PART III, ATTACHMENT 7

CLOSURE PLAN

Temple Recycling & Disposal Facility

Temple, Bell County, Texas

TCEQ Permit MSW-692B

Owner/Site Operator/Permittee:

City of Temple
201 N. Main
Temple, Texas 76501

GOLDER ASSOCIATES INC.
Professional Engineering Firm
Registration Number F-2578

INTENDED FOR PERMITTING PURPOSES ONLY

Operator:

WASTE MANAGEMENT

Waste Management of Texas
9708 Giles Lane
Austin, Texas 78781

Submitted By:

Golder Associates Inc.
500 Century Plaza Drive, Suite 190
Houston, TX 77073 USA
Professional Engineering Firm Registration Number F-2578

Submitted: June 2016
Revised: December 2016

Project No. 1400336

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GOLDER ASSOCIATES INC.
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1.0 INTRODUCTION

This Final Closure Plan has been developed for the Temple Recycling and Disposal Facility located in Bell County, Texas. This plan addresses the requirements of Title 30 of the Texas Administrative Code (TAC) §330.63(h) and Subchapter K for closure of a municipal solid waste (MSW) landfill. A copy of this plan will be placed in the facility's operating record.

The Temple Recycling and Disposal Facility is owned by the City of Temple and operated by Waste Management of Texas, Inc. ("WMTX"). The Temple Recycling and Disposal Facility is located at 706 Landfill Road, approximately 0.25 miles east of the intersection of Loop 363 and Avenue H, in Bell County, Texas. The facility will receive municipal solid waste as specified in Part IV, the Site Operating Plan.This plan includes a description of the steps that will be undertaken to close each filled disposal unit, a general schedule for final closure, a description of the final cover system, and the methods used to install the cover. Information supplemental to this closure plan, such as design drawings and a description of groundwater and methane monitoring system design, are included elsewhere in the Site Development Plan.

Portions of the landfill have been constructed with final cover and approved by the Texas Commission on Environmental Quality (TCEQ). These areas are summarized in Table III-7-1.

Table III-7-1: Areas with Final Cover

Description	Area	Cover	Date
Tract 1A	63.2 acres	6-inch thick vegetative cover 18-inch thick compacted clay with $k \leq 1 \times 10^{-7}$ cm/s	1994
Tract 1B	11.8 acres	6-inch thick vegetative cover 18-inch thick compacted clay with $k \leq 1 \times 10^{-5}$ cm/s	1994
Tract 2A portions of Cells 1A, 1B, 1C and 2	9.5 acres	6-inch thick vegetative cover 36-inch thick compacted clay with $k \leq 1 \times 10^{-7}$ cm/s 3H:1V slope	2004 2013
Tract 3 Northern portion of Cells 3B and 4	2.6 acres	6-inch thick vegetative cover 36-inch thick compacted clay with $k \leq 1 \times 10^{-7}$ cm/s 3H:1V slope	2004

Appendix III-7C includes a Class I Modification request pertaining to the closure of Tracts 1A and 1B as well as the correspondence regarding the request and the TCEQ modification approval letter. The TCEQ approval letters for the Tracts 1 and 1A final cover soil evaluations and the 2A Lower Slope Final Cover System Evaluation Report are included in Appendix III-7D.

The proposed vertical expansion will cover an approximately 2.7-acre portion of the eastern slope of the Tract 2A, Cell 1A, 1B, and 1C final cover by the initial receipt of waste. This area is shown on Figure III-7-1.

2.0 FINAL COVER

2.1 Final Cover Design

The final landfill contours and final cover details are provided on Figures III-7-1, III-7-2.1, and III-7-2.2. Landfill cross-sections are included as Figures III-7-3.1 through III-7-3.4. The remaining final cap will consist of 4 horizontal to 1 vertical (4H:1V) sideslopes to an elevation of approximately 820 feet above mean sea level (ft-msl). The upper portions of the final cover are sloped at a minimum 4 percent grade to a maximum elevation of approximately 835 ft-msl. Add-on berms intercept run-off from the top surface and along the sideslopes of the cover and direct it to downchutes. These downchutes convey rainfall run-off down the sideslopes to the perimeter channels and detention ponds. Details of the surface water management features are included in Part III, Attachment 2.

The final cover for existing and proposed disposal cells will consist of a composite system comprised of (from the bottom up):

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

The LLDPE geomembrane and geocomposite may be replaced with an alternate material that incorporates both the geomembrane and drainage layer (e.g., Super Gripnet® by Agru America), provided material equivalency in terms of barrier and flow characteristics is demonstrated. The LLDPE is textured on the 4H:1V sideslopes and may be smooth on the upper portion of the final cover, which is sloped at 4 percent. Details for the proposed and existing final cover designs are depicted on Figures III-7-2.1 and III-7-2.2.

2.2 Final Cover Installation Procedure

The installation procedures for the cover system are described in the "Final Cover Quality Control Plan," included as Appendix III-7A.

In order to maintain an adequate factor of safety against sliding, the geocomposite drainage layer in the geocomposite final cover system must be sized adequately to convey infiltration without allowing the build-up of pore water pressures. Analyses (included in Appendix III-3D-2 of Part III, Attachment 3, the Waste Management Unit Design Report) were performed to determine the geocomposite drainage layer transmissivity required to adequately convey surface water infiltration over the maximum final cover slope length. If the minimum measured transmissivity value reported in Appendix III-3D-2 is not met, the maximum

flow length must be reduced (i.e., the geocomposite drainage layer must be "daylighted") in direct proportion to the ratio of the actual measured transmissivity and the required measured transmissivity.

2.3 Quality Control and Testing Frequency

Specific quality assurance and quality control closure activities for final cover placement are presented in the "Final Cover Quality Control Plan," included as Appendix III-7A to this document.

2.4 Vegetation

To minimize erosion, the final cover surface will be seeded or sodded immediately following application of the final cover. Bermuda or a native grass mix is recommended for permanent vegetative cover. Naturally occurring grasses and wildflowers may also be used. A temporary cover of rye grass, winter wheat, or other cool-weather vegetation may also be used. These vegetative species generate root depths that are less than the soil depths on top of the infiltration layer, or less than 6 inches. During the early stages of vegetative growth, mulching, slope soil regrading, and mowing will be performed, as required, to promote erosion control. Temporary or permanent erosion control materials (e.g., mulches, containment meshes, geomatting systems, etc.) may be used to minimize erosion and aid the establishment of vegetation.

2.5 Soil Loss

Soil erosion losses for various slopes representing worst-case conditions were analyzed. The results indicate that, for these worst-case slopes, the erosion losses will be approximately 2.4 tons/acre/year. These calculations are presented in Part III, Attachment 2, Appendix III-2E.

Best Management Practices (BMPs) will be utilized at the site to ensure minimal erosion losses. BMPs will include proper seeding techniques, diverting stormwater, managing overland flow, trapping sediment in channelized flow, controlling erosive velocity impacts through channel protection, and preventing the tracking of mud by constructing adequate access roads. Additional information regarding the surface water run-off system and design is available in Part III, Attachment 2.

3.0 MAXIMUM INVENTORY OF WASTES

The total estimated airspace of the Temple Recycling and Disposal Facility is approximately 55.5 million cubic yards. This volume figure represents the total volume available for in-place solid waste and daily and intermediate cover soils. The inventory of wastes in this facility are typically municipal solid wastes, including special wastes and non-hazardous Class 2 and 3 industrial wastes, which are compacted in place at the working face as they are received. Class 1 waste that is classified as such due to asbestos content only, may also be taken at this facility.

4.0 MAXIMUM CLOSURE AREA

Based on Maximum Closure Area of the current operational fill (provided as Figure III-7-4), the largest area estimated to require final cover should unforeseen circumstances occur that would force closure of the site during the active life is approximately 108 acres. This area includes the active face and areas with daily or intermediate cover in place. The maximum area requiring final cover accounts for the previously installed final cover areas (Tract 3, northern portions of Cells 3B and 4 and a portion of Tract 2A, portions of Cells 1A, 1B, 1C and 2) equaling 12 acres.

5.0 CLOSURE COMPLETION SCHEDULE

5.1 Implementation of the Closure Plan

In accordance with 30 TAC §330.457(f), the implementation of this Closure Plan will ensure the following schedule.

- No later than 30 days after disposal units reach capacity and receive final waste
  Closure activities for each unit shall begin no more 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 executive director 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 owner or operator has taken and will continue to take all steps necessary to prevent threats to human health and the environment from the unit.
- No later than 45 days before unit closure begins
  Written notification of the intent to close the unit or the facility will be submitted to the TCEQ and placed in the site's operating record. For final facility closure, signs will be posted at all points of access notifying facility users of the upcoming closure date and the prohibition against receipt of further waste after that date.
- No later than 180 days after the initiation of final closure activities
  Final closure activities will be complete. These activities include placing the compacted soil infiltration layer, geomembrane, drainage layer, the erosion layer, the top soil, and vegetation. Installation of post-closure monitoring devices, such as monitoring wells, gas probes, and the gas collection system, will also be complete. Extending closure work beyond 180 days requires TCEQ approval.
- Following completion of all final closure activities for the facility
  The City of Temple will submit to the TCEQ by registered mail a documented certification, signed by an independent licensed professional engineer, verifying that final closure has been completed in accordance with this Closure Plan. The submittal to the TCEQ will include all applicable documentation necessary to certify final closure. Once approved, the certification will be placed in the site's operating record.

Within 10 days after closure of all landfill units, a certified copy of an "affidavit to the public" will be submitted to the TCEQ by registered mail in accordance with 30 TAC §330.19 and a copy will be placed in the site's operating record. In addition, the owner or operator shall record a certified notation of the deed to the facility property, or on some other instrument that is normally examined during title searches, that will in perpetuity notify any potential purchaser of the property that the land has been used as a landfill and that future uses of the land are restricted according to the provisions specified in 30 TAC §330.465. A certified copy of the modified deed will be submitted to the TCEQ, and a copy will be placed in the site's operating record.

5.2 Certification of Final Facility Closure

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

- No later than 90 days before final site closure begins
  Public notice for the final closure of the facility will be published in the newspaper with the largest circulation in the area of the site. The name, address and location of the facility, the permit number, and the last date that waste will be received are to be included in the published notice. Adequate copies of the approved final closure and post-closure plans will be provided for public review. Written notification of the intent to close the facility will be provided to the Executive Director and placed in the operating record.

  After notification to the executive director. The owner or operator 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 the closing for the entire facility and the prohibition against further receipt of waste materials after the stated date. Further, suitable barriers shall be installed at all gates or access points to adequately prevent the unauthorized dumping of waste at the closed facility.
- Within 10 days of completion of the site closure activities:
- A certified copy of an "affidavit to the public" by the City of Temple will be submitted to the Executive Director by registered mail.
  - in accordance with 30 TAC §330.19 and a copy will be placed in the site's operating record. The affidavit will include a metes and bounds description of the limits of the disposal areas. The affidavit will also include a notice that any future use of the land is restricted. A certified notation on the deed to the facility or site property, or on some other instrument that is normally examined during title searches, that will in perpetuity notify any potential purchaser of the property that the land has been used as a landfill and that future uses of the land are restricted will be filed and recorded in the deed records of the office of the County Clerk of Bell County. A certified copy of the modified deed will be submitted to the TCEQ, and a copy will be placed in the site's operating record. In accordance with 30 TAC §330.461(d), the owner of the facility may request permission from the TCEQ to remove the notation from the deed if all wastes are removed from the facility in accordance with 30 TAC §330.7(a) (relating to the permit required).A documented certification, signed by an independent licensed professional engineer, verifying that final closure has been completed in accordance with this Closure Plan. The submittal to the TCEQ will include all applicable documentation necessary to certify final 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 the approved 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 III-7B, TCEQ Closure Plan Form, provides guidance to detail the plan for closure of a landfill unit, closure of associated storage or processing units, 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.

6.0 CLOSURE OF STORAGE AND PROCESSING UNITS

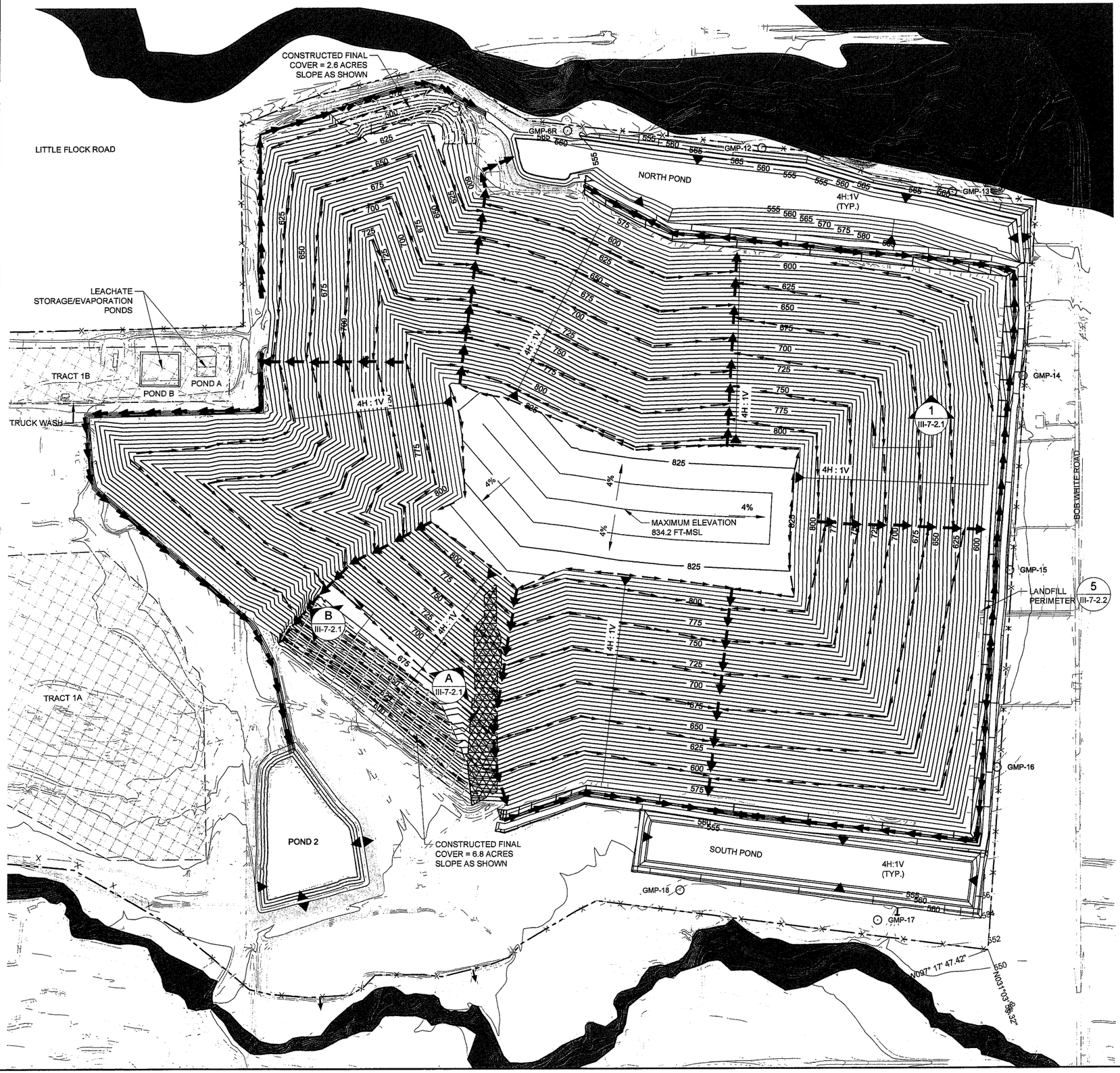
Closure for the storage and processing units at the site is addressed as follows:

- Liquid waste stabilization area: Upon closure, the waste remaining in the stabilization tank will be properly stabilized and disposed of in the landfill. The stabilization tank will be disposed of within the landfill.
- 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.
- Recyclable material staging area: Recyclable materials will transported off-site for to recyclable material end user locations.
- Leachate evaporation ponds: The leachate evaporation ponds will remain in use during the post-closure care period.
- Citizen Collection Station: Upon closure, waste remaining at the Citizen Collection Station will be transported to the landfill disposal area for disposal. The Citizen Collection Station will either be dismantled or a "Notice of Intent to Operate a Citizen's Collection Station" will be submitted to TCEQ.

FIGURES

APPENDIX III-7A

FINAL COVER QUALITY CONTROL PLAN



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Professional Engineering Firm
Registration Number F-2578

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LEGEND

- PERMIT BOUNDARY
- FENCE
- PERIMETER CHANNEL FLOW DIRECTION
- ADD-ON BERMS
- STORMWATER DOWNCHUTES
- SURFACE WATER DISCHARGE
- 100-YEAR FLOODPLAIN
- AREAS WITH TCEQ APPROVED FINAL COVER
- FINAL COVER LANDFILL AREAS TO BE COVERED BY VERTICAL EXPANSION
- SURFACE WATER ENTRANCE OR DISCHARGE
- MW-20 MONITORING WELL
- GMP-3 GAS PROBE

NOTES

1. TOPOGRAPHY COMPILED BY PHOTOGRAMMETRIC METHODS FROM AERIAL PHOTOGRAPHY DATED MARCH 6, 2015.
2. THE 100-YEAR FLOODPLAIN IS BASED ON THE CURRENTLY PROPOSED FEMA FLOODPLAIN SEE PORT I/II, APPENDIX B.
3. TOP OF FINAL COVER GRADES SHOWN ON THIS SHEET.
4. SEE PART III ATTACHMENT 2 FOR DETAILS OF STORMWATER MANAGEMENT FEATURES.

STATE OF TEXAS
12/5/16
CHARLES G. DOMINGUEZ
83247
LICENSED
PROFESSIONAL ENGINEER

0 250 500
1" = 500' FEET

REV.	DATE	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
1	2016-12	RESPONSE TO 1ST NOD MX	TNB	MX	CGD	
0	2015-12-03	INITIAL SUBMITTAL	PRM	TNB	PRM	CGD

CLIENT
CITY OF TEMPLE

CONSULTANT
Golder Associates
HOUSTON
500 CENTURY PLAZA DR., SUITE 190
HOUSTON, TX 77073
USA
(281) 821-6868
www.golder.com

PROJECT
PERMIT AMENDMENT APPLICATION MSW 692B
TEMPLE RECYCLING AND DISPOSAL FACILITY
BELL COUNTY, TEXAS

TITLE
FINAL CONTOUR MAP

PROJECT NO.
1400336

APPLICATION SECTION
III Attachment 7

REV.
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1 of 8

FIGURE
III-7-1

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

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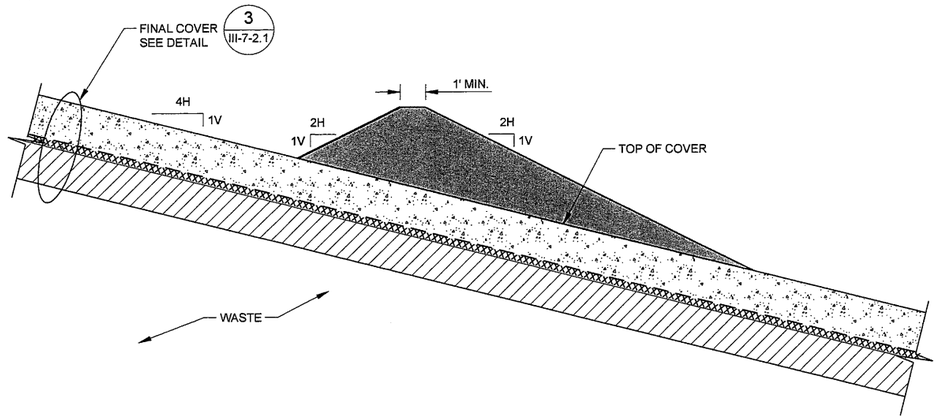

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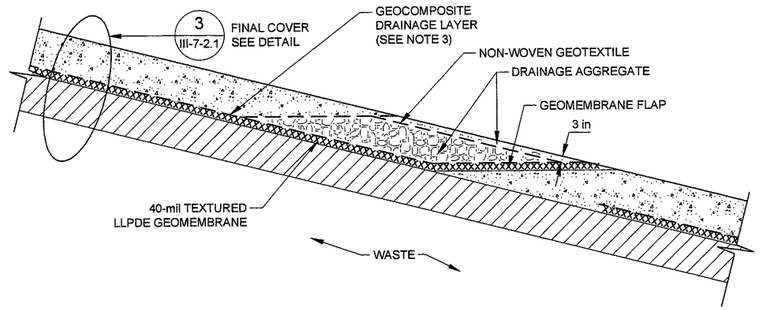
ADD-ON BERM



SCALE 1" = 6' 2 III-7-2.1 DETAIL
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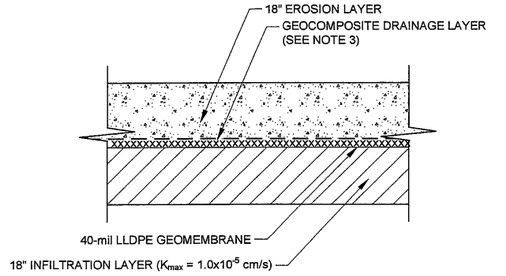
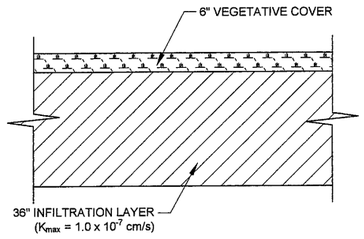
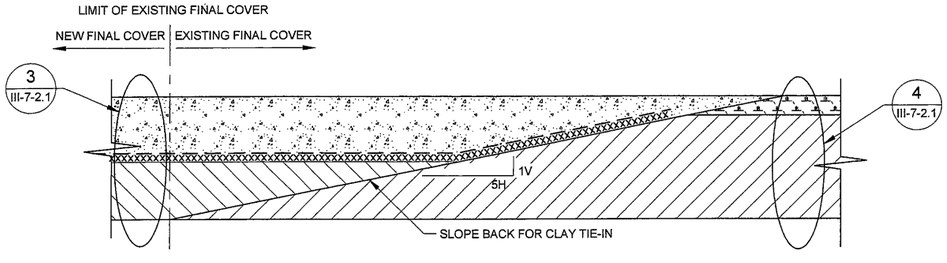


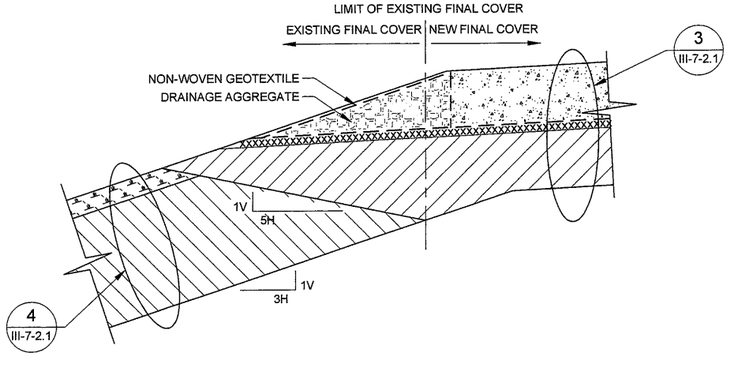
SCALE 1" = 4' 3 III-7-2.1 DETAIL
PROPOSED FINAL COVER



SCALE 1" = 4' 4 III-7-2.1 DETAIL
EXISTING FINAL COVER - TRACT 2A & 3



SCALE 1" = 4' A III-7-2.1 DETAIL
TIE-IN BETWEEN EXISTING AND PROPOSED FINAL COVER



SCALE 1" = 4' B III-7-2.1 DETAIL
TIE-IN BETWEEN EXISTING AND PROPOSED FINAL COVER

NOTES

1. GEOSYNTHETICS SHOWN EXAGGERATED FOR CLARITY.
2. SEE ATTACHMENT 2 FOR DETAILS OF STORMWATER MANAGEMENT FEATURES.
3. SEE ATTACHMENT 3, APPENDIX III-3D-2 FOR DESIGN AND LOCATIONS OF THE GEOCOMPOSITE DRAINAGE LAYER.

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0 2 4
1" = 4' FEET

0 3 6
1" = 6' FEET

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
1	2016-12	RESPONSE TO 1ST NOD MX	TNB	MX	PRM	CGD
0	2015-12-03	INITIAL SUBMITTAL	VJE	TNB	CGD	

CLIENT: CITY OF TEMPLE

CONSULTANT: Golder Associates
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PROJECT: PERMIT AMENDMENT APPLICATION MSW 692B
TEMPLE RECYCLING AND DISPOSAL FACILITY
BELL COUNTY, TEXAS

TITLE: **FINAL COVER DETAILS I**

APPLICATION SECTION: III Attachment 7

PROJECT NO. 1400336

REV. 0 | 2 of 8 | FIGURE III-7-2.1

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

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PART III, ATTACHMENT 7A

FINAL COVER QUALITY CONTROL PLAN

Temple Recycling & Disposal Facility

Temple, Bell County, Texas

TCEQ Permit MSW-692B

Owner/Site Operator/Permittee:

City of Temple
201 N. Main
Temple, Texas 76501

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WASTE MANAGEMENT

Waste Management of Texas
9708 Giles Lane
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Submitted: June 2016
Revised: December 2016

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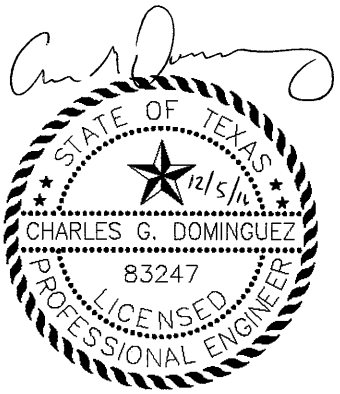

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1.0 PURPOSE

1.1 Purpose and Scope

This Final Cover Quality Control Plan (FCQCP) has been prepared in accordance with 30 TAC §330.457. This FCQCP establishes the procedures for the construction, testing, and documentation of the final cover system for Temple Recycling and Disposal Facility.

This FCQCP was developed to address the construction and quality control testing of soil and geosynthetic components of the final cover system in compliance with the Subtitle D requirements. Construction and testing of all final cover system components must be according to this FCQCP.

A copy of a current version of this FCQCP must be maintained on-site at all times with the Site Operating Record. The FCQCP shall be available for reference by the Texas Commission on Environmental Quality's (TCEQ's) inspector and construction and testing personnel. Revisions to this FCQCP shall receive written approval from the TCEQ before implementation.

1.2 General Responsibilities

The final cover will be constructed in accordance with 30 TAC §330.457(a).

Existing final cover over Subtitle D cells consists of an 18-inch thick compacted cohesive soil cover having a maximum hydraulic conductivity of 1×10^{-7} cm/sec overlain by a 6-inch vegetative soil cover capable of sustaining native vegetation, on 3H:1V slopes.

The final cover for existing and proposed disposal cells will consist of a composite system comprised of (from the bottom up):

- 18-inch thick compacted earthen material with a hydraulic conductivity of 1×10^{-5} cm/sec or less
- 40-mil linear low-density polyethylene (LLDPE) geomembrane that has a permeability less than or equal to the permeability of the bottom liner system
- Geocomposite (geonet/geotextile) drainage layer
- Erosion layer consisting of 18 inches of protective soil cover, of which the uppermost 6 inches will be capable of supporting native vegetation

The LLDPE is textured on the 4H:1V sideslopes and may be smooth on the upper portion of the final cover which is sloped at 4 percent.

The LLDPE geomembrane and geocomposite may be replaced with an alternate material that incorporates both the geomembrane and drainage layer (e.g., Super Gripnet® by Agru America) provided material equivalency in terms of barrier and flow characteristics is demonstrated.

The owner/operator is responsible for fully implementing this FCQCP. The site manager (SM) or designated alternate will be responsible for contracting with a qualified Professional of Record (POR) prior to initiating final cover construction.

Each phase of the final cover evaluation shall be conducted by or under the supervision of the POR. The POR shall be an independent third party professional engineer (PE) licensed in the State of Texas with experience in civil or geotechnical engineering and soils testing. A qualified construction quality assurance (CQA) monitor performing daily quality assurance/quality control (QA/QC) observation and testing shall be under the direct supervision of the POR. The POR or his/her qualified representative(s) shall provide full-time monitoring.

2.0 COHESIVE SOIL COVER EVALUATION (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.

2.1 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 III-7A-1.

Table III-7A-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
Standard 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 standard 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 ≤ 1×10^{-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. Rocks and stones in soil for liner construction shall be limited to no more than one inch in diameter and no more than 10% by weight.

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 standard 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 Section 2.2.

As a general rule, a minimum of one series of pre-construction tests should be performed 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, results from previous tests may be used to supplement the pre-construction data.

2.2 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.

2.2.1 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 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.

2.2.2 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.

2.2.3 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.

2.2.4 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 standard 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.

2.2.5 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.

2.3 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.

2.3.1 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 Section 1.2, 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 compactive 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 geosynthetics 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

2.3.2 Construction Testing

During cohesive soil cover construction, the minimum testing and sampling program presented in Table III-7A-2 shall be conducted to determine that adequate compaction and material conformance are being achieved.

Table III-7A-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 alternate.
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.

The percent finer than No. 200 sieve, Atterberg limits, and hydraulic conductivity tests will be performed on samples generally obtained with a thin-walled tube sampler. If more material is needed, the extra material can be obtained from cuttings at the same location. 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. Undisturbed samples will generally 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.

2.3.3 Failure Repairs

Sections of cohesive soils covers 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.

2.3.4 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.

2.3.5 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.

2.3.6 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.

3.0 GEOMEMBRANE EVALUATION

This section presents general procedures, quality control testing requirements, and construction specifications for geomembrane liner construction. Unless otherwise designed, the composite liner system will generally include the following components above the minimum 1.5-foot thick compacted cohesive soil cover:

- 40-mil, textured LLDPE geomembrane with the option to install smooth LLDPE on the upper portion of the final cover, which is sloped at 4%
- A geocomposite drainage layer composed of a geonet and filter geotextiles heat-bonded to both sides
- 18-inch protective cover soil. The upper 6 inches is an erosion control layer and must be capable of sustaining native plant growth

The geomembrane and the geocomposite drainage layer may be replaced with an alternate material that incorporates both components (e.g., Super Gripnet® by Agru America) provided material equivalency in terms of barrier and flow characteristic is demonstrated.

3.1 Pre-installation Material Evaluation

3.1.1 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 Appendix III-7A-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.

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. The test samples shall be obtained for conformance testing in accordance with the testing schedule shown in Table III-7A-3.

Table III-7A-3: Geomembrane Conformance Test Schedule

TEST	METHOD[1]	FREQUENCY
Thickness (laboratory measurement)	ASTM D5199 (Smooth) or 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 D5321	Per geomembrane/adjoining material interface

Notes:
1. Updated ASTM or GRI methods may be implemented based on a review by the POR.
2. Soak interface and apply normal stresses of 100, 200, and 400 psf for at least one hour prior to shearing at a displacement rate of 0.04 in/min.
3. The POR shall confirm that the interface shear strengths exceed the values used in the stability calculations presented in Appendix III-3C-5. If the measured interface shear strengths are less than the values used in the analyses, the stability of the liner 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.

3.2 Installation Procedures

3.2.1 Geomembrane Liner Subgrade Preparation and Acceptance

Prior to geomembrane installation over a cohesive soil cover, the top of the cohesive soil cover shall be checked for irregularities, protrusions, sharp stones, stones larger than 3/8 inch in size, loose soil, and abrupt changes in grade. The cohesive soil cover surface shall be prepared by rolling with a smooth-drum roller to minimize the roughness and to press down protruding soil or rock particles prior to geomembrane deployment. Loose rocks and/or dry soil particles that could damage the geomembrane shall be removed. Excessive voids or dimples shall be filled in with a soil-bentonite mixture. The surface shall not exhibit excessive desiccation prior to geomembrane deployment. The geomembrane subgrade acceptance shall be documented.

3.2.2 Geomembrane Deployment

The geomembrane shall be installed in direct and uniform contact with the compacted cohesive soil cover. 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.

3.3 Installation Monitoring and Testing

3.3.1 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 GRI Test Method GM19. The current versions of the GRI test methods are included in Appendix III-7A-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.

3.3.2 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.

3.3.3 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 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 III-7A-1 and III-7A-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 (both smooth and textured), the minimum passing criteria for destructive seam testing are described in the 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
- 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.

4.0 DRAINAGE LAYER AND SOIL COVER LAYER EVALUATION

4.1 Drainage Layer

The geocomposite drainage layer shall conform to the material and performance properties specified in Table III-7A-4. Manufacturers' certificates of material and performance characteristics shall be obtained and documented at the minimum frequency shown on Table III-7A-4, 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 III-7A-4.

The drainage layer will consist of a geonet with a non-woven geotextile heat-bonded on both sides deployed over the final cover area. The geosynthetic drainage layer shall be anchored in an anchor trench at the perimeter of the final cover area or as shown on Figure III-7-2.2. 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 III-7A-4: Geocomposite Drainage Layer Specifications(1)

GEOCOMPOSITE					
Property	**Qualifier**	**Unit**	**Value**	**Test Method**	**Frequency**
Transmissivity	Min.	m^2/sec	1.6×10^{-3}	ASTM D4716(2)	200,000 ft^2
Ply Adhesion	Min.	lb/in	0.5	ASTM D7005	200,000 ft^2
GEONET CORE					
Property	**Qualifier**	**Unit**	**Value**	**Test Method**	**Frequency**
Thickness	Min.	mils	200	ASTM D5199	200,000 ft^2
Density (black resin)	Min.	g/cm^3	0.940	ASTM D1505	200,000 ft^2
Carbon Black Content	Range	%	2 to 3	ASTM D4218	200,000 ft^2
GEOTEXTILE					
Property	**Qualifier**	**Unit**	**Value**	**Test Method**	**Frequency**
Mass per Unit Area	MARV	oz/yd^2	6	ASTM D5261	200,000 ft^2
AOS		US Sieve (mm)	70 (0.210)	ASTM D4751	540,000 ft^2
Puncture Resistance		lb	435	ASTM D6241	540,000 ft^2
Grab Tensile Strength		lb	160	ASTM D4632	540,000 ft^2

Notes:
1. Appendix III-3D-2 shall be referenced to determine the suitability of the alternate materials.
2. The transmissivity shall be measured at a minimum gradient of 0.25 under a minimum normal pressure of 1,000 psf with a minimum seating period of 1 hour.

4.2 Soil Cover Material

The soil cover layer will consist of an 18-inch thick single protective/erosion layer. See Section 1.2 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 and disposal 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 18 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.

5.0 DOCUMENTATION AND REPORTING

5.1 Final Cover System Evaluation Reports

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.

For cohesive soil covers:

- 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

For geomembrane:

- 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/adjoin material interface and a recalculation of the factor of safety, if needed.

The report shall also include pertinent record drawings including:

- Layout plan
- Previous covered areas
- As-built cohesive soil cover drawings, showing sample and test locations, and thickness
- 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