 (Textured)	Not less than 1 test per 100,000 ft^2 with not less than 1 per resin lot
Density	ASTM D1505 or D792	
Carbon black content(5)	ASTM D4218	
Carbon black dispersion	ASTM D5596	
Tensile properties	ASTM D6693, Type IV	
Direct Shear(2)(3)(4)	ASTM D6243	1 test per GM/adjoining materials

Notes:

1. Updated ASTM or GRI methods may be implemented based on a review by the POR.

2. Direct shear testing shall be performed on the soil or GCL/geomembrane/geocomposite sandwich. Soak interface and apply normal stresses of 100, 200 and 400 psf for at least 1 hour prior to shearing at a displacement rate of 0.04 in/min.
3. The testing results shall be compared to the values used in the final cover system stability analyses included in the Appendix III3B-2E. If the measured interface shear strength is less than the values used in the analyses, the stability of the final cover system shall be reassessed and revised calculations shall be included in the FCSER.
4. Test results from materials used during one construction event may be used in subsequent events provided the materials used are the same and approved by the POR.
5. Other methods such as D1603 (tube furnace) or D6370 (TGA) are acceptable if an appropriate correlation to D4218 (muffle furnace) can be established.

5.2 Installation Procedures

5.2.1 Geomembrane Deployment

The geomembrane shall be installed in direct and uniform contact with the cohesive soil coder or GCL. The geomembrane shall not be placed during inclement weather such as high winds or rain.

Geomembrane seaming should generally not take place when ambient temperatures are below 32 degrees Fahrenheit (°F), unless preheating is used. For extrusion welding, preheating will be required if the temperature is below 32°F. For fusion welding, preheating may be waived if the installer demonstrates that quality welds may be obtained without preheating. Seaming shall not be permitted at ambient temperatures above 104°F, unless the installer can demonstrate that seam quality is not compromised.

In general, only low ground pressure rubber-tired support equipment approved by the POR may be allowed on the geomembrane. If the POR observes any potential damage done to the liner by the support equipment, use of the equipment will cease and the damage will be repaired. Personnel working on the geomembrane shall not smoke, wear damaging shoes, or engage in any other activity likely to damage the geomembrane. Only those sections that are to be placed and seamed in one day should be unrolled. Panels left unseamed should be anchored with sandbags or other suitable weights. In general, seams should be oriented parallel to the line of maximum slope (i.e., oriented up and down, not across the slope). In corners and odd-shaped geometric locations, the number of field seams should be minimized.

Panels should be overlapped as recommended by the manufacturer as appropriate for the type of seam welding to be performed; however, overlapping shall be no less than 2 inches. Field seaming shall only be performed by the method(s) approved by the manufacturer, either by extrusion welding or double-tracked fusion welding. No seaming shall take place without the installer's supervisor or Master Seamer and CQA monitor being present. Fishmouths or wrinkles at the seam overlap shall be cut along the ridge of the wrinkle to achieve a flat overlap. The cut shall be seamed and/or patched. Seams shall extend to the outside edge of panels placed in the anchor trench.

Panel layout and field seams shall be given an identification code, mapped, and logged to record relevant installation information. Inspection and testing records shall be logged as well as repair and retest data. Section 5.0 includes a list of items to be documented during geomembrane construction and testing.

5.3 Installation Monitoring and Testing

5.3.1 Trial Seams

Each day prior to commencing field seaming, trial seams shall be made on pieces of geomembrane material to verify that conditions are adequate for production seaming. Trial seams shall be made at the beginning of each seaming period and shift (generally, at least twice each day) for each combination of production seaming machine and operator to be used that day. The trial test seam shall be at least 3 feet long by 1 foot wide (after seaming) with the seam centered lengthwise. Four 1-inch wide specimens shall be die-cut from the trial seam sample. Two specimens shall be tested in the field for shear and two for peel (test both inner and outer welds for dual track fusion welding) and shall be compared to the minimum seam strength requirements specified in the most current version of the Geosynthetic Institute, GRI Test Method GM19. The current versions of the GRI test methods are included in Attachment 1.

If any of the trial seam specimens fail, the entire trial seam operation shall be repeated. If an additional specimen fails during the second trial seam, the seaming machine and seamer shall not be used for seaming until the deficiencies are corrected and two consecutive successful trial seams are achieved. Additional trial seams shall be made at each occurrence of significantly different environmental conditions, including, but not limited to, temperature, humidity, and dust, and after any machine is turned off for more than 30 minutes.

5.3.2 Non-Destructive Testing

Continuous, non-destructive testing shall be performed on all seams by the installer. All leaks must be isolated and repaired by following the procedures described in this FCQCP.

Air Pressure Testing – ASTM D5820. The ends of the air channel of the dual-track fusion weld must be sealed and pressured to approximately 30 pounds per square inch (psi), if possible. The air pump must then be shut off and the air pressure observed after 2 minutes. A loss of less than 4 psi is acceptable if it is determined that the air channel is not blocked between the sealed ends. A loss greater or equal to 4 psi indicates the presence of a seam leak that must then be isolated and repaired by following the procedures described in this FCQCP. The POR or his/her qualified representative must observe and record all pressure gauge readings.

Vacuum-Box Testing – ASTM D5641. Apply a vacuum of approximately 4 to 8 psi to all extrusion welded seams that can be tested in this manner. The seam must be observed for leaks for at least 10 seconds while subjected to this vacuum. The POR or his/her qualified representative must observe 100 percent of this testing.

Other Testing. Other non-destructive testing must have prior written approval from the TCEQ.

5.3.3 Destructive Seam Testing

Destructive samples shall be taken at a minimum frequency of one test location, selected randomly, within each 500 linear feet of seam length, inclusive of both primary longitudinal and cross seams, cap strips, and repairs 20 square feet in total area or larger. Each test sample should be of sufficient length and 12 inches wide with the seam located in the middle. Test specimens, approximately 1 inch wide, shall be cut from both ends of the sample for field testing (peel and shear). The remaining sample should be cut into three parts (one for quality assurance laboratory testing, one for installer quality control laboratory testing, and one for archive storage to be maintained at a location selected by the owner).

The field tests shall be conducted on a certified calibrated tensiometer capable of maintaining a constant extension rate of 2 inches per minute. If one of the field test specimens from the ends of the destructive sample fails, then the seam will be considered to have failed, and repairs shall be initiated, as described below. If both specimens pass, then a sample for laboratory testing will be sent to the quality assurance laboratory for testing in both peel and shear. Seam strengths for LLDPE geomembranes shall meet the minimum values specified in the most current version of the Geosynthetic Institute, GRI Test Method GM19, “Seam Strength and Related Properties of Thermally Bonded Polyolefin Geomembranes.”

Destructive test results for both field and laboratory tests shall include qualitative data, including the location of the failure and locus-of-break code as described in ASTM D6392. Peel tests on double-tracked fusion welds shall be performed on both inside and outside tracks of the weld. Seam break classifications for extrusion and fusion welds are shown on Figures III7A-1 and III7A-2, respectively.

At a minimum, a destructive test must be done for each welding machine used for seaming or repairs. A sufficient amount of the seam must be removed to conduct field testing, independent laboratory testing, and archiving of enough material to retest the seam when necessary. Destructive seam testing locations shall be cap-stripped and the cap completely seamed by extrusion welding to the geomembrane. Capped sections shall be non-destructively tested. Additional destructive test samples may be taken if deemed necessary by the POR or his/her qualified representative.

> Weld Acceptance Criteria: For LLDPE seams, the minimum passing criteria for destructive seam testing are described in the Geosynthetic Institute, GRI Test Method GM19. The POR must use the most current version of GM19 when evaluating welded seams.
>
> Seam Failure Delineation: When a sample fails a destructive test, the installer shall trace the welding path to an intermediate location at least 10 feet in each direction, or a distance determined by the POR, from the point of the failed test in each direction and take 1-inch wide specimens for an additional set of field tests. If these additional samples pass the tests, then two laboratory destructive samples shall be taken adjacent to the intermediate locations or at locations determined by the POR or his/her representative. If these laboratory samples pass the tests, then the seam shall be repaired between these locations. If either sample fails, then the process shall be repeated to establish a zone where the seam should be repaired. All

acceptable repaired seams shall be bounded by two locations from which samples passing laboratory destructive tests have been taken.

Seam Failure Repairs: Any portion of the geomembrane exhibiting a flaw or failing a destructive or non-destructive test shall be repaired. Repair methods may include spot welding (extrusion) for minor flaws and punctures; patches for larger holes and tears; capping for large lengths of failed seams or panel damage; and extrusion welding of outer flap to repair of an inadequate fusion seam (less than 100-foot cumulative length) that has an exposed edge.

For any repair method, the following provision shall be satisfied:

- Surfaces of the geomembrane that are to be repaired using extrusion methods shall be ground no more than one hour prior to the repair;
- All surfaces shall be clean and dry at the time of repair;
- Patches or caps shall extend at least 6 inches beyond the edge of the defect, and all corners of patches shall be rounded with a radius of approximately 3 inches;
- All repairs shall be non-destructively tested, as previously described; and
- All seaming equipment, personnel, and operation procedures used in repair work shall meet the same requirements as for new seaming operations.

The POR or his/her qualified representative shall observe all non-destructive testing of repairs and shall record the number of each repair, type, date, and test outcome. Repairs that pass the non-destructive tests shall be taken as an indication of an adequate repair. Repairs more than 150 feet long shall also be required to have a destructive test performed. Repairs that fail the initial retest shall be redone and retested until a passing test results. All work and testing of repairs shall be fully documented in a repair log.

When placing overlying material on the geomembrane, effort must be made to minimize wrinkle development. If possible, cover should be placed during the coolest weather available. Small wrinkles should be isolated and covered as quickly as possible to prevent their growth. In no case shall the geomembrane be allowed to fold over on itself.

6.0 DRAINAGE LAYER

The geocomposite drainage layer shall conform to the material and performance properties specified in Table III7C-6, Geocomposite Drainage Layer Specifications. Manufacturers' certificates of material and performance characteristics shall be obtained and documented at the minimum frequency shown on Table III7C-6, Geocomposite Drainage Layer Specifications, with not less than 1 per resin lot. Geosynthetic drainage material conformance testing will consist of transmissivity testing on each material type using the test set-up described in Table III7C-6, Geocomposite Drainage Layer Specifications.

The drainage layer is a double-sided geocomposite that consists of a geonet with a non-woven geotextile heat-bonded on both sides deployed over the final cover area. The double-sided geocomposite shall be anchored in an anchor trench at the perimeter of the final cover area or as shown on Figures III7-2A and

III7-2B. The geonet core of the geocomposite will be tied together using plastic ties placed at a frequency of one per 5 feet along the length of the panel and every 6 inches along the ends of the panels. The upper geotextile panels will be secured by either overlapping and heat bonding or field sewn.

Only low ground pressure rubber-tired support equipment approved by the POR may be allowed on the geotextile. Personnel working on the geotextile shall not smoke, wear damaging shoes, or engage in any activity that damages the geotextile or underlying geosynthetics.

Table III7C-6: Geocomposite Drainage Layer Specifications

Test Category	Product	Test[a]	Test Method[b]	Testing Frequency
Manufacturer	Resin (Geonet)	Density	ASTM D792 or D1505	One test per 100,000 ft^2 and every resin lot
		Melt Flow Index	ASTM D1238	
Manufacturer	Geonet	Density	ASTM D792 or D1505	One test per 100,000 ft^2 and every resin lot
		Nass / Area	ASTM D5261	
		Thickness	ASTM D5199	
		Compression	ASTM D1621	
		Transmissivity	ASTM D4716	
Manufacturer	Geotextile	Mass/Area	ASTM D5261	One test per 100,000 ft^2 and every resin lot
		Grab Tensile Strength	AASTM D4632	
		Trapezoidal Tear Strength	ASTM D4533	
		Burst Strength	ASTM D3786	
		Puncture Strength	ASTM D4833	
		Thickness	ASTM D5199	
		Apparent Opening Size	ASTM D4751	
		Permittivity	ASTM D4491	
Independent Laboratory	Geocomposite Product	Transmissivity	ASTM D4716	One test per product type
		Interface Shear or Ply Adhesion	ASTM D5321 OR D413	One test per project

[a] Adapted from EPA/600/R-93/182, September 1993, and *Designing with Geosynthetics*, 6th ed.
[b] The POR may propose equivalent or better tests.

7.0 EROSION LAYER

The soil cover layer will consist of an 24-inch thick single protective/erosion layer. See Section 2.0 of this plan for a detailed description of the final cover system.

Soil cover does not require compaction control; however, it should be stable for construction traffic. Care shall be exercised in placement so as not to shift, wrinkle, or damage any underlying geosynthetic layers, and the placement methods shall be documented. Soil cover placement shall be monitored by the POR or his/her representative on a full-time basis.

Only the geocomposite should be placed in direct contact with the geomembrane. Light equipment, such as low ground pressure dozers (less than 5 psi contact pressure), shall be used to place the soil cover and a minimum of 12-inches of material shall be maintained between the dozer and the underlying geosynthetics. If possible, cover should be placed during the coolest weather available. Soil cover material shall be deployed in “fingers” along the geosynthetics to control the amount of slack and minimize wrinkles and prevent folds. Soil cover shall generally be placed in an upslope direction on sideslopes.

The final thickness of the soil cover layer shall be a minimum of 24-inches directly above the geocomposite drainage layer. The required thickness of the layer shall be verified by survey techniques on an established grid system with not less than one verification point per 10,000 square feet of surface area. A minimum of two verification points is required.

The soil used as the soil cover layer will be capable of sustaining native plant growth and must be seeded or sodded immediately after completion of the final cover (weather permitting). Temporary or permanent erosion control materials (i.e., mulches, containment meshes, geomatting systems, etc.) may be used to minimize erosion and aid establishment of vegetation. An alternative erosion layer may also be constructed (subject to the approval of TCEQ) consisting of cobbles, riprap, or other hard armor systems for areas where establishing vegetative cover has proven difficult.

Other quality assurance for the soil cover layer should consist of continuous observation by the POR or his/her representative during construction; inspection of any manufacturer’s or supplier’s material test data and certification; and performing any additional test believed necessary by the POR to verify that the layer has been constructed in accordance with the closure plan.

8.0 FINAL COVER SYSTEM EVALUATION REPORT

Upon completion of all required final cover construction and evaluation, the POR shall prepare and submit in triplicate the FCSER, prepared in accordance with this plan, to the TCEQ for review and approval.

Each FCSER will include a discussion of the construction of the final cover elements and a cover placement map, which not only shows the covered area being submitted for approval, but also the areas covered by all previous FCSER submittals with the dates of acceptance by the TCEQ. The map should depict the site grid system, graphic scale, and north arrow. It may be a print from a master drawing that is annotated and updated with each new submittal. The FCSER shall be signed and/or sealed by the POR performing the evaluation and counter-signed by the site operator or his/her authorized representative.

The construction documentation will contain a narrative describing the conduct of work and testing programs required by the FCQCP, "as-built" or record drawings, and appendices of field and laboratory testing. Constructed cover details ("as-builts"), where applicable, will be depicted and will show slopes, widths, and thickness for compaction lifts as determined from the field documentation. The construction documentation report will contain or discuss the following information at a minimum.

Table III7C-7: FCSER Content

Cohesive Soil Cover	Pre-construction soil test results
	Summary of construction material conformance tests results
	Summary of field moisture-density control test methods and results
	Summary of hydraulic conductivity test results
	Cohesive soil cover construction practices
	Placement and processing methods
	Observations of soil conditions prior to and after compaction, including soil structure, clod size, and presence of inclusions
	Compaction methods, equipment type, compactor weight and foot length, and number of passes
	Lift tie-in and bonding observations
	Repair of failed and damaged lifts
	Any and all deviations from the permitted design
	Thickness Verification
	Post-construction care of cohesive soil cover

Geosynthetic Clay Liner	Roll shipment and receipt information
	Manufacturer's quality control certificates and results
	Storage and handling information
	Conformance test sampling and test results
	Subgrade acceptance
	Panel deployment, identification, and placement
	Equipment placed or operated on GCL
	100 percent visual inspection for defects, damage, etc.
	Seaming methods
	Repairs, including patch size and shape
Geomembrane Liner	Roll shipment and receipt information
	Manufacturer's quality control certificates and results
	Storage and handling information
	Conformance test sampling and test results
	Seamer's names and resumes of experience and qualifications
	Subgrade acceptance
	Panel deployment, identification, and placement
	Seam preparation, orientation, and identification
	Equipment placed or operated on geomembrane
	100 percent visual inspection for defects, damage, etc.
	Trial seam tests for each combination of seaming equipment and personnel
	Seaming methods, times, temperature, and equipment shutdowns and startups
	Continuous 100 percent non-destructive seam testing, methods, criteria, and results
	Destructive testing methods, criteria, and results
	Repairs, including preparation and procedures, failure delineation, patch size and shape, and retesting
	Material properties and placement of drainage materials and soil cover
	Confirmation of the interface friction angle for the geomembrane/adjoining material interface and a recalculation of the factor of safety, if needed.
Record Drawings	Layout plan
	Previous covered areas
	As-built cohesive soil cover drawings, showing sample and test locations, and thickness
	As-built GCL panel layout drawings
	As-built geomembrane panel layout drawings, showing location of destructive test samples, patches, and repairs
	As-built drawings showing elevations of soil cover to confirm its thickness

9.0 REFERENCES

Scalia, J.S. and C.H. Benson, 2011. Hydraulic Conductivity of Geosynthetic Clay Liners Exhumed from Landfill Final Covers with Composite Barriers, Journal of Geotechnical and Geoenvironmental Engineering, Vol. 137, No. 1.

FIGURES

ATTACHMENT 1

GEOSYNTHETIC RESEARCH INSTITUTE (GRI) TEST METHODS

GRI Test Method GM17

GRI Test Method GM19