TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Protecting Texas by Reducing and Preventing Pollution

February 8, 2011

Mr. Alfredo J. Riera
Director of Public Works
U.S. Army Garrison, Fort Bliss
Building 777
Fort Bliss, TX 79916

Re: Fort Bliss Solid Waste Landfill – El Paso County
Municipal Solid Waste (MSW) - Permit No. 1422
Permit Modification – Evapotranspiration (ET) Final Cover Notice of Deficiency (NOD)
Tracking No. 15183873; RN100210095/CN600126262

Dear Mr. Riera:

The MSW Permits Section of the Texas Commission on Environmental Quality (TCEQ) has reviewed your response to address the concerns included in our November 22, 2011 NOD letter commenting on the application for a municipal solid waste permit modification dated October 19, 2011 and received on November 1, 2011, requesting modifications to the existing site development plan to allow for use of an alternative ET final cover.

Our review indicates that insufficient information has been provided to demonstrate compliance with Title 30 of the Texas Administrative Code (30 TAC) Section (§)305.70. Therefore, we are unable to complete processing of your request at this time. Please review and address the following comments:

1. The response to Comment No. 35 of our November 22, 2011 NOD letter states that "all geotechnical parameters are based on published average data for similar materials and on our experience. No testing was performed to determine these values. The parameters were also based on the approved original slope stability report for the same landfill." The moist unit weights listed for the ET layers on page 6 of Appendix I range from 115 to 120 pcf, and the friction angles for the same ET layers are from 26 to 30. Page 7 of Appendix I lists the modeled factors of safety (FS) at 2.0 for the two worst case slope sections, comparing with the U.S. Army Corp of Engineers recommended minimum FS of 1.4. Please discuss how it can be sure that the constructed ET covers will meet the minimum FS and revise the application as appropriate. Please note that our ET guidance asks for site specific data, not published averages. Please be reminded that Appendix Q, ET Cover Design Report, includes on-site soil testing data, and some of the tested data may be used in the stability analysis. For the parameters used in the stability analysis, but not tested yet, please revise the application to ensure site specific data are used in the stability analysis. Please review Comment No. 23 of the November 22, 2011 NOD letter and address the similar concern with respect to the stability issue. Please revise the application per this comment.

2. The response to Comment No. 37 of our November 22, 2011 NOD letter states that "this facility surface water drainage report was developed from the report submitted as a part of the March 2009 MOD. Therefore, the drainage analysis, erosion and sediment controls, and maintenance/inspection requirements were updated only where changes were necessary. This report replaces the report which was approved as a part of the March 2009 MOD." Page 3 of Appendix L, Facility Surface Water Drainage Report, was revised to state that "these existing off-site discharge locations and contributing drainage areas will not significantly change as a result of the alternative cover design and grading plan. Therefore, the surrounding drainage patterns will not be adversely altered as a result of this alternative cover design and grading plan." The response to Comment No. 43 of our November 22, 2011 NOD states that "Section 1.3 has been revised to state that all surface runoff from the landfill will ultimately discharge to the storm water retention basin downstream which is managed by the Fort Bliss Stormwater Pollution Prevention Team." The actual revisions to Section 1.3 of Appendix L are different than the NOD response letter stated. Please revise Section 1.3 as described in the NOD response. Please clarify whether the inflow from the landfill runoff has impact on the retention basin's capacity maintenance and discharge, if applicable. Please revise the application as necessary.

3. The response to Comment No. 51 of our November 22, 2011 NOD letter states that the updated Stormwater Pollution Prevention Plan (SWPPP) has not been reviewed by the TCEQ, and is being included to demonstrate compliance but is not for review and approval. Please note that this permit modification, if approved, will include a statement to clarify that approval of this modification does not include the SWPPP. Review of the SWPPP is not part of the drainage report review.

4. The revisions made to address Comment No. 53 of our November 22, 2011 NOD letter appear to only cover compaction rate. Please discuss how the parameter values (for example, the saturated hydraulic conductivity) specified in Appendix Q for the ET layers will be satisfied (please consider the QC/QA measures included in Section 5 of Appendix O, and specify proper ranges for the parameter values).

5. A check into the permittee's delinquent fee status showed that the permittee has not paid the $100.00 fee that was due on January 31, 2011 (Fee Code: GPS; Invoice Number: GPS0151262; Tran Description: Gen Pmts Stormwtr). According to the agency's policy, review and processing of this permit modification cannot be complete until the overdue fee is paid.

Please revise your permit modification request and submit the revisions within 30 days from the date of this letter or your request may be considered withdrawn. In accordance with 30 TAC §330.57, please ensure that each page has a header or footer that indicates the revision number and date. Your revised and/or additional pages should be in a form suitable for replacement and/or inclusion in the initial permit modification application. In accordance with 30 TAC §305.44, please include an original certification statement with the revision. Along with the original signature, the certification statement should indicate the name, title, and address of the responsible official.

To facilitate our review, please submit one original, two unmarked copies, and one marked copy (for example, in redline/strikeout format) of the revisions in conformance with 30 TAC §305.70(f). Please send one of the unmarked copies directly to the Texas Commission on Environmental Quality Region 6, to the attention of Mr. Kent Waggoner, Waste Program Manager, at 401 E. Franklin Ave., Ste. 560, El Paso, TX 79901-1212. Also, please include the tracking number referenced above in the subject line of your response.

Failure to submit a satisfactory response to the item(s) listed above may result in a recommendation to deny this modification request. If you have questions regarding this letter, please contact me at (512) 239-1132. When addressing written correspondence, please use mail code MC 124.

Sincerely,

Frank Zeng
Municipal Solid Waste Permits Section
Waste Permits Division
Texas Commission on Environmental Quality

FZ/pt

cc: Mr. Francisco X. Urueta, P.E., Zia Engineering & Environmental Consultants, LLC, Las Cruces, New Mexico

TEXAS COMMISSION ON
ENVIRONMENTAL QUALITY
P.O. Box 13087
Austin, Texas 78711-3087
MC-126

RETURN SERVICE REQUESTED

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FIRST CLASS

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FEB 13 2012
MAILED FROM ZIP CODE 78753

RECEIVED
FEB 16 2012

MR FRANCISCO X URUETA P E
ZIA ENGINEERING & ENVIRONMENTAL
CONSULTANTS LLC
755 S TELSHOR BLVD STE F-201
LAS CRUCES NM 88011

AAXPS3B 88011

DEPARTMENT OF THE ARMY
US ARMY INSTALLATION MANAGEMENT COMMAND
HEADQUARTERS, UNITED STATES ARMY GARRISON, FORT BLISS
1 PERSHING ROAD
FORT BLISS, TEXAS 79916-3803

REPLY TO
ATTENTION OF:

March 16, 2012

Directorate of Public Works

Frank Zeng
Municipal Solid Waste Permits Section
Waste Permits Division
Texas Commission on Environmental Quality
P.O. Box 13087
Austin, Texas 78711-3087

Re: Fort Bliss Solid Waste Landfill – El Paso County
Municipal Solid Waste (MSW) - Permit No. 1422
Permit Modification – Response to Evapotranspiration (ET) Final Cover Notice of Deficiency (NOD)
Tracking No. 15183873; RN100210095/CN600126262

Dear Mr. Zeng:

Fort Bliss Directorate of Public Works has reviewed the Texas Commission on Environmental Quality (TCEQ) Permit Modification – Evapotranspiration (ET) Final Cover Notice of Deficiency (NOD) dated February 8, 2012 and received on February 16, 2012 (attached), identifying additional information required to the NOD response submitted to TCEQ February 3, 2012.

After review of the comments and discussion with your office, the following responses and necessary form are enclosed.

If you have any questions, comments or suggestions regarding responses to the NOD comments, please contact Mrs. Lilia Lenhart via phone at (915) 568-5724 or e-mail at lilia.a.lenhart.civ@mail.mil.

Sincerely,

For Alfredo J. Riera, P.E.
Director of Public Works

Enclosure

Attachment: Responses to Feb. 8, 2012 Notice of Deficiency (NOD) Comments

1. The response to Comment No. 35 of our November 22, 2011 NOD letter states that "all geotechnical parameters are based on published average data for similar materials and - on our experience. No testing was performed to determine these values. The parameters were also based on the approved original slope stability report for the same landfill." The moist unit weights listed for the ET layers on page 6 of Appendix I range from 115 to 120 pcf, and the friction angles for the same ET layers are from 26 to 30. Page 7 of Appendix I lists the modeled factors of safety (FS) at 2.0 for the two worst case slope sections, comparing with the U.S. Army Corp of Engineers recommended minimum FS of 1.4. Please discuss how it can be sure that the constructed ET covers will meet the minimum FS and revise the application as appropriate. Please note that our ET guidance asks for site specific data, not published averages. Please be reminded that Appendix Q, ET Cover Design Report, includes on-site soil testing data, and some of the tested data may be used in the stability analysis. For the parameters used in the stability analysis, but not tested yet, please revise the application to ensure site specific data are used in the stability analysis. Please review Comment No. 23 of the November 22, 2011 NOD letter and address the similar concern with respect to the stability issue. Please revise the application per this comment.

   The geotechnical parameters used in the Terracon Slope Stability and Settlement Analyses Report dated April 5, 2011 were taken from the previous Slope Stability and Settlement Analysis performed by Malcolm Pirnie and included as Appendix I in the TCEQ approved March 2009 permit modification. As stated on Page 2-2 of the Slope Stability and Settlement Analyses Report, "The soil strength parameters used in the analysis for the existing soils sub grade (i.e., internal friction angle and cohesion) were obtained from correlations with the standard penetration test (SPT) blow counts for four geotechnical boring logs taken in 1993 of the native soil in the area of the Subtitle D cell as well as strength parameters for municipal solid waste from industry literature. The boring locations across the subject site are shown on Sheet 2 of Appendix B of the 2008 permit modification application." Based on this information, the soil properties used in the 2011 Permit Modification Application analysis are site-specific and indicative of anticipated site specific performance.

   Terracon's analysis shows that the Evapotranspiration (ET) Cap as designed results in a factor of safety (FS) of 2.0, which exceeds the U.S. Army Corp of Engineers (USACE) recommended minimum FS of 1.4. The slope stability and settlement analysis serves as a minimum requirement for our construction standards. Once the actual borrow source (material) that will be used to construct the ET Cap has been identified, additional site specific quality assurance and quality control geotechnical tests will be run to confirm that friction angles and cohesion are within range of the prior modeled results and will result in the minimum FS required. As long as the material tested meets or exceeds the minimum requirements set forth in Terracon's report (page 6, Appendix D-2, Slope Stability and Settlement Analysis, 2011 Permit Modification Application) the material will be considered acceptable for construction of the ET cap from a stability perspective. We have adjusted the construction quality assurance and quality control (QA/QC) section of Appendix O to further detail the pre- and during construction testing and frequencies that will ensure that the constructed ET Cover will meet the minimum stability FS and perform as anticipated.

2. The response to Comment No. 37 of our November 22, 2011 NOD letter states that "this facility surface water drainage report was developed from the report submitted as a part of the March 2009 MOD. Therefore, the drainage analysis, erosion and sediment controls, and maintenance/inspection requirements were updated only where changes were necessary. This report replaces the report which was approved as a part of the March 2009 MOD." Page 3 of Appendix L, Facility Surface Water Drainage Report, was revised to state that "these existing off-site discharge locations and contributing drainage areas will not significantly change as a result of the alternative cover design and grading plan. Therefore, the surrounding drainage patterns will not be adversely altered as a result of this alternative cover design and grading plan." The response to Comment No. 43 of our November 22, 2011 NOD states that "Section 1.3 has been revised to state that all surface runoff from the landfill will ultimately discharge to the storm water retention basin downstream which is managed by the Fort Bliss Stormwater Pollution Prevention Team." The actual revisions to Section 1.3 of Appendix L are different than the NOD response letter stated. Please revise Section 1.3 as described in the NOD response. Please clarify whether the inflow from the landfill runoff has impact on the retention basin's capacity maintenance and discharge, if applicable. Please revise the application as necessary.

   Comment No. 43 from the November 22, 2011 NOD asks to clarify whether all surface runoff from the landfill site will flow into the storm water retention basin. The paragraph in Section 1.3 has been revised to more clearly state what was intended in the November 22, 2011 NOD response which was that all runoff from the landfill flows toward the retention basin and that the volume discharging into the retention basin is dependent on factors such as the magnitude of the storm event and losses due to evaporation and infiltration along the 2 mile flow path. In addition, language has been added to the paragraph in Section 1.3 stating that it has been demonstrated that the proposed alternative cover design and grading plan will not significantly alter the peak discharges, runoff volumes, average flow depths, average flow velocities and discharge locations. Therefore, there will be no negative impact to the retention basins capacity, maintenance requirements, and outlet discharge.

3. The response to Comment No. 51 of our November 22, 2011 NOD letter states that the updated Stormwater Pollution Prevention Plan (SWPPP) has not been reviewed by the TCEQ, and is being included to demonstrate compliance but is not for review and approval. Please note that this permit modification, if approved, will include a statement to clarify that approval of this modification does not include the SWPPP. Review of the SWPPP is not part of the drainage report review.

   Agreed.

4. The revisions made to address Comment No. 53 of our November 22, 2011 NOD letter appear to only cover compaction rate. Please discuss how the parameter values (for example, the saturated hydraulic conductivity) specified in Appendix Q for the ET layers will be satisfied (please consider the QC/QA measures included in Section 5 of Appendix 0, and specify proper ranges for the parameter values).

The Natural Resources Conservation Service soil survey of the landfill site shows that two soil types exist across the Fort Bliss landfill site. One is a Hueco loamy fine sand down to 30" below grade (approximately 30% of the area) and the other a Copia-Nations complex fine sandy loam down to 30" below grade (approximately 70% of the area). The design of the ET cover system was based on the hydraulic properties of a composite soil sample of on-site material collected from multiple locations within the landfill boundaries. Given the composite makeup of the laboratory sample, it is believed to be generally indicative of a blend of the two soil types on-site and therefore representative of the gradation and hydraulic performance of the existing on-site soils.

The laboratory reported the gradation and hydraulic properties of the composite on-site soil for varying compaction rates in an effort to identify the optimal ET cover section and compaction requirements. Therefore, quality control and quality assurance (QA/QC) testing requirements prior to and during the final landfill closure construction were focused on the gradation, hydraulic properties (saturated hydraulic conductivity, saturated water content, residual water content), and compaction of the ET final cover soil to ensure that the ET final cover will be constructed in accordance with the design intent to maximize ET performance.

The sieve analysis of the composite soil sample indicated that the soil classifies as silty sand (SM) in accordance with ASTM D 2487. Additional site-specific sieve analysis data from 2008 was reviewed and confirmed that existing on-site soils are classified as silty sands (SM), clayey sands (SC), or other combinations thereof. The EPA published UNSODA Unsaturated Hydraulic Database (Leij, Alves, and van Genucthen, August 1996) indicates that soils that fall within similar USCS Classifications can be expected to perform similarly from a hydraulic standpoint. To verify this assumption, van Genuchten parameters were back-calculated from the 2008 on-site sieve analysis data by methods published by Aubertin (2003) and compared to the laboratory-reported composite sample values. Additionally, estimates of typical unsaturated hydraulic properties for similar soil textures reported in the UNSODA manual were considered for consistency verification. All referenced values were of the same order of magnitude as the laboratory-reported data, indicating that the on-site soils can be expected to perform similarly.

To ensure performance of the constructed ET cap is similar to that modeled, QA/QC requirements included in this Closure Plan were expanded to include verification of gradation and hydraulic properties of the materials to be used in the ET cap. In addition, the UNSAT-H model was further evaluated for sensitivity to individual input parameters based on the back-calculated and published data to identify material property requirements that must be met in order to be considered acceptable for use in the ET cover. The construction QA/QC section of Appendix O has been revised to further detail the required gradation testing based on this additional analyses. Should existing on-site soils not meet the material requirements, additional screening and processing of soils will be allowed pending additional QA/QC testing at the required frequencies.

During construction, the ET cover soils will be sampled and tested at the minimum frequencies presented below and will be subject to the following acceptance criteria:

- ***Modified Proctor moisture/density testing (ASTM D1557) – Minimum frequency of 1 test per 10,000 CY***
- ***Sieve and hydrometer analysis testing (ASTM D422) - Minimum frequency of 1 test per 10,000 CY. Soils shall be classified as SM, SC, or any combination thereof to be considered acceptable for use in the final ET cover system.***
- ***Atterberg limits testing (ASTM D4318) - Minimum frequency of 1 test per 10,000 CY***
- ***Soil water characteristic curve (ASTM D6836) and saturated hydraulic parameter testing (ASTM D5084) - Minimum frequency of 1 test per 20,000 CY. Saturated hydraulic conductivity shall be on the order of 10E-4 to 10E-5 cm/sec, saturated water content shall be greater than 0.34 and residual water content less than 0.12 to be considered acceptable for use in the final ET cover system.***
- ***Field density and moisture content testing (ASTM D6938) – Minimum frequency of 2 tests per acre.***

5. A check into the permittee's delinquent fee status showed that the permittee has not paid the $100.00 fee that was due on January 31, 2011 (Fee Code: GPS; Invoice Number: GPSoi51262; Tran Description: Gen Pmts Stormwtr). According to the agency's policy, review and processing of this permit modification cannot be complete until the overdue fee is paid.

   Fort Bliss reviewed the status of the fee payment for its two storm water general permits and found that invoice number GPS0151262 is for the US Army Corps of Engineers, Fort Worth and not Fort Bliss. The Fort Bliss storm water general permit invoices are GPS0159332 (account no. 20037623) and GPS0158633 (account no. 20036797). Invoice GPS0158633 was paid on 13 Feb 2012 and the GPS 0159332 payment is in process.


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Map Scale: 1:6,250 if printed on A size (8.5" x 11") sheet.
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Meters
0 50 100 200 300
Feet
0 300 600 1,200 1,800

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Units

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other

Special Line Features
- Gully
- Short Steep Slope
- Other

Political Features
- Cities

Water Features
- Oceans
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

MAP INFORMATION

Map Scale: 1:6,250 if printed on A size (8.5" × 11") sheet.

The soil surveys that comprise your AOI were mapped at 1:24,000.

Please rely on the bar scale on each map sheet for accurate map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: UTM Zone 13N NAD83

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Fort Bliss Military Reservation, New Mexico and Texas
Survey Area Data: Version 8, Sep 24, 2009

Date(s) aerial images were photographed: 1/28/1996

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Fort Bliss Military Reservation, New Mexico and Texas (NM719)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
21	Hueco loamy fine sand, 1 to 3 percent slopes	1.7	1.5%
22	Copia-Nations complex, 1 to 3 percent slopes	8.6	7.7%
93	Dumps	102.0	90.8%
Totals for Area of Interest		**112.3**	**100.0%**

BLISS-A10-001-11-001

Permit Modification Application

Fort Bliss, TX

Municipal Solid Waste Landfill
Permit 1422

U.S. Army Corps of Engineers
Fort Worth District
819 Taylor Street
Fort worth, TX 76012

Revision ~~1~~ 2 - ~~December 21, 2011~~March 19, 2012

This document is released for the purpose of Fort Bliss ED Review under the authority of Francisco Xavier Urueta P.E. #99473 on 3-19-2012. It is not to be used for construction or bidding purposes.

zia engineering & environmental consultants, llc

ARCADIS MALCOLM PIRNIE
Infrastructure · Water · Environment · Buildings

Permit Modification Application

Fort Bliss, TX

Municipal Solid Waste Landfill
Permit 1422

U.S. Army Corps of Engineers
Fort Worth District
819 Taylor Street
Fort worth, TX 76012

Revision ~~1~~ 2 – ~~December 21, 2011~~March 19, 2012

This document is released for the purpose of Fort Bliss ED Review under the authority of Francisco Xavier Urueta P.E. #99473 on 3-19-2012. It is not to be used for construction or bidding purposes.

Prepared for:
U.S. Army Corps of Engineers

Prepared by:

Francisco X. Urueta, P.E.
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Texas Reg. Num. 11907

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Our Ref.:
Bliss-A10-001 06400003.0000

Date:
~~December 2011~~March 2012

1.0 Permit Modification Narrative 1

1.1 Background and Description of Proposed Change 1

1.1.1 Currently Permitted Final Cover Design 1

1.1.2 Alternative ET Final Cover Design 2

1.2 Purpose of Change and Provision Under Which Modification is Sought 4

1.3 Permit Modification Application Organization and Structure 4

Appendices

A TCEQ Core Data form

B TCEQ Part I form

C Redline/Strikeout Copies
C-1 – Replacement Documents Summary Table
C-2 – *Appendix O* – Closure Plan [redline]
C-3 – *Appendix P* – Post-Closure Plan [redline]
C-4 – Permit Modification Application [redline]
C-5 – *Appendix B* – Landfill Modification and Closure Design Drawings [redline]
C-6 - *Appendix I* – Slope Stability and Settlement Analysis [redline]
C-7 – *Appendix L* – Facility Surface Water Drainage Report [redline]
C-8 – *Appendix Q* – Evapotranspiration Cover Design Report [redline]

D Clean Copy Replacement Documents
D-1 – *Appendix B* – Landfill Modification and Closure Design Drawings
D-2 – *Appendix I* – Slope Stability and Settlement Analysis
D-3 – *Appendix L* – Facility Surface Water Drainage Report
D-4 – *Appendix O* – Closure Plan
D-5 – *Appendix P* – Post-Closure Plan
D-6 – *Appendix Q* – Evapotranspiration Cover Design Report

E Adjacent Landowner Information

1.0 PERMIT MODIFICATION NARRATIVE

1.1 Background and Description of Proposed Change

The Fort Bliss Municipal Solid Waste Landfill is an approximately 106 acre facility consisting of several cells as follows:

- An active 10.5-acre Subtitle D Type I Cell;
- A closed 3-acre Non-Subtitle D Type I Cell (TCEQ closure approval received February 24, 1999);
- An active 5-acre Non-Subtitle D Type IV C&D Cell;
- Approximately 80 acres of 1970's era previously filled and operationally closed areas;
- Approximately 7 acres designated for landfill roads, access areas, and guard shack/scale house, etc.

1.1.1 Currently Permitted Final Cover Design

A March 2009 permit modification (MOD) for vertically extending the height of the Subtitle D cell by 10 feet was approved and issued by the TCEQ effective on March 19, 2009. The permit modification approval included final cover designs for all the landfill cells. For the Subtitle D cell the approved cover design is as follows (from top to bottom):

- Six inches of 1-inch to 4-inch diameter cobbles;
- A 12-inch drainage layer, $k \geq 1 \times 10^{-2}$ cm/sec;
- Geocomposite drainage net;
- 60-mil textured High Density Polyethylene (HDPE) or Linear Low Density Polyethylene (LLDPE) geomembrane; and
- 18-inch clayey material layer, $k \leq 1 \times 10^{-5}$ cm/sec.

For the previously filled and operationally closed areas and the Non-Subtitle D Type IV C&D cell, the approved cover design included an 18-inch thick (minimum) compacted low permeability soil layer (i.e., compacted clay) overlain by six inches of soil capable of sustaining native plant growth.

The Non-Subtitle D Type I cell was closed in 1999 with a non-Subtitle D final cover that complied with the closure plan for that cell and for which TCEQ closure approval was obtained in 1999.

1.1.2 Alternative ET Final Cover Design

Both the active Subtitle D and Non-Subtitle D Type IV C&D cell are nearing capacity and are scheduled to close in 2012. In addition, the facility permit does not allow further placement of waste within the 1970's era inactive areas. According to the March 1995 Final Closure Plan and Cost Estimate, these 80 acres are closed; however, formal TCEQ approval documentation has not been located in the DOE or TCEQ files.

The low permeability soil material required for the approved final cover systems for these cells is not readily available in the area and will need to be imported at considerable expense. Accordingly, Fort Bliss is seeking a permit modification to provide an alternative evapotranspiration (ET) final cover system to replace the final cover systems for those parts of the landfill that have not already received a permitted final cover (i.e. all landfill cells except the non-subtitle D cell that was capped/closed in 1999).

The proposed ET Final Cover System will consist of a 3.5-foot layered soil cap comprised of (from top to bottom) the following:

- 12-inch thick Vegetative Surface Layer consisting of stockpiled Silty Sand (United Soil Classification System (USCS) classification SM) or Clayey Sand (SC) material compacted to 75% of the Modified Proctor maximum dry density and seeded. The Vegetative Surface Layer serves as a medium for seed germination and plant growth, and provides protection against erosion and desiccation;
- 12-inch thick Storage Layer consisting of stockpiled Silty Sand (SM) or Clayey Sand (SC) material compacted to 75% of the Modified Proctor maximum dry density. The Storage Layer will provide storage volume during wet weather periods to promote deep root growth while limiting infiltration to the underlying Capillary Break and Intermediate Cover materials;
- 6-inch thick Capillary Break Layer consisting of well-graded, fine to coarse grained sand. The Capillary Break Layer will allow the fine-textured soil of the Storage Layer to store more water than a comparable layer without the capillary break layer. The additional water stored within the Storage Layer will help promote the establishment and development of surface vegetation, contribute to greater evapotranspiration, and reduce surface erosion; and,
- 12-inch thick Intermediate Cover Layer consisting of existing cover material and/or additional stockpiled Silty Sand (SM) or Clayey Sand (SC) material compacted to 75% of the Modified Proctor maximum dry density to provide additional water retention storage volume.

The TCEQ Municipal Solid Waste (MSW) Permitting Program uses a 25-inch average annual precipitation line as defined by Title 30 of the Texas Administrative Code (TAC) Rule §330.5(b)(1)(D)) to delineate areas of the State defined as arid. El Paso lies to the west of the 25-inch average annual precipitation line and therefore has been deemed arid for the purposes of considering an alternative landfill design and modeling without calibration.

The alternative ET landfill cover final grading plan doesn't significantly alter the final grades presented in the March 2009 MOD; rather, the ET landfill cover final grading plan adjusts the final grades to generally conform to the grades developed during filling operations to provide more easily constructible ridges, swales, and slopes and a more uniform surface for installation and maintenance of the ET cap. Specifically:

- The final closure grades of the northwest inactive cell were adjusted from inconsistently directed and varying top and side slopes generally ranging between 2% and 2.2% to a more uniform pyramidal shape with a 3.6% top slope facing to the west and between 6% and 18% side slopes facing to the north, east, and south.
- The final closure grades of the northeast inactive cell were adjusted from inconsistently directed 2% side slopes to a more uniform pyramidal shape with a 2.2% top slope facing to the west and between 5% and 8.3% side slopes facing to the north, east, and south.
- The final closure grades of the southeast inactive cell were adjusted from inconsistently directed and varying top and side slopes generally ranging between 2% and 3.3% to a more uniform plateau shape with a 2% top slope facing to the south and between 8.3% and 25% slopes facing east and north respectively.
- The final closure grades of the Type IV C&D cell were adjusted from steep 25% plateau side slopes to a more uniform pyramidal shape with 2% side slopes in all directions.
- The final closure grades of the Subtitle D cell were generally kept consistent with the 2008 permit modification grades.

The final grading and drainage plan remains consistent with the previously approved March 2009 MOD. Final drainage patterns at the landfill will consist mostly of overland flow paths and shallow concentrated flow leading off the ET cover landfill side slopes. Swales provide flow paths for internal watersheds to the existing landfill perimeter swales. Surface water runoff flows off the landfill into the existing shallow perimeter drainage swales that discharge to the natural flow patterns of the surrounding area, generally towards the southwest and southeast corners of the landfill.

Conventional landfill covers typically include a gas collection layer and passive gas vents to relieve landfill gas pressures on the overlying impermeable geomembrane and minimize slope stability concerns. The alternative ET landfill cover will only consist of course-grained permeable soil; therefore, no passive gas venting system is proposed as part of the final ET landfill cover design. Rather, the ET cover soils will naturally and effectively vent landfill gas, similar to the existing conditions and the daily/intermediate cover soil at the site. Additionally, the microbes in the ET cover soil will oxidize some of the methane as it vents, creating more environmentally friendly emissions. While the venting of the landfill gas may affect vegetative growth on the landfill cover, the ET cover system was designed to be effective with only 10% vegetative coverage. Based on the operational and regulatory history of the landfill (83 acres of

1970's era waste), significant landfill gas generation is not expected. Should excessive methane concentrations be detected in perimeter landfill gas monitoring probes or ambient landfill air during routine landfill gas monitoring, corrective venting and reporting procedures are outlined in the Fort Bliss Guidance Document titled *Procedures Following a Methane Exceedance*.

1.2 Purpose of Change and Provision Under Which Modification is Sought

The purpose of the proposed ET Final Cover System is to provide a more cost effective closure that offers equivalent environmental protections as those provided by the closure design previously approved. Accordingly, per Title 30 TAC §305.70(k)(10), the purpose of this permit modification application is to request approval of an ET Final Cover System as an alternative final cover system for closure of the Fort Bliss Landfill.

1.3 Permit Modification Application Organization and Structure

In accordance with Title 30 TAC §305.70(e), this permit modification application consists of a new TCEQ Core Data form and Part I form, a description of the proposed permit changes, revisions to existing applicable permit documents (including strikeout and clean copies), and an updated landowners map and landowners list as required under Title 30 TAC §330.59(c)(3).
This application is organized as follows:

- Appendix A – TCEQ Core Data form *[for information only]*
- Appendix B – TCEQ Part I form
- Appendix C - Redline/Strikeout Copy Replacement Pages. This appendix includes redline/strikeout replacement pages to the *Permit Modification Application, Fort Bliss Municipal Solid Waste Landfill, Permit 1422* (March 2008, Malcolm Pirnie, Inc.) document which reflect the inclusion of the ET Final Cover System Design
- Appendix D – Clean Copy Replacement Pages. This appendix includes clean copy replacement pages of the changes reflected in Appendix C
- Appendix E – Adjacent Landowner Information. This appendix includes a list and map of adjacent property owners for notice as required by Title 30 TAC §330.59(c)(3)

Department of the Army

Fort Bliss Department of Public Works - Environmental

IMWE-BLS-PW

Final Closure Plan

USAADACENFB Fort Bliss Municipal Solid Waste Landfill Permit #1422

Revised ~~December 2011~~March 2012

Prepared By:

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6400003

ARCADIS MALCOLM PIRNIE
Infrastructure · Water · Environment · Buildings

Engineering Certification

I attest that this Plan has been prepared in accordance with good engineering practices, including consideration of applicable industry standards, and with the requirements of Title 30 of the Texas Administrative Code (Title 30 TAC) Rule §330. This certification in no way relieves Fort Bliss of its duty to prepare and fully implement this Plan.

Certifying Engineer:	Jeffrey Rusch, P.E.
State:	Texas
Registration Number:	109130

Signature: _____

Certification Date: _____

Engineering Seal:

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1. Introduction

The final closure plan has been prepared to provide a general guidance for the Fort Bliss Municipal Solid Waste Landfill (MSWLF) in meeting the Texas Commission on Environmental Quality (TCEQ) rules listed in Title 30 of the Texas Administrative Code Chapter 330 Rule 457 (Title 30 TAC §330.457) in reference to the closure requirements for MSWLF units.

2. Final Cover Requirements

2.1. Final Cover Design

Title 30 TAC §330.457(a)

The Fort Bliss MSWLF was permitted on November 1, 1982 for a total area of 106 acres. Currently, approximately 80% of the MSWLF has been operationally closed or is inactive. Three acres of the MSWLF have been closed as a Type I landfill unit. Ten and a half acres of the remaining portion of the landfill are designed to meet both USEPA Subtitle D and the Texas Municipal Solid Waste regulations. The remaining landfill area is classified as a Type IV construction and demolition debris cell.

The currently permitted final cover requirements for the MSWLF are summarized as follows:

Table 2-1
Fort Bliss MSWLF Final Cover Requirements (Title 30 TAC §330.457(e)(2))

Area*	Cover Requirements	Current Status
80 Acres	24" Clean Soil	Operationally Closed/Inactive
10.5 Acres (Type I)	Subtitle D Cover	Active
3 Acres (Type I)	Non-Subtitle D Cover	Closed 1999
5 Acres (Type IV)	24" Clean Soil	Active
7 Acres **	N/A	N/A

* Acreage is approximate and for estimation purposes only.
** Designed landfill access area.

Pursuant to Title 30 TAC §305.70(k)(10), an alternative final cover design may be approved as long as the alternative design achieves an equivalent reduction in infiltration as the clay-rich soil specified in 30 TAC §330.457(a)(1) and provides equivalent protection from wind and water erosion as the erosion layer specified in Title 30 TAC §330.457(a)(3). As summarized in Table 2-1, the 3-acre Non-Subtitle D Type I cell was closed in 1999 with a final cover that complied with the closure plan for that cell and for which TCEQ closure approval was obtained on February 24, 1999. However, the

remainder of the facility will be closed with an alternative evapotranspiration (ET) final cover designed to be equivalent with the currently permitted final cover systems. The ET cover will be the only final cover design for those parts of the landfill that have not received a permitted final cover (i.e. all landfill cells except the non-subtitle D cell that was capped/closed in 1999). The ET final cover will also be installed over top of the approved final cover of the Non-Subtitle D Type I cell for site grading and drainage purposes.

The ET final cover system will consist of a 3.5-foot layered soil cap comprised of (from top to bottom) the following:

- 12-inch thick Vegetative Surface Layer consisting of stockpiled Silty Sand or Clayey Sand (United Soil Classification System (USCS) classification SM or SC or any combination thereof) material compacted to 75% of the Modified Proctor maximum dry density and seeded. The Vegetative Surface Layer serves as a medium for seed germination and plant growth, and provides protection against erosion and desiccation;
- 12-inch thick Storage Layer consisting of stockpiled Silty Sand or Clayey Sand (SM or SC or any combination thereof) material compacted to 75% of the Modified Proctor maximum dry density. The Storage Layer will provide storage volume during wet weather periods to promote deep root growth while limiting infiltration to the underlying Capillary Break and Intermediate Cover materials;
- 6-inch thick Capillary Break Layer consisting of well-graded, fine to coarse grained sand. The Capillary Break Layer will allow the fine-textured soil of the Storage Layer to store more water than a comparable layer without the capillary break layer. The additional water stored within the Storage Layer will help promote the establishment and development of surface vegetation, contribute to greater evapotranspiration, and reduce surface erosion; and,
- 12-inch thick Intermediate Cover Layer consisting of existing cover material and/or additional stockpiled Silty Sand or Clayey Sand (SM or SC or any combination thereof) material compacted to 75% of the Modified Proctor maximum dry density to provide additional water retention storage volume.

2.2. Final Cover Area

As summarized in Table 2-1, the 3-acre Non-Subtitle D Type I cell was closed in 1999. However, the remainder of the facility will be closed with an alternative evapotranspiration (ET) landfill cover. The total area to be capped and closed with the ET landfill cover includes the 1970's era inactive cells, the 10.5-acre Type I cell, and the 5-acre Type IV C&D cell, and encompasses approximately 98.5 acres.

3. Maximum Inventory of Waste

Title 30 TAC §330.457(e)(3)

Based on the approved 1995 final landfill contours, the total permitted waste capacity of the Fort Bliss MSWLF is 5.9 million cubic yards. The March 2009 MOD for the 10-foot height increase in the Subtitle-D cell added an additional 180,000 cubic yards of landfill capacity. The alternative ET landfill cover final grading plan doesn't significantly alter the final grades presented in the March 2009 MOD; however, the ET landfill cover final grading plan generally conforms to the grades developed during filling operations (based on the 2010 topographic survey) to provide more easily constructible ridges, swales, and slopes and a more uniform surface for installation and maintenance of the ET final cover. Specifically:

- The final closure grades of the northwest inactive cell were adjusted from inconsistently directed and varying top and side slopes generally ranging between 2% and 2.2% to a more uniform pyramidal shape with a 3.6% top slope facing to the west and between 6% and 18% side slopes facing to the north, east, and south.
- The final closure grades of the northeast inactive cell were adjusted from inconsistently directed 2% side slopes to a more uniform pyramidal shape with a 2.2% top slope facing to the west and between 5% and 8.3% side slopes facing to the north, east, and south.
- The final closure grades of the southeast inactive cell were adjusted from inconsistently directed and varying top and side slopes generally ranging between 2% and 3.3% to a more uniform plateau shape with a 2% top slope facing to the south and between 8.3% and 25% slopes facing east and north respectively.
- The final closure grades of the Type IV C&D cell were adjusted from steep 25% plateau side slopes to a more uniform pyramidal shape with 2% side slopes in all directions.
- The final closure grades of the Subtitle D cell were generally kept consistent with the March 2009 MOD grades.

As reported in the March 2009 MOD the current volume of in-place waste at that time was about 5.1 million cubic yards. The Annual Solid Waste Reports from FY 2009 and FY 2010 and the most recent Daily Landfill Log from FY 2011 document an additional 85,000 cubic yards of in-place waste. Based on the existing landfill grades and the ET landfill cover final grading plan, the remaining capacity in the active Type I and Type IV

cells is 100,200 cubic yards. Therefore, at the time of closure the maximum in-place waste volume is expected to be 5,285,200 cubic yards.

It should be noted that the landfill will be closed prior to reaching its permitted waste capacity of 5,893,932 CY. As reported in the 21 February 1996 Report on Volume Calculations and Case Studies, exploratory trenches advanced through the 1970's era filled and operationally closed landfill cells discovered an in-place waste depth of 25-feet corresponding to an in-place waste volume of 2,984,467 CY. The permitted waste capacity over this same area, based on the design waste depth of 30-ft, is 3,676,542 CY. Therefore, the disparity between the permitted capacity and the anticipated final volume of in-place waste is primarily related to the shallower waste depth in the historic cells.

4. Final Cover Design

4.1. ET Cover System

As previously discussed in Section 2.1, the Fort Bliss MSWLF will be closed with an alternative evapotranspiration (ET) final cover designed to be equivalent with the currently permitted final cover systems. The ET cover will be the only final cover design for those parts of the landfill that have not received a permitted final cover. The alternative ET cover system was designed to meet the requirements listed in Title 30 TAC §330.457 and will consist of a 3.5-foot layered soil cap comprised of (from top to bottom) the following components:

- 12-inch thick Vegetative Surface Layer consisting of stockpiled Silty Sand or Clayey Sand (SM or SC or any combination thereof) material compacted to 75% of the Modified Proctor maximum dry density and seeded. The Vegetative Surface Layer serves as a medium for seed germination and plant growth, and provides protection against erosion and desiccation;
- 12-inch thick Storage Layer consisting of stockpiled Silty Sand or Clayey Sand (SM or SC or any combination thereof) material compacted to 75% of the Modified Proctor maximum dry density. The Storage Layer will provide storage volume during wet weather periods to promote deep root growth while limiting infiltration to the underlying Capillary Break and Intermediate Cover materials;
- 6-inch thick Capillary Break Layer consisting of well-graded, fine to coarse grained sand. The Capillary Break Layer will allow the fine-textured soil of the Storage Layer to store more water than a comparable layer without the capillary break layer. The additional water stored within the Storage Layer will help promote the establishment and development of surface vegetation, contribute to greater evapotranspiration, and reduce surface erosion; and,
- 12-inch thick Intermediate Cover Layer consisting of existing cover material and/or additional stockpiled Silty Sand or Clayey Sand (SM or SC or any combination thereof) material compacted to 75% of the Modified Proctor maximum dry density to provide additional water retention storage volume.

It should be noted that the TCEQ Municipal Solid Waste (MSW) Permitting Program uses a 25-inch average annual precipitation line as defined by Title 30 TAC §330.5(b)(1)(D) to delineate areas of the State defined as arid. El Paso lies to the west of the 25-inch average annual precipitation line and therefore has been deemed arid for the purposes of considering an alternative landfill design and modeling and constructing without model calibration.

4.2. Landfill Cells

Title 30 TAC §330.457(e)(1)

The Fort Bliss MSWLF is comprised of five distinct areas:

1. 1970's era inactive cells that consist of 30-foot deep trenches with two feet of clean soil cover. These cells cover an 80 acre area and are unlined and without leachate collection. The permit does not allow further placement of MSW on these cells. According to the March 1995 Final Closure Plan and Cost Estimate these 80 acres are closed; however, formal TCEQ approval documentation has not been located in the DOE or TCEQ files.
2. A three-acre Type 1 cell with final cover in place (non-Subtitle D) that complies with the closure plan and TCEQ closure requirements. TCEQ approval was received on February 24, 1999.
3. A 10.5-acre Type I active cell meeting Subtitle D requirements. This cell is lined and has a leachate collection system. This cell is nearing permitted capacity and is anticipated to be full by January 2012.
4. A 5-acre active Type IV construction debris cell. This cell is unlined and without leachate collection. This cell is also anticipated to reach capacity by July 2012.
5. Seven acres designated for landfill roads, access areas, gatehouse, etc.

4.3. 1970's Inactive Cells

The 1970's era inactive areas are covered with 24-inch thick clean soil, as indicated in the March 1995 Final Closure Plan and Cost Estimate sealed by Mr. John Karlsruher of Cardenas-Salcedo and Associates, Inc. These landfill areas are also indicated as closed in the May 1999 Final Cover Quality Control Plan for the 3-acre Type 1 cell. However, this area is described as in interim closure by Fort Bliss DPW-ENV and no TCEQ approval or Texas P.E. certification of closure has been found in TCEQ or Fort Bliss DPW-ENV records. Accordingly, the ET final cover system as described in Section 4.1 will be installed over these areas. The existing intermediate cover material will require clearing/grubbing and/or tilling, watering and regrading, and compaction as defined in Section 5 to meet the requirements of the intermediate cover component of the ET cover system.

The final grades of these 1970's era cells will be adjusted to create uniform pyrimdal shapes as summarized in Section 3. All cells will be crowned at the top to promote positive drainage off the landfill and preclude ponding of surface water when total fill height and expected subsidence are taken into consideration.

4.4. Non-Subtitle D Area (Type I)

The closure of the Non-Subtitle D Type I cell was approved by TCEQ on February 24, 1999. However, the ET final cover system will be installed over top of the approved final cover for site grading and drainage purposes.

4.5. Subtitle D Area (Type I)

The final cover for the Type I Subtitle D area will be the ET final cover system as described in Section 4.1. Final closure grades will be generally consistent with the March 2009 MOD grades and will form a landfill plateau with 2% top slopes and 25% side slopes.

4.6. Non-Subtitle D Area (Type IV)

The final cover for the Type IV Non-Subtitle D area will be the ET final cover system as described in Section 4.1. The final grading of the Non-Subtitle D cell will create a uniform pyramidal shape with 2% side slopes in all directions.

5. Construction Quality Assurance

5.1. Introduction

Title 30 TAC §330.457(e)(1)

Construction of the ET final cover system will be performed by using equipment that is suitable for completing the construction and achieving the desired grading, compaction and vegetative cover requirements.

5.2. Construction Quality Control Plan (CQCP)

This section addresses the construction of the soil components of the alternative ET final cover system and outlines the Construction Quality Control Plan (CQCP) to be implemented with regard to material selection and evaluation, laboratory test requirements, and field test requirements.

The primary soil parameters and construction specifications that will impact the performance of the ET final cover system are soil gradation, saturated hydraulic properties, and degree of compaction. The modeling and design of the ET cover system was based on these material and construction specification requirements. Therefore, the QA testing procedures presented herein will be required prior to and during the final closure construction to ensure that the ET final cover is constructed in accordance with the design intent and to maximize ET performance.

5.2.1. Source Material Evaluation

Material evaluations shall be performed on stockpiled or delivered material prior to and during construction to ascertain its acceptability for the intended purpose. All material shall be sampled and tested by the Contractor in accordance with the requirements ~~summarized~~ specified in the following subsections and summarized in Table 5-1 below. ~~Stockpile materials shall not be altered in any manner, including adding or taking material, until the results from the material testing laboratory have been received and reviewed.~~ Copies of the laboratory inspection testing results will be submitted to the Engineer of Record and will also be included in the Final Cover System Evaluation Report (FCSER).

Standards referenced in this Section are:

- ASTM D422, Test Method for Particle Size Analysis of Soils

- ASTM D1557, Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3)
- ASTM D2216, Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
- ASTM D3080, Test Method for Direct Shear Test of Soils Under Consolidated Drained Conditions
- ASTM D4318, Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
- ASTM D5084 – Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter
- ASTM D6836 - Standard Test Methods for Determination of the Soil Water Characteristic Curve for Desorption Using a Hanging Column, Pressure Extractor, Chilled Mirror Hygrometer, and/or Centrifuge
- ASTM D6938, Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

Table 5-1
Fort Bliss MSWLF ET Cover Source Material Evaluation

Material	Parameter	Test Method	Frequency	Acceptance Criteria
Vegetative Surface Layer Material	Modified Proctor	ASTM D1557	1 test per 10,000 CY	--
	Sieve and Hydrometer	ASTM D422		SC/SM
	Atterberg Limits	ASTM D4318		--
	Soil Water Characteristic Curve	ASTM D6836		$\Theta r \leq 0.12$ $\Theta s \geq 0.34$
	Saturated Hydraulic Conductivity	ASTM D5084		ksat ~ 10^{-4} to 10^{-5} cm/sec
	Moisture Content	ASTM D2216		--
	Direct Shear	ASTM D3080		$\Phi \geq 26°$
	Field Density and Moisture Content	ASTM D6938	2 tests per acre	Within ±2% of 75% Modified

Table 5-2 [CONT.]
Fort Bliss MSWLF ET Cover Source Material Evaluation

Storage Layer Material	Modified Proctor	ASTM D1557	1 test per 10,000 CY	--
	Sieve and Hydrometer	ASTM D422		SC/SM
	Atterberg Limits	ASTM D4318		--
	Soil Water Characteristic Curve	ASTM D6836		$\Theta r \leq 0.12$ $\Theta s \geq 0.34$
	Saturated Hydraulic Conductivity	ASTM D5084		ksat ~ 10^{-4} to 10^{-5} cm/sec
	Moisture Content	ASTM D2216		--
	Direct Shear	ASTM D3080		$\Phi \geq 30°$
	Field Density and Moisture Content	ASTM D6938	2 tests per acre	Within ±2% of 75% Modified
Capillary Break Layer Material	Modified Proctor	ASTM D1557	1 test per 10,000 CY	--
	Sieve Analysis	ASTM D422		SW
	Moisture Content	ASTM D2216		--
	Soil Water Characteristic Curve	ASTM D6836	1 test per 20,000 CY	--
	Saturated Hydraulic Conductivity	ASTM D5084		--
	Direct Shear	ASTM D3080		$\Phi \geq 30$
	Field Density and Moisture Content	ASTM D6938	2 tests per acre	Within ±5% of 90% Modified and ±5% of the optimum
Intermediate Cover Layer Material	Modified Proctor	ASTM D1557	1 test per 10,000 CY	--
	Sieve and Hydrometer	ASTM D422		SC/SM
	Atterberg Limits	ASTM D4318		--
	Soil Water Characteristic Curve	ASTM D6836		$\Theta r \leq 0.12$ $\Theta s \geq 0.34$
	Saturated Hydraulic Conductivity	ASTM D5084		ksat ~ 10^{-4} to 10^{-5} cm/sec
	Moisture Content	ASTM D2216		--
	Direct Shear	ASTM D3080		$\Phi \geq 30°$
	Field Density and Moisture Content	ASTM D6938	2 tests per acre	Within ±2% of 75% Modified

Table 5-3 [CONT.]
Fort Bliss MSWLF ET Cover Source Material Evaluation

Existing Intermediate Cover Layer Material	Modified Proctor	ASTM D1557	1 test per 10 acres	--
	Sieve and Hydrometer	ASTM D422		SC/SM
	Atterberg Limits	ASTM D4318		--
	Soil Water Characteristic Curve	ASTM D6836		$\Theta r \leq 0.12$ $\Theta s \geq 0.34$
	Saturated Hydraulic Conductivity	ASTM D5084		ksat ~ 10^{-4} to 10^{-5} cm/sec
	Moisture Content	ASTM D2216	1 test per 10,000 CY	--
	Direct Shear	ASTM D3080		$\Phi \geq 30°$
	Field Density and Moisture Content	ASTM D6938	2 tests per acre	Within ±2% of 75% Modified

5.2.2. Intermediate Cover Layer

5.2.2.1. Material Specification

The Intermediate Cover Layer will consist of twelve-inches of existing placed cover material or stock-piled cover material (SM or SC or any combination thereof) placed over the waste and compacted to approximately within ±2% of 75% of the Modified Proctor maximum dry density. Sensitivity simulations confirmed that compaction within ±2% of the desired compaction specification achieves sufficient performance of the ET final cover system.

5.2.2.2. Existing Intermediate Cover Material Construction Requirements

Across the 1970's era inactive cells, the Intermediate Cover Layer will likely consist of the existing intermediate cover soil placed in accordance with the Site Operating Plan. In general, over 24-inches of compacted intermediate cover material has been placed over these inactive cells. Over time, isolated patches of native vegetation have taken root across these calls. Therefore, the Contractor will be required to clear and grub all existing intermediate cover material of all vegetation, roots, and other deleterious materials using bulldozers, graders, tillers, or other suitable equipment to provide a smooth uniformly graded bare surface.

All existing intermediate cover material will require watering, re-working, and compaction as necessary to create an intermediate cover material subgrade consistent with the final cover requirements. Prior to final grading and compaction, the existing

intermediate cover material will be probed at 100-foot intervals to verify that a minimum of 12-inches of cover soil is in place and verify the existing in-place density. Where existing suitable intermediate cover material does not meet or cannot be re-worked to meet the final cover material or compaction requirements or does not measure the minimum of 12-inches in depth, additional stockpiled SM/SC cover material shall be backfilled, graded, and compacted to create a uniform bare surface of suitable intermediate cover material. Intermediate cover material may exceed the minimum 12-inches in thickness, where necessary.

5.2.2.3. Other Construction Requirements

Where existing intermediate cover material has not been installed, stockpiled intermediate cover SM/SC material will be placed as a single lift to achieve a minimum compacted thickness of 12-inches. All intermediate cover material (existing re-worked material and stockpiled backfill) will require static and/or vibratory compaction to meet the project compaction requirements of within ±2% of 75% of the Modified Proctor maximum dry density through the full 12-inch soil layer. Should in-place density exceed project requirements, intermediate cover material will be tilled to a minimum depth of 12-inches, watered, and re-compacted with appropriate energy to meet the project requirements. Surveying and grade stakes will be used to verify the final grades of the intermediate cover material.

5.2.2.4. Field QA Testing

To ensure performance of the constructed ET cap is similar to that modeled during design, ~~During construction,~~ the intermediate cover material will be sampled and tested at the minimum frequencies presented below prior to and during construction:

- Modified Proctor moisture/density testing (ASTM D1557) – Minimum frequency of 1 test per 10 acres of existing intermediate cover material ~~installed~~or 1 test per 10,000 CY of stockpiled intermediate cover material installed
-
- Sieve and hydrometer analysis testing (ASTM D422) - Minimum frequency of 1 test per 10 acres of existing intermediate cover material ~~installed~~ or 1 test per 10,000 CY stockpiled intermediate cover material installed. Soils shall be classified as SM, SC, or any combination thereof to be considered acceptable for use in the final ET cover system.
-
- Atterberg limits testing (ASTM D4318) - Minimum frequency of 1 test per 10 acres of existing intermediate cover material ~~installed~~or 10,000 CY stockpiled intermediate cover material installed

- Soil water characteristic curve (ASTM D6836) and saturated hydraulic parameter testing (ASTM D5084) - Minimum frequency of 1 test per 10 acres of existing intermediate cover material or 1 test per per 20,000 CY. Saturated hydraulic conductivity shall be on the order of 10E-4 to 10E-5 cm/sec, saturated water content shall be greater than 0.34 and residual water content less than 0.12 to be considered acceptable for use in the final ET cover system.
- ~~Modified Proctor moisture/density testing (ASTM D1557) - Minimum frequency of 1 test per 10,000 CY stockpiled intermediate cover material~~
- ~~Sieve analysis testing (ASTM D422) - Minimum frequency of 1 test per 10,000 CY stockpiled intermediate cover material~~
- ~~Atterberg limits testing (ASTM D4318) - Minimum frequency of 1 test per 10,000 CY stockpiled intermediate cover material~~
- Moisture content testing (ASTM D2216) - Minimum frequency of 1 test per 10,000 CY ~~stockpiled~~ of intermediate cover material for existing and/or installed intermediate cover material
- Direct shear testing (ASTM D3080) – Minimum frequency of 1 test per 10,000 CY of intermediate cover material for existing and/or installed intermediate cover material. Direct shear testing shall be performed at confining stresses of 250 psf, 500 psf, and 1,000 psf. Intermediate cover material shall exhibit a minimum internal angle of friction 30° to be considered acceptable for use in the final ET cover system.
- Field density and moisture content testing (ASTM D6938) – Minimum frequency of 2 tests per acre for existing and/or ~~backfilled~~ installed intermediate cover material

5.2.3. Capillary Break Layer

5.2.3.1. Material Specification

The Capillary Break Layer will be installed over the Intermediate Cover Layer as approved by the Engineer of Record and will consist of 6-inches of well-graded, fine to coarse grained sand (SW). Sand will be a fine granular material produced by the crushing of rock, gravel, or naturally produced by disintegration of rock and will be free of organic material, mica, loam, clay and other deleterious substances.

5.2.3.2. Construction Requirements

Capillary break layer material will be placed as one lift to achieve a minimum compacted thickness of six inches and compacted to within ±5% of 90% of the Modified Proctor maximum dry density. Sensitivity simulations confirmed that compaction within ±5% of the desired compaction specification achieves sufficient performance of the ET final

cover system. Over-compacted material will be tilled and re-compacted. Material installed as part of the capillary break layer will be placed at ±5% of the optimum moisture content at the time of placement and will be covered with the overlying storage layer as soon as practical. Placement of capillary break layer material will not occur during rainfall events to prevent saturation and over-compaction. Surveying will be performed to verify the thickness of the capillary break layer.

5.2.3.3. Field QA Testing

To ensure performance of the constructed ET cap is similar to that modeled during design, ~~During construction,~~ the capillary break layer material will be sampled and tested at the minimum frequencies presented below during construction:

- Modified Proctor moisture/density testing (ASTM D1557) – Minimum frequency of 1 test per 10,000 CY of imported capillary break material
- Sieve analysis testing (ASTM D422) - Minimum frequency of 1 test per 10,000 CY of imported capillary break material
- Moisture content testing (ASTM D2216) - Minimum frequency of 1 test per 10,000 CY of imported capillary break material
- Soil water characteristic curve (ASTM D6836) and saturated hydraulic permeameter testing (ASTMD5084) - Minimum frequency of 1 test per 20,000 CY of imported capillary break material
- Direct shear testing (ASTM D3080) – Minimum frequency of 1 test per 20,000 CY of imported capillary break material. Direct shear testing shall be performed at confining stresses of 250 psf, 500 psf, and 1,000 psf. Capillary break material shall exhibit a minimum internal angle of friction 30° to be considered acceptable for use in the final ET cover system
- Field density and moisture content testing (ASTM D6938) – Minimum frequency of 2 tests per acre

5.2.4. Storage Layer

5.2.4.1. Material Specification

The Storage Layer will be installed over the capillary break layer as approved by the Engineer of Record and will consist of a minimum of 12-inches of stockpiled SM/SC material compacted to within ±2% of 75% of the Modified Proctor maximum dry density. Sensitivity simulations confirmed that compaction within ±2% of the desired compaction specification achieves sufficient performance of the ET final cover system. The soil will be inspected as placed to be free of vegetation, roots, debris, and rocks greater than 2-inches in diameter.

5.2.4.2. Construction Requirements

The Storage Layer will be placed as a single lift to achieve a minimum compacted thickness of 12-inches and compacted to within ±2% of 75% of the Modified Proctor maximum dry density. Over-compacted material will be tilled and recompacted. Surveying will be performed to verify the thickness of the storage layer.

5.2.4.3. Field QA Testing

To ensure performance of the constructed ET cap is similar to that modeled during design ~~During construction,~~ the storage layer material will be sampled and tested at the minimum frequencies presented below during construction:

- Modified Proctor moisture/density testing (ASTM D1557) – Minimum frequency of 1 test per 10,000 CY of stockpiled storage layer material
- Sieve and hydrometer analysis testing (ASTM D422) - Minimum frequency of 1 test per 10,000 CY of stockpiled storage layer material. Soils shall be classified as SM, SC, or any combination thereof to be considered acceptable for use in the final ET cover system.
- Atterberg limits testing (ASTM D4318) - Minimum frequency of 1 test per 10,000 CY of stockpiled storage layer material
- Soil water characteristic curve (ASTM D6836) and saturated hydraulic permeameter testing (ASTMD5084) - Minimum frequency of 1 test per 20,000 CY of stockpiled storage layer material. Saturated hydraulic conductivity shall be on the order of 10E-4 to 10E-5 cm/sec, saturated water content shall be greater than 0.34 and residual water content less than 0.12 to be considered acceptable for use in the final ET cover system.
- Direct shear testing (ASTM D3080) – Minimum frequency of 1 test per 20,000 CY of stockpiled storage layer material. Direct shear testing shall be performed at confining stresses of 250 psf, 500 psf, and 1,000 psf. Storage layer material shall exhibit a minimum internal angle of friction 30° to be considered acceptable for use in the final ET cover system
- Field density and moisture content testing (ASTM D6938) – Minimum frequency of 2 tests per acre

5.2.5. Vegetative Surface Layer

5.2.5.1. Material Specification

The vegetative Surface layer will be installed over the storage layer as approved by the Engineer of Record and will consist of a minimum of 12-inches of stockpiled SM/SC material compacted to within ±2% of 75% of the Modified Proctor maximum dry density. Sensitivity simulations confirmed that compaction within ±2% of the desired compaction specification achieves sufficient performance of the ET final cover system. The soil will be inspected as placed to be free of vegetation, roots, debris, and rocks greater than 2-inches in diameter. Where possible, stockpiled SM/SC material visually observed to contain a higher organic content will be reserved for use in the vegetative surface layer.

5.2.5.2. Construction Requirements

The Surface Layer will be placed as a single lift to achieve a minimum compacted thickness of 12-inches and compacted to within ±2% of 75% of the Modified Proctor maximum dry density. Over-compacted material will be tilled and recompacted. Material installed as part of the vegetative surface layer will be placed at ±2% of the optimum moisture content at the time of placement. Placement of vegetative surface layer layer material will not occur during rainfall events to prevent saturation and overcompaction. Surveying will be performed to verify the thickness and final grades of the vegetative surface layer.

The top 4-inches of the vegetative surface layer will be tilled perpendicular to the slope of the surface in preparation for seeding in accordance with Section 5.3.

5.2.5.3. Field QA Testing

To ensure performance of the constructed ET cap is similar to that modeled during design~~During construction,~~ the vegetative surface layer material will be sampled and tested at the minimum frequencies presented below during construction:

- Modified Proctor moisture/density testing (ASTM D1557) – Minimum frequency of 1 test per 10,000 CY of stockpiled surface layer material
- Sieve and hydrometer analysis testing (ASTM D422) - Minimum frequency of 1 test per 10,000 CY of stockpiled surface layer material. Soils shall be classified as SM, SC, or any combination thereof to be considered acceptable for use in the final ET cover system.
- Atterberg limits testing (ASTM D4318) - Minimum frequency of 1 test per 10,000 CY of stockpiled surface layer material
- Moisture content testing (ASTM D2216) - Minimum frequency of 1 test per 10,000 CY of stockpiled surface layer material
- Soil water characteristic curve (ASTM D6836) and saturated hydraulic permeameter testing (ASTMD5084) - Minimum frequency of 1 test per 20,000 CY of stockpiled surface layer material. Saturated hydraulic conductivity shall be on the order of 10E-4 to 10E-5 cm/sec, saturated water content shall be greater than 0.34 and residual water content less than 0.12 to be considered acceptable for use in the final ET cover system.
- Direct shear testing (ASTM D3080) – Minimum frequency of 1 test per 20,000 CY of stockpiled surface layer material. Direct shear testing shall be performed at confining stresses of 250 psf, 500 psf, and 1,000 psf. Surface layer material shall exhibit a minimum internal angle of friction 26° to be considered acceptable for use in the final ET cover system

- Field density and moisture content testing (ASTM D6938) – Minimum frequency of 2 tests per acre

5.3. Vegetation Planting Plan

The purpose of this plan is to detail the procedures to be used for soil preparation and initial planting on the ET Cover. This plan sets forth use a specified native seed mix for permanent cover which includes the two target grass species from the genera *Aristida* and *Sporobolus* for permanent establishment, but also allows for use of non-native and cultivated seed mixes per TxDOT specifications which are designed for temporary cover to achieve soil stabilization in the event final grading is completed outside of the germination period for target species (May 15 – November).

5.3.1. Soil Preparation and Seeding

All seeds must conform to the requirements of the USDA rules and regulations set forth in the Federal Seed Act and Texas seed law. Utilization of local soils stockpiled on-site will constitute the 12-inch thick Vegetative Surface Layer. These soils consist of silty sands (SM) and clayey sands (SC) and will be compacted to 75% of the Modified Proctor maximum dry density prior to seedbed preparation as discussed in Section 5.2.5.

Seedbed preparation will start as soon as possible after completion of the Vegetative Surface Layer to the lines and grades specified in the construction plans. The vegetated area will be cultivated to a typical depth of 4-inches before placement of seed or seed mix. If temporary seeding is utilized, the area covered with temporary grass will be cultivated to a typical depth of 4 inches before application of permanent seeds.

Table 5-21 includes the schedule and species for seeding as well as the seed application rate of pure live seed (PLS) per acre. The schedule is subject to potentially change depending on the availability of grass species specified as well as due to unexpected climatic conditions during and immediately after final cover construction are encountered.

Table 5-2

~~Table 5-1~~
Fort Bliss MSWLF ET Cover Seeding Schedule

Dates	Seed Type to Use	Seed Species to Use (Common Name)	Seed Species to Use (Latin Name)	Rates (lb Pure Live Seed/ac)
February 1 – May 15	Perennial (Native Species Seed Mix)	Green Sprangletop	*Leptochloa dubia*	0.3
		Red threeawn	***Aristida purpurea Nutt.***	0.4
		Mesa dropseed	***Sporobolus flexuosus***	0.9
		Blue Grama	*Bouteloua gracilis*	1.0
		Indian Ricegrass	*Oryzopsis hymenoides*	1.6
		Purple Prairieclover	*Dalea purpurea*	0.5
May 16 – August 31	Temporary Warm (Summer) Season (A Native Species and A Cultivated Species)	Buffalo Grass	*Buchloe dactyloides*	50
September 1 – November 30	Temporary Cool (Winter) Season (Introduced Species)	Plains Bristlegrass	*Setaria vulpiseta*	4.0

Plant seeding may utilize one or a combination of the following methods, as suggested by the Texas Department of Transportation *Specifications Book*.

1. Broadcast Seeding. Distribute seed/mixture uniformly over the areas shown on the plans using hand or mechanical distribution or hydro-seeding on top of the soil. When seed and water are to be distributed as a slurry during hydroseeding, apply the mixture to the area to be seeded within 30 minutes of placement of components in the equipment. Roll the planted area with a light roller or other suitable equipment. Roll sloped areas along the contour of the slope.

2. Straw or Hay Mulch Seeding. Use Broadcast Seeding method to plant seed. Immediately after planting the seed/mixture, apply straw or hay mulch uniformly

over the seeded area. Apply straw mulch at 2 to 2.5 tons per acre. Apply hay mulch at 1.5 to 2 tons per acre. Use a tacking method over the mulched area.

3. Cellulose Fiber Mulch Seeding. Plant seed using broadcast seeding. Immediately after planting seed/mixture, apply cellulose fiber mulch uniformly over the seeded area at the following rates:
   - Clay soils with slopes of 3:1 or less – 2,000 lbs per acre
   - Clay soils with slopes greater than 3:1 – 2,300 lbs per acre
   - Sandy soils with slopes of 3:1 or less – 2,500 lbs per acre
   - Sandy soils with slopes greater than 3:1 – 3,000 lbs per acre

4. Drill Seeding. Using a pasture or rangeland type drill, plant seed/mixture uniformly over the area at a depth of 1/4 inch to 1/3 inch. Plant seed along the contour of the slopes.

5. Straw or Hay Mulching. Apply straw or hay mulch uniformly over the area as indicated on the plans. Apply hay mulch at 1.5 to 2 tons per acre. Apply straw at 2 to 2.5 tons per acre. Use a tacking method over the mulched area.

5.3.2. Fertilizer Recommendations

The installed vegetation layer will be tested for fertilizer need prior to seeding. Except for broadcast seeding, initial fertilization will occur prior to seeding. Fertilizer needs for the installed vegetation layer will be determined by collecting one soil sample per every 10 acres of installed vegetation layer, (for the purpose of this plan only one vegetation layer is proposed). Soil nutrient needs will be tested by a qualified agronomic testing laboratory (e.g. Texas A&M University Soil, Water and Forage Testing Laboratory). The laboratory testing report will determine macro and micro nutrient needs and may also contain suggestions for soil inoculants, organic matter, etc. for the installed vegetation layer. The nitrogen, phosphoric acid and potash ratio is 2:1:1, and will be applied at a rate of 100 pounds of nitrogen, 50 pounds of phosphoric acid and 50 pounds of potash per acre, unless laboratory testing results mandate higher rates. At a minimum, micronutrients will be applied at a minimum rate of 1 pound per acre of boron, calcium and magnesium.

Seed and fertilizer may be distributed simultaneously during Broadcast Seeding operations, provided each component is applied at the specified rate. When temporary and permanent seeding are both specified for the same area, apply half of the amount of fertilizer during temporary seeding operation and the other half during the permanent seeding operation. Fertilization will occur at intervals of no more than six week after

initial seeding and until vegetation is established. To prevent damage to established vegetation, turf type line equipment will be used to apply fertilizer.

Unless otherwise specified on the plans, use a fertilizer containing nitrogen, phosphoric acid and potash nutrients. Similar to urea-based and plastic resin-coated fertilizers, at least 50 percent of the nitrogen component must be of a slow release formulation unless otherwise dictated by the soils laboratory. The vegetation establishment contractor will ensure that fertilizer is in an acceptable condition for distribution in containers labeled with the analysis. Fertilizer is subject to testing by the Texas A&M Feed and Fertilizer Control Service in accordance with the Texas Fertilizer Law.

5.4. Vegetation Establishment Verification Plan

5.4.1. Introduction

The Vegetation Establishment Verification Plan will ensure that the vegetation is established consistent with the parameters used in the ET Alternative Final Cover Demonstration and includes the following subsections:

- Vegetation Establishment Period
- Maintenance Activities to be Completed During the Vegetation Establishment Period
- Vegetation Performance Specification

5.4.2. Vegetation Establishment Period

The maintenance period will start immediately after seeding is conducted and will continue until TCEQ approves the vegetation establishment verification. Vegetation will be considered established when a satisfactory population of mature plants belonging to the *Aristida* and/or *Sporobolus* genera is verified to cover no less than 10% of the ET final ground cover area with no more than 50% bare areas. A bare area is defined as zero plants within a square meter quadrant (~10.76 square feet). It is assumed that re-use of local stockpiled soils containing native plant seed stock will significantly aide in facilitating vegetative growth.

The vegetation establishment period begins after the Final Cover System Evaluation Report (see Section 5.5.1) is approved by TCEQ and ends when the Vegetation Establishment Report (see Section 5.5.2) is approved by TCEQ. The standard timeframe is 2 to 3 years. The facility will establish the vegetation consistent with the parameters specified in the Vegetation Planting Plan.

5.4.3. Maintenance Activities to be Completed during the Vegetation Establishment Period

The following maintenance activities ensure that the planted vegetation will meet the vegetation performance specification:

- Following application of perennial seed mix, if less than 10% vegetative ground coverage or greater than 50% bare areas are determined to exist, re-seeding of areas that will amount to achieving the 10% ground coverage with no more than 50% bare areas will need to be completed prior to May 15.
- Following application of a temporary seed mix, if less than 10% vegetative ground coverage or greater than 50% bare areas are determined to exist, re-seeding of areas that will amount to achieving the 10% ground coverage with no more than 50% bare areas will need to be completed prior to November 30 to avoid over-winter exposure of said bare areas.
- Temporary erosion protection measures will be installed, as necessary, if greater than 50% bare areas are determined to exist.
- Additional landfill gas extraction wells will be installed in any specific vegetative area where landfill gas poses a detrimental threat.
- Areas of significant differential settlement will be re-graded and re-seeded.
- Depending on the season, vegetation will be maintained and mowed as appropriate. No mowing will be allowed until grasses establish mature seeds.
- The facility will irrigate and fertilize the ET final cover area to stimulate and promote vegetative.
- Erosion and sediment controls will be added to areas that experience erosion.

5.4.4. Vegetation Performance Specification

The vegetation layer will be evaluated at the end of the vegetation establishment period by a Texas Licensed Professional Engineer to determine if the vegetation is established in accordance with the Evapotranspiration Cover Design Report. The performance specification for the vegetation layer is summarized herein:

- Vegetative Coverage – The vegetative coverage specification is based upon a demonstration of a satisfactory population of mature plants belonging to the *Aristida* and/or *Sporobolus* genera covering no less than 10% of the ET final ground cover area with no more than 50% bare areas larger than one square meter without a matured vegetative species.
- Root Penetration – The minimum root depth required of 12” is based on achieving 10% vegetative cover entirely comprised of *Aristida* and/or *Sporobolus* species as an input parameter for completing the UNSAT-H model demonstration. This root

depth will ensure that these two grass species are established and will survive drought conditions.

5.5. Documentation

5.5.1. Final Cover System Evaluation Report (FCSER)

Following the installation of the ET cover system, a Final Cover System Evaluation Report will be submitted certifying that the ET soils were constructed in accordance with the construction methods and test procedures in the Final Cover Quality Control Program. The FCSER will be signed and sealed by a Professional Engineer in the State of Texas and include, at a minimum:

- Completed report forms required by TCEQ
- Summary of construction activities
- Summary of the initial installation of vegetation
- Summary of all laboratory and field test results
- Drawings showing sample and test locations
- Field and laboratory test results
- As-built drawings
- A description of significant construction problems and the resolution of these problems
- A statement of compliance with the Final Cover Quality Control Program

The Final Cover Evaluation Report will be signed and sealed by the Professional Engineer, signed by the site operator, and submitted to the MSW Permits Section of Waste Permits Division of the TCEQ for acceptance. Upon acceptance of the Final Cover Evaluation Report, the vegetation establishment period will begin as noted in the Vegetation Establishment Verification Plan. After the acceptance of the Final Cover Evaluation Report and during the vegetation establishment period, the applicant will request closure of the site in accordance with this Report. Since the vegetation establishment period timeframe is 2 to 3 years, closure of the site will occur prior to the completion of the vegetation establishment period.

5.5.2. *Vegetation Establishment Verification Report*

At the end of the vegetation establishment period, a Vegetation Establishment Verification Report will be completed as described in the Vegetation Establishment Verification Plan. A quarterly report will be submitted to TCEQ during the vegetation establishment period. The quarterly report will include the status of vegetation

establishment activities (fertilizer application, watering, reseeding, etc.) and any other activities that are related to installed final cover or vegetation

The Vegetation Establishment Verification Report will be prepared and submitted to TCEQ for approval at the end of the vegetation establishment period. The report will be prepared by a Texas Licensed Professional Engineer and include the following:

- Documentation of the root penetration performance. A hand auger or drive cylinder will be driven at a frequency of every acre within vegetative cover areas consisting of *Aristida* and/or *Sporobolus* species to a depth of 12 inches to determine and verify the rooting depth. In addition, each core obtained will be examined by the certifying engineer to observe that the *Aristida* and/or *Sporobolus* roots are denser in the upper portion of the soul profile and extend to 12 inches in depth. Each sample location will be shown on design drawings.
- Documentation that the percent vegetative cover is in accordance with the ground cover and bare area determination procedures included in this plan. This documentation will include the engineers' assessment of the vegetation cover and photographs that document compliance with the performance specification.
- The certifying engineer will also provide a statement indicating that the vegetation layer of the ET final cover system has been maintained consistent with the parameters used in the UNSAT-H analysis.

6. Schedule for Closure Activities

The landfill closure schedule and other closure related activities shall follow the requirements of Title 30 TAC §330.457(f) and (g).

6.1. Closure Schedule

Title 30 TAC §330.457(e)(4)

An overall timetable for the closure of the Fort Bliss MSWLF is presented following this section. This schedule is based on the current BRAC realignment process at Fort Bliss and the regulatory closure requirements described in subsequent sections.

6.2. Final Contour Map

Title 30 TAC §330.457(e)(5)

A final contour map depicting the proposed final contours, top slopes, and side slopes, and proposed surface drainage features is provided as Sheet 3 in Appendix B of the permit modification application. The MSWLF is not within a 100-year flood plain.

6.3. Location of Plan

Title 30 TAC §330.457(f)(1)

Fort Bliss DPW-ENV shall maintain a copy of the closure plan in the operating record.

6.4. Written Notification

Title 30 TAC §330.457(f)(2)

No later than 45 days prior to the initiation of closure activities for any area or final closure of the facility, Fort Bliss shall provide written notification to the Executive Director of the intent to close the unit or facility and place this notice of intent in the operating record.

No later than 90 days prior to the initiation of a final facility closure, Fort Bliss 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 following information:

- Facility Name
- Facility Address
- Physical Location of the Facility
- The Permit Number
- Last Date of Intended Receipt of Waste.

6.5. Start of Final Closure Activities

Title 30 TAC §330.457(f)(3)

Fort Bliss shall begin final closure activities for each unit or facility no later than 30 days after the date on which the unit or facility receives the known final receipt of wastes or, if the unit or facility has remaining capacity and there is a reasonable likelihood that the unit or facility 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 Fort Bliss has taken and will continue to take all steps necessary to prevent threats to human health and the environment from the MSWLF.

6.6. Completion of Final Closure Activities

Title 30 TAC §330.457(f)(4)

Fort Bliss shall complete final closure activities for the unit or facility in accordance with the approved final closure plan within 180 days following the initiation or final closure activities. A request for an extension for the completion of final closure activities may be submitted to the Executive Director 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 MSWLF unit.

6.7. Certification

Title 30 TAC §330.457(f)(5)

Following final closure of the MSWLF unit or facility, the owner or operator shall submit to the Executive Director for review and approval a Final Cover System Evaluation Report (FCSER), a Vegetation Establishment Report, signed by an independent licensed professional engineer, verifying that final closure has been completed in accordance with the approved final 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.

6.8. Inspection Report

Title 30 TAC §330.457(f)(6)

Following receipt of the required final closure documents, as applicable, and an inspection report from the commission's district office verifying proper closure of the MSWLF unit or facility according to the approved final closure plan, the executive director may acknowledge the termination of operation and closure of the unit or facility and deem it properly closed.

6.9. Affidavit to the Public

Title 30 TAC §330.457(g)

Upon notification to the executive director, Fort Bliss 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 on closing for specific unit(s) or the entire facility and the prohibition against further receipt of waste materials after the stated date.

Within 10 days after completion of final closure of the MSWLF unit or facility, Fort Bliss shall submit to the executive director a certified copy of an "Affidavit to the Public" in accordance with the requirements of Title 30 TAC §330.19 and place a copy of the affidavit in the operating record. In addition, a certified notation of the deed to the facility property, or on some other instrument that is normally examined during title search, needs to be recorded. This is intended so that in perpetuity any potential purchaser of the property is notified that the land has been used as a landfill facility and use of the land is restricted.

Post-closure care maintenance specified in Title 30 TAC §330.463(b) (relating to Post-Closure Care Requirements) shall begin immediately upon the date of final closure as approved by the executive director.

6.10. Post-Closure Care

Following the professional engineer certification of the completion of closure as accepted by the Executive Director of the TCEQ Waste Permits Division, Fort Bliss DPW-ENV shall commence the 30-year post-closure care period. A Vegetation Establishment Report shall be submitted semi-annually during the cover vegetation start-up period indicating the type and quantity of vegetation established, the percent vegetative cover, and the vegetative root structure. If the type or quantity of vegetation or root structure does not meet specifications, then corrective action shall be taken to improve the vegetation consistent with the ET final cover design. Post-closure care requirements are discussed in the *Post Closure Plan.*

7. Closure Cost Estimate

Title 30 TAC §330.63(j)

As an agency of the Federal Government, Fort Bliss is not required to complete financial assurance mechanism requirements. Therefore, a closure cost estimate is not required per Title 30 TAC §37.8001.

This document is released for the purpose of review under the authority of Francisco Xavier Urueta P.E. #99473 on ~~12-21-2011~~ 3-19-2012. It is not to be used for construction or bidding purposes

FACILITY SURFACE WATER DRAINAGE REPORT

FORT BLISS FINAL CLOSURE DESIGN AND PERMIT MODIFICATION APPLICATION BLISS-A10-001

Revised ~~December 21, 2011~~
March 19, 2012

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FACILITY SURFACE WATER DRAINAGE REPORT

FORT BLISS MUNICIPAL SOLID WASTE LANDFILL FINAL CLOSURE DESIGN AND PERMIT MODIFICATION APPLICATION FORT BLISS, TEXAS

Zia Project No. BLISS-A10-001

Prepared for:
U.S. Army Corps of Engineers, Fort Worth District
819 Taylor Street
Fort Worth, Texas 76102

Prepared and Certified by:
I attest that this Report has been prepared in accordance with good engineering practices, including consideration of applicable industry standards, and with the requirements of Title 30 TAC §330.303. This document is released for the purpose of review. It is not to be used for construction or bidding purposes.

Certifying Engineer:	Francisco X. Urueta
State:	Texas
Registration Number:	99473
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1.0 INTRODUCTION

The Fort Bliss Municipal Solid Waste Landfill (MSWLF) includes active Subtitle D Type I and Type IV landfill cells that are currently in use to serve the United States Army Air Defense Artillery Center and Fort Bliss area. Permitted types of solid wastes disposed of at the Fort Bliss MSWLF are non-hazardous solid waste from military operations, bulky items, grass and tree trimmings, refuse from litter cans, construction debris, classified waste (dry), dead animals, Regulated Asbestos Containing Material (RACM), and empty oil cans (1-quart and 5-gallon sizes). The MSWLF does not receive hazardous waste nor does it recover incoming waste.

The landfill area is comprised of five distinct areas:

- 1970's-era inactive cells that cover approximately 80-acres that are considered closed.
- An approximately 3-acre Type I cell with final cover in place (non-Subtitle D) that complies with the 1995 closure plan and TCEQ requirements.
- An approximately 10.5-acre Type I active cell meeting Subtitle D requirements (Subtitle D Cell).
- An approximately 5-acre Type IV construction and demolition (C&D) debris cell.
- Approximately 7 acres designated for landfill roads, access areas, guard shack/scale house, etc.

This Facility Surface Water Drainage Report has been completed to meet the requirements of Title 30 of the Texas Administrative Code Chapter 330.63(c) (30 TAC §330.63(c)) as part of the final closure and permit modification application for an alternative cover design and grading plan. This report was developed from the March 2009 Facility Surface Water Drainage Report by updating it to reflect the changes resulting from the alternative cover design and grading plan. This report replaces the March 2009 Facility Surface Water Drainage Report. This report illustrates that the proposed modification does not adversely alter the existing (permitted) drainage patterns and that these drainage patterns can be retained for the modification.

This report also serves as the surface water drainage report required by 30 TAC § Subchapter G. The facility design complies with the requirements of 30 TAC § 330.303 relating to management of run-on and runoff. The surface water drainage analysis for the Fort Bliss MSWLF is presented in Section 2. An Erosion and Sediment Control Plan is included in Section 3. Section 4 presents the maintenance and inspection requirements.

1.1 General Geology and Soils

The Fort Bliss MSWLF is underlain by Hueco Bolson deposits of tertiary age and typically are composed of unconsolidated to slightly consolidated interbedded sands, clay, silt, gravel, and caliche. Individual beds are not well defined and range in thickness from a fraction of an inch to about 100 feet. The general geology and soils details for the MSWLF site are provided in Attachment 6 of this report.

1.2 General Climate and Weather

The MSWLF is located in west Texas where desert conditions exist; therefore, surface water flow near the MSWLF is limited. Maximum daytime summer temperatures range between 90 and 105 degrees Fahrenheit (°F) and winter temperatures range from 55 to 60°F. The surrounding area receives less than 10 inches of rain per year and relative humidity is very low. Depending upon the intensity and duration of each precipitation event, the water delivered by the occurrence may infiltrate into the soil or become surface runoff. The infiltrated water may percolate downward to the water table or return to the atmosphere via evapotranspiration.

1.3 Surface Water Bodies

No surface water bodies exist at or near the MSWLF. ~~Given a large rain event, all~~ All surface water runoff from the landfill ~~may~~ will flow ~~downstream to~~ in the direction of the stormwater retention basin located approximately 2 miles south of the landfill, north of Fred Wilson Boulevard. The volume of runoff originating from the landfill and ultimately discharging to this retention basin will be dependent on the magnitude of the storm event and losses due to infiltration and evaporation along the 2 mile flow path. As demonstrated in Section 2.4, the proposed alternative cover design and grading plan will not significantly alter the peak discharges, runoff volumes, average flow depths, average flow velocities and discharge locations. Therefore, there will be no negative impact to the retention basins capacity, maintenance requirements, and outlet discharge. This storm water retention basin is located on the Fort Bliss Military Reservation and is managed by the Fort Bliss Storm Water Pollution Prevention Team. Structural control measures to reduce sediment are described in the 2011 Storm Water Pollution Prevention Plan (Attachment 5). Further discussion on the surface water drainage and erosion and sedimentation controls are given in Sections 2 and 3 respectively.

2.0 FACILITY SURFACE WATER DRAINAGE ANALYSIS

The final grading/drainage plan for the approximately 106 acre landfill was modified to incorporate the reduced cover design and provide more easily constructible ridges, swales and slopes than provided in the previous (2009) permit modification. However, the drainage concept remains consistent with the previously approved site plans and consists of mostly overland and shallow concentrated flows leading off the landfill side slopes. Swales provide flow paths for internal watersheds to the perimeter. There are four pairs of drainage swales located along the edges of the access roads entering the site form the north, east, and west. Surface water runoff flows off the landfill into shallow perimeter drainage ditches that discharge to the natural flow patterns of the surrounding area. In general, the perimeter drainage ditches discharge to the natural surrounding topography at the northwest, southwest and southeast corners of the landfill as shown on Sheet C-3 of Appendix D (Design Drawings) of the permit modification. These existing off-site discharge locations and contributing drainage areas will not significantly change as a result of the alternative cover design and grading plan. Therefore, the surrounding drainage patterns will not be adversely altered as a result of this alternative cover design and grading plan.

A hydrologic and hydraulic analysis was conducted on the final grading plan, shown on Sheet C-2 in Appendix D (Design Drawings) of the permit modification. The analysis incorporates the proposed alternative cover design and grading modifications to estimate the peak discharge and run-off volumes associated with the 25-year, 24-hour design storm event as required in 30 TAC §330.305I. The runoff volumes and peak discharges show that the drainage is not adversely affected and that the previously designated storm water control features (i.e. landfill drainage swales down the side slopes) remain adequate.

Appendix D (Design Drawings) of the permit modification application provides the drainage areas, cross-sectional areas, and swale grades used in the analysis.

Per the *TCEQ Guidelines for Preparing a Surface Water Drainage Report for a Municipal Solid Waste Facility* (RG-417), the Rational Method described in Chapter 5, Section 6 of the Texas Department of Transportation's Hydraulic Design Manual (TxDOT 2004) was used to calculate the peak discharge flows. Use of USDA Natural Resources Conservation Service (NRCC) Technical Release 55 (TR-55) method has been approved by the Texas Commission on Environmental Quality (TCEQ) Executive Director for the calculation of the runoff volumes. The values for runoff volume, peak discharge, and flow velocity calculated in this analysis are used to design the erosion and sediment controls and to confirm that the existing drainage patterns for the landfill will not be adversely affected because of these modifications.

2.1 Runoff Volume

The volume of runoff from the landfill cover is dependent on the anticipated amount of precipitation and potential abstractions (principally infiltration) which depend on the soil type, vegetative cover, and the hydraulic conditions of the soil and proposed cover material.

EVAPOTRANSPIRATION COVER DESIGN REPORT

FORT BLISS DESIGN AND PERMIT MODIFICATION APPLICATION BLISS-A10-001

Revised ~~December 2011~~ March 2012

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INTRODUCTION

The purpose of report is to present the approach and methodologies used during the design of the proposed evapotranspiration (ET) final cover system for the Fort Bliss Municipal Solid Waste Landfill (MSWLF). The MSWLF consists of the following distinct areas:

- An active 10.5-acre Type Subtitle D Cell
- A closed 3-acre Type 1 Non-Subtitle D cell (TCEQ closure approval received February 24, 1999)
- An active 5-acre Type IV C&D cell
- Approximately 80 acres of previously filled and closed areas
- Approximately 7 acres designated for landfill roads, access areas, and guard shack / scale house, etc.

Based on capacity estimations performed by Zia Engineering and Environmental Consultants (Zia) and current disposal rates provided by the Fort Bliss Environmental Division, the Subtitle D cell is expected to reach its capacity in the second quarter of FY 2012. At that time, the Subtitle D cell will be closed, followed shortly thereafter by the Type IV C&D cell. The permitted closure design for the Subtitle D Cell, the C&D Cell, and the previously filled and closed areas includes an 18 inch thick prescriptive layer with low permeability soil (i.e. clay) that is not readily available in the area and would need to be imported at a considerable expense.

The purpose of the proposed ET final cover system is to create a more cost-effective and sustainable landfill cover alternative that is equally protective of human health and the environment as the prescriptive closure design. The proposed ET cover system will utilize readily available fill material located on-site to create a layered soil cover designed to optimize water storage and evapotranspiration. This report discusses the feasibility and preliminary design requirements of an ET cover system at Fort Bliss and presents a demonstration of its performance.

The proposed ET cover system was designed in accordance with the draft Texas Commission on Environmental Quality (TCEQ) document Guidance for Requesting a Water Balance Alternative Final Cover for a Municipal Solid Waste Landfill (guidance document), revised November 17, 2010.

FEASIBILITY

According to the United States Environmental Protection Agency Fact Sheet on Evapotranspiration Cover Systems for Waste Containment, evapotranspiration cover systems are increasingly being considered for use at waste disposal sites in arid regions when equivalent performance to conventional final cover systems can be demonstrated. The TCEQ Municipal Solid Waste (MSW) Permitting Program uses a 25-inch average annual precipitation line as defined by 30 TAC §330.5(b)(1)(D) to delineate areas of the State defined as arid. El Paso lies to the west of the 25-inch average annual precipitation line and therefore has been deemed arid for considering alternative landfill designs. Additionally, over 60% of the precipitation in the El Paso region is received during the growing season, between March and August.

Numerous species of indigenous herbaceous and vascular vegetation inhabit the native soils at Fort Bliss. As such, the utilization of local soils stockpiled on-site and native plant species bodes well for the successful performance of an ET cap. Additionally, a balanced seed design of both herbaceous and vascular native plants has been chosen in an effort to promote and sustain evapotranspiration throughout the year.

During preliminary research, Malcolm Pirnie (MP) found that the Interstate Technology and Regulatory Council (ITRC) document titled Technical and Regulatory Guidance for Design, Installation, and Monitoring of Alternative Final Landfill Covers (December 2003) states that a range of 75%-85% compaction is best for ET cover systems. Hydraulic laboratory testing of the native material stockpiled on-site at 75% and 80% compaction was performed in December of 2008 by AMEC and indicates adequate water retention and saturated hydraulic conductivity parameters for use in an ET cover system, with a plant-available water content (difference between water content at field capacity and at wilting point) of 0.3. Additionally, a substantial portion of the landfill area currently contains in excess of 1.5-feet of interim cover material that will be incorporated into the ET cover system as supplemental intermediate cover material.

DESCRIPTION OF PROPOSED DESIGN

The proposed ET cover system, shown in **Figure 2**, will consist of a 3.5-foot layered soil cap and include the following components (from top of cover to top of waste):

- 12-inch thick Vegetative Surface Layer, consisting of stock-piled Silty Sand (SM) or Clayey Sand (SC) or any combination thereof compacted to 75% of the Modified Proctor maximum dry density and seeded. The Vegetative Surface Layer will serve as a medium for seed germination and plant growth as well as provide protection against erosion and desiccation.
- 12-inch thick Storage Layer, consisting of stock-piled SM or SC material or any combination thereof also compacted to 75% of the Modified Proctor maximum dry density (ASTM D 1557). The Storage Layer will provide approximately 11.3 cm of storage volume during wet weather periods to promote deep root growth while limiting infiltration to the underlying Capillary Break and Intermediate Cover materials.
- 6-inch thick Capillary Break Layer, consisting of well-graded, fine to coarse grained sand. Installation of the Capillary Break Layer will allow the fine-textured soil of the Storage Layer to store more water than a comparable layer without the capillary break due to the difference in the hydraulic conductivities of the two layers. The additional water stored within the Storage Layer will help promote the establishment and development of the surface vegetation. The increased vegetative cover will contribute to greater ET and reduce surface erosion from both wind and rain.
- 12-inch thick Intermediate Cover Layer, consisting of existing cover material and/or additional stock-piled SM or SC material or any combination thereof compacted to approximately 75% of the Modified Proctor maximum dry density (ASTM D 1557). The Intermediate Cover Layer will provide approximately 11.3 cm of additional water retention storage volume.

COMPUTER MODELING

The performance of the proposed ET cover system was predicatively modeled using UNSAT-H version 3.01 software, which is managed by the Hydrology Group at the Pacific Northwest National Laboratory. UNSAT-H is a one-dimensional model that simulates soil water infiltration, redistribution, evaporation, plant transpiration, and deep drainage. UNSAT-H is commonly used to evaluate and optimize performance of barrier designs. The following sections summarize input parameters, the source of those parameters, and major assumptions made in modeling the proposed ET cover system.

Options, Constants, and Limits

The input parameters noted below define the modeling period, the components of groundwater flow to be modeled, and the solution methods.

- IPLANT: The plant option was selected to include plants, as transpiration will be a critical component of the performance of the proposed ET cap system.
- NGRAV: The model was given a vertical orientation to model vertical infiltration through the proposed ET cap system
- IFDEND, IDTBEG, and IDTEND: The ending day of the simulation and the number of days that weather data was provided annually was set at 365.
- IYS and NYEARS: The model was set to run for a 30-year period. The first year of the simulation was set as 1981.
- ISTEAD: The model was set to solve in transient mode, utilizing variable historical weather data.
- NPRINT: The level of output was set for end of day and end of simulation summaries.
- ISMETH: The Crank-Nicholson solution method was specified based on guidance from the Pacific Northwest National Laboratory.
- KOPT: Soil hydraulic properties were defined by the van Genuchten parameters.
- KEST: The arithmetic mean was selected to calculate liquid conductivity at the midpoint between nodes.
- ITOPBC and LOWER: A flux surface boundary and unit gradient lower boundary condition was specified.
- IEVOPT and NFHOUR: The evaporation option was selected as evaporation will be a critical component of the performance of the proposed ET cap system. The option to generate hourly factors from a sine wave function for distribution of daily potential evapotranspiration was selected to calculate the surface boundary condition.
- HIRRI and HDRY: Minimum and maximum heads to which the soil can wet up and dry out were defined as 1 and 1 x 10^6 cm, respectively.
- RHA, IETOPT, ICLOUD, and IRAIN: Daily meteorological data from the National Oceanic and Atmospheric Administration (NOAA) was provided for the model.

Daily solar radiation values were synthetically generated using the Hydrologic Evaluation of Landfill Performance (HELP) model. Average relative humidity was also obtained from the HELP model for the El Paso, Texas region.

- IHYS and IHEAT: Hysteresis and heat flow were not simulated.
- IVAPOR: The option to model vapor flow was selected. Fayer and Gee (2004) have documented that vapor flow is a necessary process to be included in simulations of drainage in sandy soil in arid and semiarid climates.
- MATN: Four soil layers were modeled, as previously described in the Description of Proposed Design section.

Soil Property Information

The Natural Resources Conservation Service soil survey of the landfill site shows that two soil types exist across the Fort Bliss landfill site. One is a Hueco loamy fine sand down to 30" below grade (approximately 30% of the area) and the other a Copia-Nations complex fine sandy loam down to 30" below grade (approximately 70% of the area). Soil samples were collected in April of 2009 from the stockpiled material on-site for hydraulic laboratory testing by TRI Environmental Inc. in order to evaluate the water retention and saturated hydraulic conductivity parameters. The design of the ET cover system was based on the hydraulic properties of this soil sample of on-site material, which was collected from multiple locations within the landfill boundaries. Given the composite makeup of the laboratory sample, it is believed to be generally indicative of a blend of the two soil types on-site and therefore representative of the gradation and hydraulic performance of the existing on-site soils.

The sieve analysis of the composite soil sample indicated that the soil classifies as silty sand (SM) in accordance with ASTM D 2487. Additional site-specific sieve analysis data from 2008 was reviewed and confirmed that existing on-site soils are classified as silty sands (SM), clayey sands (SC), or other combinations thereof. The EPA published UNSODA Unsaturated Hydraulic Database (Leij, Alves, and van Genucthen, August 1996) indicates that soils that fall within similar USCS Classifications can be expected to perform similarly from a hydraulic standpoint.

~~Composite soil samples were collected in December of 2008 by AMEC from the stockpiled material on-site for hydraulic laboratory testing by TRI Environmental Inc. in order to evaluate its water retention and saturated hydraulic conductivity parameters.~~ The ITRC states that a range of 75%-85% compaction is best for ET cover systems. As such, the soil was prepared at 75% of the Modified Proctor (MP) maximum dry density (ASTM D 1557) for laboratory testing. The 75% compaction material was specified for the surficial Vegetative Surface Layer to promote vegetative growth, for the Storage Layer to increase water retention capacity, and the Intermediate Cover Layer to conservatively estimate the existing conditions of the interim cover material. Compaction requirements were based on the Modified Proctor maximum dry density to more accurately simulate compaction of the landfill area by modern construction equipment and methods. It should be noted that, due to the low fines content of the available fill on-site, minimal variance (i.e. 5%) between the Standard and Modified Proctor maximum dry densities is expected. As such, estimated equivalent compaction requirements based on the Standard Proctor maximum dry density (i.e. 80%) can be specified as well. Hydraulic properties of the Capillary

Break Layer were estimated using typical parameter values of van Genuchten models for sand from Leij, Alves, and van Genuchten (1996).

The Mualem-van Genuchten conductivity model was used with an exponent of the pore interaction term of 2, as recommended in the UNSAT-H User's Manual. The hydraulic properties of the proposed ET cover system materials are summarized below. Laboratory data is included in Appendix A.

Layers 1 and 2 – Stockpiled SM/SC Material at 75% MP Compaction Density

- THET - Saturated water content: 0.372
- THTR – Residual water content: 0.1025
- VGA – Van Genuchten α coefficient: 0.020
- VGN - Van Genuchten n coefficient: 1.560
- SK – Saturated hydraulic conductivity: 0.504 cm/hr (1.4 x 10^{-4} cm/sec)

Layer 3 – Capillary Break Layer of Well-Graded Clean Sand

- THET - Saturated water content: 0.43
- THTR – Residual water content: 0.045
- VGA – Van Genuchten α coefficient: 0.145
- VGN - Van Genuchten n coefficient: 2.68
- SK – Saturated hydraulic conductivity: 29.7 cm/hr (8.25 x 10^{-3} cm/sec)

Layer 4 – Stockpiled SM/SC Material and Regraded Intermediate Cover Material at 75% MP Compaction Density

- THET - Saturated water content: 0.372
- THTR – Residual water content: 0.1025
- VGA – Van Genuchten α coefficient: 0.020
- VGN - Van Genuchten n coefficient: 1.560
- SK – Saturated hydraulic conductivity: 0.504 cm/hr (1.4 x 10^{-4} cm/sec)

Initial Conditions

Initial suction head values were estimated using the soil water characteristic curves generated during hydraulic laboratory testing. The suction head values, summarized below, assume that the soil will be placed with ±2% of the optimum water content for the given compaction requirements.

- Layer 1 and 2: 1.0 x 10^{4} cm
- Layer 3: 1.0 x 10^{2} cm
- Layers 4: 1.0 x 10^{4} cm

Plant Information

Transpiration will be a contributing component of the performance of the proposed ET cover system. For the purposes of this preliminary ET model, a conservative 10% coverage of vegetative growth over the area was assumed. Vegetative growth of the final design of the proposed ET cover system will consist of a balanced mixture of native herbaceous and vascular

plants. Dr. Rafael Corral of the Fort Bliss Environmental Division and Leah Markiewitz with Zia provided an optimum vegetative design to utilize indigenous species of the area such as mesa dropseed and red threeawn.

The plant information for mesa dropseed and red threeawn required for UNSAT-H simulations was not readily available through our research efforts. Due to the difficulty in finding root data, the rooting depth of the indigenous species in our vegetative design was estimated using seasonal cheatgrass data published by Harris (1967). Cheatgrass contains very shallow, fibrous roots which makes it an ideal plant choice for plant growth with a shallow soil depth requirement. The indigenous species mentioned above were chosen due to their similar fibrous roots and fairly shallow growth patterns described through the studies of Robert P. Gibbens and James M. Lenz (2001) at the Jornada Experimental Range in Las Cruces, New Mexico (**Figure 1**). Additionally, these plants extend out horizontally which will allow for additional erosion control (Gibbens & Lenz, 2001) (**Figure 2**). Due to the rooting similarities, our vegetative experts felt using cheatgrass plant information for the purposes of modeling transpiration was a reasonable choice considering the limited plant information available.

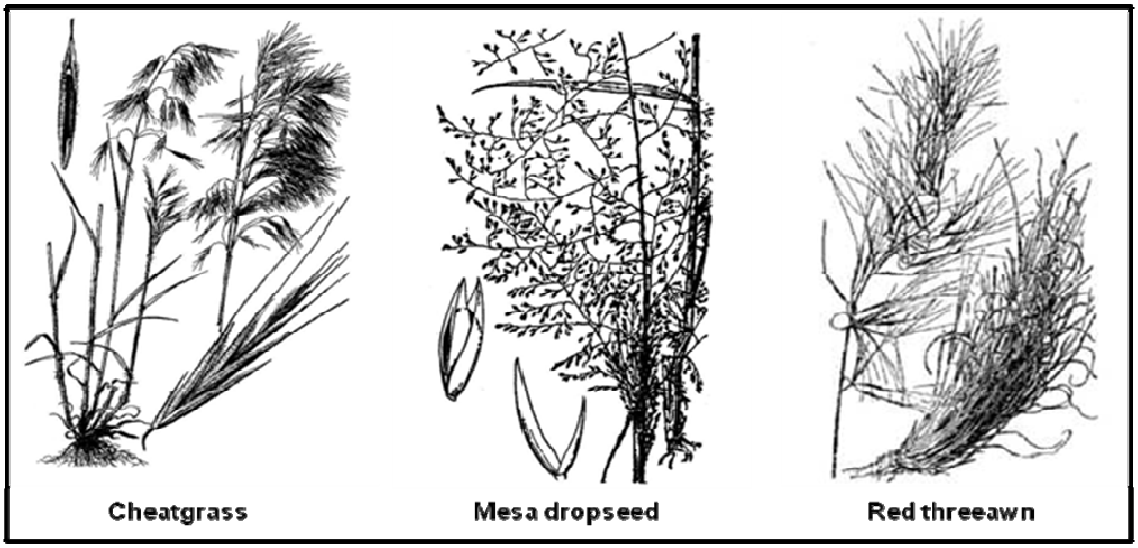

Figure 1: Rooting Depth Comparison

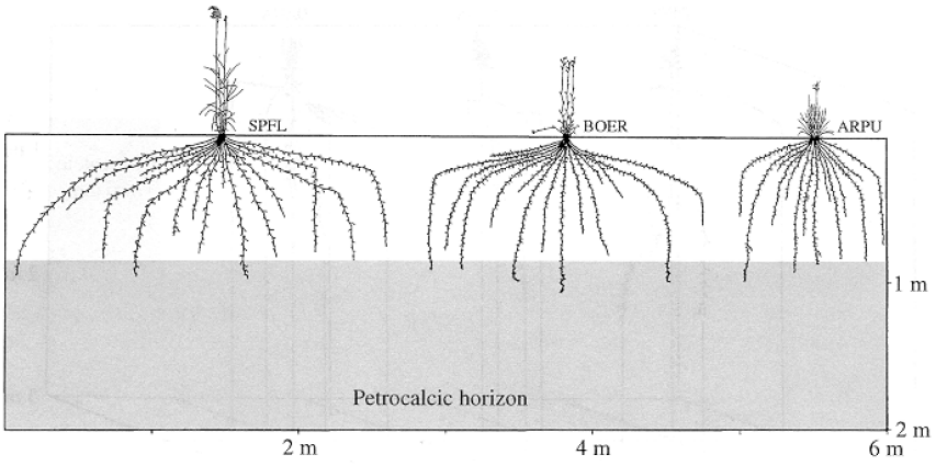

Figure 1. Mesa dropseed and red threeawn rooting system

Potential transpiration and evaporation were generated from empirical cheatgrass data published by Hinds (1975). The HELP model was consulted to define the growing season of the El Paso region, between March and August. The HELP model was also consulted to define the plant water uptake parameters. The influence of landfill gas on vegetative growth was modeled by limiting maximum root growth to within the top 12-inches of the Vegetative Support Layer only.

Boundary Conditions

The boundary conditions required for the model include general site-specific data and daily meteorological data. Daily meteorological input data includes maximum and minimum temperature, dew point, solar radiation, average wind speed, cloud cover, and daily precipitation. Data was obtained for the El Paso International Airport weather station from the National Oceanic and Atmospheric Administration (NOAA). The El Paso International Airport weather station is located approximately 4.4 nautical miles south of the landfill.

DEMONSTRATION OF PERFORMANCE

The TCEQ set two performance criteria for the demonstration of performance of an ET cover system, as summarized below:

- Less than 4 millimeters per year of drainage from the base of the ET cover system
- Modeled runoff less than 10% of the annual water applied.

Table 1 summarizes annual results of the 30-year simulation of the proposed ET cover system. It should be noted that the model is conservative in that transpiration was modeled based on 10% coverage of vegetative growth and incorporates influences of landfill gas. The data presented in **Table 1** demonstrates that the proposed ET cover system meets the TCEQ drainage performance criteria over the 30-year modeling period. Furthermore, the model's performance over years 24 through 28, which on average received 40% more precipitation than the annual average, demonstrate the ability of the proposed cover system to perform under variable weather conditions. The runoff ratio exceeds the TCEQ Performance Criteria of 10% by 1% during the floods of 2006, but it should be noted that 2006 was the wettest year on record in the El Paso region.

Figure 3 shows the annual storage requirement of the proposed ET cover system compared to the available storage capacity of the cover system design. It can be seen that the annual storage requirement never exceeds 53% of the overall storage capacity.

The sensitivity of the model was evaluated by varying input parameters, including time-stop factors; initial suction head conditions, and solution types. To verify the assumption that soils that fall within similar USCS Classifications can be expected to perform similarly from a hydraulic standpoint, van Genuchten parameters were back-calculated from the 2008 on-site sieve analysis data by methods published by Aubertin (2003) and compared to the laboratory-reported composite sample values. Additionally, estimates of typical unsaturated hydraulic properties for similar soil textures reported in the UNSODA manual were considered for consistency verification. All referenced values were of the same order of magnitude as the laboratory-reported data, indicating that the on-site soils can be expected to perform similarly. Layer thicknesses were also varied in order to develop the proposed cover system design. The laboratory reported the gradation and hydraulic properties of the composite on-site soil for varying compaction rates in an effort to identify the optimal ET cover section and compaction requirements. Therefore, quality control and quality assurance (QA/QC) testing requirements prior to and during the final landfill closure construction were focused on the gradation, hydraulic properties (saturated hydraulic conductivity, saturated water content, residual water content), and compaction of the ET final cover soil to ensure that the ET final cover will be constructed in accordance with the design intent to maximize ET performance.

Once the optimum layer thickness and compaction requirements were determined, additional simulations were run at varying compactions and van Genuchten input parameters to identify a range of acceptance during construction (Additional simulations for compaction range are attached as Appendix E). Parameter values of native soil were interpolated using known data for 75% and 80% compaction and simulations were run at 73% and 77% compaction (Interpolation results are attached). Results for 73% compaction consistently meet drainage Performance Criteria and meet the runoff Performance Criteria in 26 of the 30 years. Results for 77% compaction meet drainage Performance Criteria in 28 of the 30 years and meet the runoff Performance Criteria in 29 of the 30 years. Additional sensitivity modeling also showed an acceptable saturated hydraulic conductivity on the range of from 10E-4 to 10E-5, a minimum saturated water content of 0.34 and a maximum residual water content of 0.12. These results provide significant confidence in the performance of the cap over a ±2% compaction range. QA/QC procedures requiring the evaluation of material prior to use and compaction testing after placement on the cap will ensure native soil used in the construction of the ET Cap meets the requirements set forth in this document.

The performance of the cover system design presented in this Preliminary Design Report was determined to be stable with respect to variable non-boundary condition and/or initial condition input parameters. The design-specific input parameters were conservatively developed to accurately portray the anticipated conditions during the construction and performance of the cover system.

ATTACHMENTS

Table 1 – Proposed ET Cover System Performance Demonstration Summary

Figure 2 – Schematic of Proposed ET Cover System
Figure 3 - Storage Requirement / Capacity Comparison

Appendix A - UNSAT-H Input File
Appendix B - UNSAT-H Output Data
Appendix C - Hydraulic Parameter Lab Testing Data
Appendix D - Meteorological Data
Appendix E –Additional UNSAT-H Simulations

BLISS-A10-001-11-001

Permit Modification Application

Fort Bliss, TX

Municipal Solid Waste Landfill
Permit 1422

U.S. Army Corps of Engineers
Fort Worth District
819 Taylor Street
Fort worth, TX 76012

Revision 2 - March 19, 2012

This document is released for the purpose of Fort Bliss ED Review under the authority of Francisco Xavier Urueta P.E. #99473 on 3-19-2012. It is not to be used for construction or bidding purposes.

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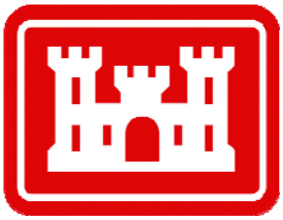
Infrastructure · Water · Environment · Buildings

Permit Modification Application

Fort Bliss, TX

Municipal Solid Waste Landfill
Permit 1422



U.S. Army Corps of Engineers
Fort Worth District
819 Taylor Street
Fort worth, TX 76012

Revision 2 – March 19, 2012

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Prepared for:
U.S. Army Corps of Engineers

3-16-12

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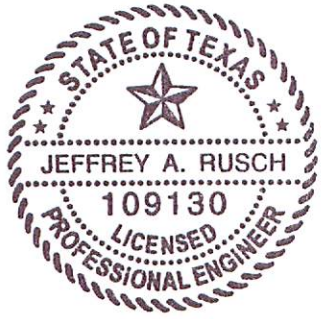


Our Ref.:
Bliss-A10-001 06400003.0000

Date:
March 2012

1.0 Permit Modification Narrative 1

1.1 Background and Description of Proposed Change 1

1.1.1 Currently Permitted Final Cover Design 1

1.1.2 Alternative ET Final Cover Design 2

1.2 Purpose of Change and Provision Under Which Modification is Sought 4

1.3 Permit Modification Application Organization and Structure 4

Appendices

A TCEQ Core Data form

B TCEQ Part I form

C Redline/Strikeout Copies
C-1 – Replacement Documents Summary Table
C-2 – *Appendix O* – Closure Plan [redline]
C-3 – *Appendix P* – Post-Closure Plan [redline]
C-4 – Permit Modification Application [redline]
C-5 – *Appendix B* – Landfill Modification and Closure Design Drawings [redline]
C-6 - *Appendix I* – Slope Stability and Settlement Analysis [redline]
C-7 – *Appendix L* – Facility Surface Water Drainage Report [redline]
C-8 – *Appendix Q* – Evapotranspiration Cover Design Report [redline]

D Clean Copy Replacement Documents
D-1 – *Appendix B* – Landfill Modification and Closure Design Drawings
D-2 – *Appendix I* – Slope Stability and Settlement Analysis
D-3 – *Appendix L* – Facility Surface Water Drainage Report
D-4 – *Appendix O* – Closure Plan
D-5 – *Appendix P* – Post-Closure Plan
D-6 – *Appendix Q* – Evapotranspiration Cover Design Report

E Adjacent Landowner Information

1.0 PERMIT MODIFICATION NARRATIVE

1.1 Background and Description of Proposed Change

The Fort Bliss Municipal Solid Waste Landfill is an approximately 106 acre facility consisting of several cells as follows:

- An active 10.5-acre Subtitle D Type I Cell;
- A closed 3-acre Non-Subtitle D Type I Cell (TCEQ closure approval received February 24, 1999);
- An active 5-acre Non-Subtitle D Type IV C&D Cell;
- Approximately 80 acres of 1970's era previously filled and operationally closed areas;
- Approximately 7 acres designated for landfill roads, access areas, and guard shack/scale house, etc.

1.1.1 Currently Permitted Final Cover Design

A March 2009 permit modification (MOD) for vertically extending the height of the Subtitle D cell by 10 feet was approved and issued by the TCEQ effective on March 19, 2009. The permit modification approval included final cover designs for all the landfill cells. For the Subtitle D cell the approved cover design is as follows (from top to bottom):

- Six inches of 1-inch to 4-inch diameter cobbles;
- A 12-inch drainage layer, $k \geq 1 \times 10^{-2}$ cm/sec;
- Geocomposite drainage net;
- 60-mil textured High Density Polyethylene (HDPE) or Linear Low Density Polyethylene (LLDPE) geomembrane; and
- 18-inch clayey material layer, $k \leq 1 \times 10^{-5}$ cm/sec.

For the previously filled and operationally closed areas and the Non-Subtitle D Type IV C&D cell, the approved cover design included an 18-inch thick (minimum) compacted low permeability soil layer (i.e., compacted clay) overlain by six inches of soil capable of sustaining native plant growth.

The Non-Subtitle D Type I cell was closed in 1999 with a non-Subtitle D final cover that complied with the closure plan for that cell and for which TCEQ closure approval was obtained in 1999.

1.1.2 Alternative ET Final Cover Design

Both the active Subtitle D and Non-Subtitle D Type IV C&D cell are nearing capacity and are scheduled to close in 2012. In addition, the facility permit does not allow further placement of waste within the 1970's era inactive areas. According to the March 1995 Final Closure Plan and Cost Estimate, these 80 acres are closed; however, formal TCEQ approval documentation has not been located in the DOE or TCEQ files.

The low permeability soil material required for the approved final cover systems for these cells is not readily available in the area and will need to be imported at considerable expense. Accordingly, Fort Bliss is seeking a permit modification to provide an alternative evapotranspiration (ET) final cover system to replace the final cover systems for those parts of the landfill that have not already received a permitted final cover (i.e. all landfill cells except the non-subtitle D cell that was capped/closed in 1999).

The proposed ET Final Cover System will consist of a 3.5-foot layered soil cap comprised of (from top to bottom) the following:

- 12-inch thick Vegetative Surface Layer consisting of stockpiled Silty Sand (United Soil Classification System (USCS) classification SM) or Clayey Sand (SC) material compacted to 75% of the Modified Proctor maximum dry density and seeded. The Vegetative Surface Layer serves as a medium for seed germination and plant growth, and provides protection against erosion and desiccation;
- 12-inch thick Storage Layer consisting of stockpiled Silty Sand (SM) or Clayey Sand (SC) material compacted to 75% of the Modified Proctor maximum dry density. The Storage Layer will provide storage volume during wet weather periods to promote deep root growth while limiting infiltration to the underlying Capillary Break and Intermediate Cover materials;
- 6-inch thick Capillary Break Layer consisting of well-graded, fine to coarse grained sand. The Capillary Break Layer will allow the fine-textured soil of the Storage Layer to store more water than a comparable layer without the capillary break layer. The additional water stored within the Storage Layer will help promote the establishment and development of surface vegetation, contribute to greater evapotranspiration, and reduce surface erosion; and,
- 12-inch thick Intermediate Cover Layer consisting of existing cover material and/or additional stockpiled Silty Sand (SM) or Clayey Sand (SC) material compacted to 75% of the Modified Proctor maximum dry density to provide additional water retention storage volume.

The TCEQ Municipal Solid Waste (MSW) Permitting Program uses a 25-inch average annual precipitation line as defined by Title 30 of the Texas Administrative Code (TAC) Rule §330.5(b)(1)(D)) to delineate areas of the State defined as arid. El Paso lies to the west of the 25-inch average annual precipitation line and therefore has been deemed arid for the purposes of considering an alternative landfill design and modeling without calibration.

The alternative ET landfill cover final grading plan doesn't significantly alter the final grades presented in the March 2009 MOD; rather, the ET landfill cover final grading plan adjusts the final grades to generally conform to the grades developed during filling operations to provide more easily constructible ridges, swales, and slopes and a more uniform surface for installation and maintenance of the ET cap. Specifically:

- The final closure grades of the northwest inactive cell were adjusted from inconsistently directed and varying top and side slopes generally ranging between 2% and 2.2% to a more uniform pyramidal shape with a 3.6% top slope facing to the west and between 6% and 18% side slopes facing to the north, east, and south.
- The final closure grades of the northeast inactive cell were adjusted from inconsistently directed 2% side slopes to a more uniform pyramidal shape with a 2.2% top slope facing to the west and between 5% and 8.3% side slopes facing to the north, east, and south.
- The final closure grades of the southeast inactive cell were adjusted from inconsistently directed and varying top and side slopes generally ranging between 2% and 3.3% to a more uniform plateau shape with a 2% top slope facing to the south and between 8.3% and 25% slopes facing east and north respectively.
- The final closure grades of the Type IV C&D cell were adjusted from steep 25% plateau side slopes to a more uniform pyramidal shape with 2% side slopes in all directions.
- The final closure grades of the Subtitle D cell were generally kept consistent with the 2008 permit modification grades.

The final grading and drainage plan remains consistent with the previously approved March 2009 MOD. Final drainage patterns at the landfill will consist mostly of overland flow paths and shallow concentrated flow leading off the ET cover landfill side slopes. Swales provide flow paths for internal watersheds to the existing landfill perimeter swales. Surface water runoff flows off the landfill into the existing shallow perimeter drainage swales that discharge to the natural flow patterns of the surrounding area, generally towards the southwest and southeast corners of the landfill.

Conventional landfill covers typically include a gas collection layer and passive gas vents to relieve landfill gas pressures on the overlying impermeable geomembrane and minimize slope stability concerns. The alternative ET landfill cover will only consist of course-grained permeable soil; therefore, no passive gas venting system is proposed as part of the final ET landfill cover design. Rather, the ET cover soils will naturally and effectively vent landfill gas, similar to the existing conditions and the daily/intermediate cover soil at the site. Additionally, the microbes in the ET cover soil will oxidize some of the methane as it vents, creating more environmentally friendly emissions. While the venting of the landfill gas may affect vegetative growth on the landfill cover, the ET cover system was designed to be effective with only 10% vegetative coverage. Based on the operational and regulatory history of the landfill (83 acres of

1970's era waste), significant landfill gas generation is not expected. Should excessive methane concentrations be detected in perimeter landfill gas monitoring probes or ambient landfill air during routine landfill gas monitoring, corrective venting and reporting procedures are outlined in the Fort Bliss Guidance Document titled *Procedures Following a Methane Exceedance*.

1.2 Purpose of Change and Provision Under Which Modification is Sought

The purpose of the proposed ET Final Cover System is to provide a more cost effective closure that offers equivalent environmental protections as those provided by the closure design previously approved. Accordingly, per Title 30 TAC §305.70(k)(10), the purpose of this permit modification application is to request approval of an ET Final Cover System as an alternative final cover system for closure of the Fort Bliss Landfill.

1.3 Permit Modification Application Organization and Structure

In accordance with Title 30 TAC §305.70(e), this permit modification application consists of a new TCEQ Core Data form and Part I form, a description of the proposed permit changes, revisions to existing applicable permit documents (including strikeout and clean copies), and an updated landowners map and landowners list as required under Title 30 TAC §330.59(c)(3).
This application is organized as follows:

- Appendix A – TCEQ Core Data form *[for information only]*
- Appendix B – TCEQ Part I form
- Appendix C - Redline/Strikeout Copy Replacement Pages. This appendix includes redline/strikeout replacement pages to the *Permit Modification Application, Fort Bliss Municipal Solid Waste Landfill, Permit 1422* (March 2008, Malcolm Pirnie, Inc.) document which reflect the inclusion of the ET Final Cover System Design
- Appendix D – Clean Copy Replacement Pages. This appendix includes clean copy replacement pages of the changes reflected in Appendix C
- Appendix E – Adjacent Landowner Information. This appendix includes a list and map of adjacent property owners for notice as required by Title 30 TAC §330.59(c)(3)

Department of the Army

Fort Bliss Department of Public Works - Environmental

IMWE-BLS-PW

Final Closure Plan

USAADACENFB Fort Bliss Municipal Solid Waste Landfill Permit #1422

Revised March 2012

Prepared By:

ARCADIS Malcolm Pirnie

44 South Broadway
15th Floor
White Plains, NY 10601

6400003

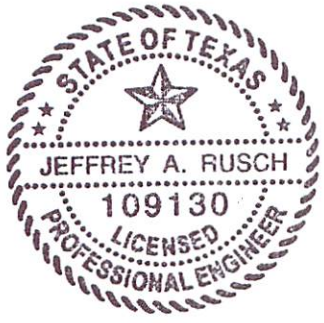
ARCADIS MALCOLM PIRNIE
Infrastructure · Water · Environment · Buildings

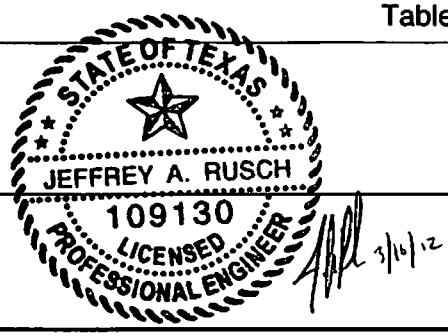
Engineering Certification

I attest that this Plan has been prepared in accordance with good engineering practices, including consideration of applicable industry standards, and with the requirements of Title 30 of the Texas Administrative Code (Title 30 TAC) Rule §330. This certification in no way relieves Fort Bliss of its duty to prepare and fully implement this Plan.

Certifying Engineer:	Jeffrey Rusch, P.E.
State:	Texas
Registration Number:	109130
Signature:	
Certification Date:	3/16/2012

Engineering Seal:





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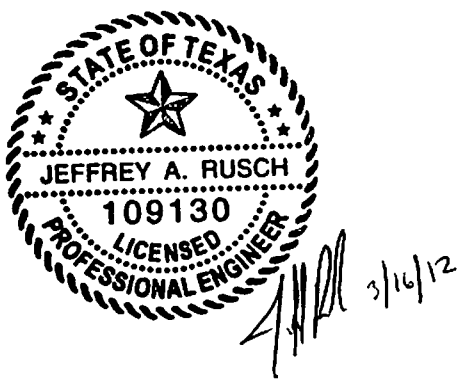

1. Introduction

The final closure plan has been prepared to provide a general guidance for the Fort Bliss Municipal Solid Waste Landfill (MSWLF) in meeting the Texas Commission on Environmental Quality (TCEQ) rules listed in Title 30 of the Texas Administrative Code Chapter 330 Rule 457 (Title 30 TAC §330.457) in reference to the closure requirements for MSWLF units.

2. Final Cover Requirements

2.1. Final Cover Design

Title 30 TAC §330.457(a)

The Fort Bliss MSWLF was permitted on November 1, 1982 for a total area of 106 acres. Currently, approximately 80% of the MSWLF has been operationally closed or is inactive. Three acres of the MSWLF have been closed as a Type I landfill unit. Ten and a half acres of the remaining portion of the landfill are designed to meet both USEPA Subtitle D and the Texas Municipal Solid Waste regulations. The remaining landfill area is classified as a Type IV construction and demolition debris cell.

The currently permitted final cover requirements for the MSWLF are summarized as follows:

Table 2-1
Fort Bliss MSWLF Final Cover Requirements (Title 30 TAC §330.457(e)(2))

Area*	Cover Requirements	Current Status
80 Acres	24" Clean Soil	Operationally Closed/Inactive
10.5 Acres (Type I)	Subtitle D Cover	Active
3 Acres (Type I)	Non-Subtitle D Cover	Closed 1999
5 Acres (Type IV)	24" Clean Soil	Active
7 Acres **	N/A	N/A

* Acreage is approximate and for estimation purposes only.
** Designed landfill access area.

Pursuant to Title 30 TAC §305.70(k)(10), an alternative final cover design may be approved as long as the alternative design achieves an equivalent reduction in infiltration as the clay-rich soil specified in 30 TAC §330.457(a)(1) and provides equivalent protection from wind and water erosion as the erosion layer specified in Title 30 TAC §330.457(a)(3). As summarized in Table 2-1, the 3-acre Non-Subtitle D Type I cell was closed in 1999 with a final cover that complied with the closure plan for that cell and for which TCEQ closure approval was obtained on February 24, 1999. However, the

remainder of the facility will be closed with an alternative evapotranspiration (ET) final cover designed to be equivalent with the currently permitted final cover systems. The ET cover will be the only final cover design for those parts of the landfill that have not received a permitted final cover (i.e. all landfill cells except the non-subtitle D cell that was capped/closed in 1999). The ET final cover will also be installed over top of the approved final cover of the Non-Subtitle D Type I cell for site grading and drainage purposes.

The ET final cover system will consist of a 3.5-foot layered soil cap comprised of (from top to bottom) the following:

- 12-inch thick Vegetative Surface Layer consisting of stockpiled Silty Sand or Clayey Sand (United Soil Classification System (USCS) classification SM or SC or any combination thereof) material compacted to 75% of the Modified Proctor maximum dry density and seeded. The Vegetative Surface Layer serves as a medium for seed germination and plant growth, and provides protection against erosion and desiccation;
- 12-inch thick Storage Layer consisting of stockpiled Silty Sand or Clayey Sand (SM or SC or any combination thereof) material compacted to 75% of the Modified Proctor maximum dry density. The Storage Layer will provide storage volume during wet weather periods to promote deep root growth while limiting infiltration to the underlying Capillary Break and Intermediate Cover materials;
- 6-inch thick Capillary Break Layer consisting of well-graded, fine to coarse grained sand. The Capillary Break Layer will allow the fine-textured soil of the Storage Layer to store more water than a comparable layer without the capillary break layer. The additional water stored within the Storage Layer will help promote the establishment and development of surface vegetation, contribute to greater evapotranspiration, and reduce surface erosion; and,
- 12-inch thick Intermediate Cover Layer consisting of existing cover material and/or additional stockpiled Silty Sand or Clayey Sand (SM or SC or any combination thereof) material compacted to 75% of the Modified Proctor maximum dry density to provide additional water retention storage volume.

2.2. Final Cover Area

As summarized in Table 2-1, the 3-acre Non-Subtitle D Type I cell was closed in 1999. However, the remainder of the facility will be closed with an alternative evapotranspiration (ET) landfill cover. The total area to be capped and closed with the ET landfill cover includes the 1970's era inactive cells, the 10.5-acre Type I cell, and the 5-acre Type IV C&D cell, and encompasses approximately 98.5 acres.

3. Maximum Inventory of Waste

Title 30 TAC §330.457(e)(3)

Based on the approved 1995 final landfill contours, the total permitted waste capacity of the Fort Bliss MSWLF is 5.9 million cubic yards. The March 2009 MOD for the 10-foot height increase in the Subtitle-D cell added an additional 180,000 cubic yards of landfill capacity. The alternative ET landfill cover final grading plan doesn't significantly alter the final grades presented in the March 2009 MOD; however, the ET landfill cover final grading plan generally conforms to the grades developed during filling operations (based on the 2010 topographic survey) to provide more easily constructible ridges, swales, and slopes and a more uniform surface for installation and maintenance of the ET final cover. Specifically:

- The final closure grades of the northwest inactive cell were adjusted from inconsistently directed and varying top and side slopes generally ranging between 2% and 2.2% to a more uniform pyramidal shape with a 3.6% top slope facing to the west and between 6% and 18% side slopes facing to the north, east, and south.
- The final closure grades of the northeast inactive cell were adjusted from inconsistently directed 2% side slopes to a more uniform pyramidal shape with a 2.2% top slope facing to the west and between 5% and 8.3% side slopes facing to the north, east, and south.
- The final closure grades of the southeast inactive cell were adjusted from inconsistently directed and varying top and side slopes generally ranging between 2% and 3.3% to a more uniform plateau shape with a 2% top slope facing to the south and between 8.3% and 25% slopes facing east and north respectively.
- The final closure grades of the Type IV C&D cell were adjusted from steep 25% plateau side slopes to a more uniform pyramidal shape with 2% side slopes in all directions.
- The final closure grades of the Subtitle D cell were generally kept consistent with the March 2009 MOD grades.

As reported in the March 2009 MOD the current volume of in-place waste at that time was about 5.1 million cubic yards. The Annual Solid Waste Reports from FY 2009 and FY 2010 and the most recent Daily Landfill Log from FY 2011 document an additional 85,000 cubic yards of in-place waste. Based on the existing landfill grades and the ET landfill cover final grading plan, the remaining capacity in the active Type I and Type IV

cells is 100,200 cubic yards. Therefore, at the time of closure the maximum in-place waste volume is expected to be 5,285,200 cubic yards.

It should be noted that the landfill will be closed prior to reaching its permitted waste capacity of 5,893,932 CY. As reported in the 21 February 1996 Report on Volume Calculations and Case Studies, exploratory trenches advanced through the 1970's era filled and operationally closed landfill cells discovered an in-place waste depth of 25-feet corresponding to an in-place waste volume of 2,984,467 CY. The permitted waste capacity over this same area, based on the design waste depth of 30-ft, is 3,676,542 CY. Therefore, the disparity between the permitted capacity and the anticipated final volume of in-place waste is primarily related to the shallower waste depth in the historic cells.

4. Final Cover Design

4.1. ET Cover System

As previously discussed in Section 2.1, the Fort Bliss MSWLF will be closed with an alternative evapotranspiration (ET) final cover designed to be equivalent with the currently permitted final cover systems. The ET cover will be the only final cover design for those parts of the landfill that have not received a permitted final cover. The alternative ET cover system was designed to meet the requirements listed in Title 30 TAC §330.457 and will consist of a 3.5-foot layered soil cap comprised of (from top to bottom) the following components:

- 12-inch thick Vegetative Surface Layer consisting of stockpiled Silty Sand or Clayey Sand (SM or SC or any combination thereof) material compacted to 75% of the Modified Proctor maximum dry density and seeded. The Vegetative Surface Layer serves as a medium for seed germination and plant growth, and provides protection against erosion and desiccation;
- 12-inch thick Storage Layer consisting of stockpiled Silty Sand or Clayey Sand (SM or SC or any combination thereof) material compacted to 75% of the Modified Proctor maximum dry density. The Storage Layer will provide storage volume during wet weather periods to promote deep root growth while limiting infiltration to the underlying Capillary Break and Intermediate Cover materials;
- 6-inch thick Capillary Break Layer consisting of well-graded, fine to coarse grained sand. The Capillary Break Layer will allow the fine-textured soil of the Storage Layer to store more water than a comparable layer without the capillary break layer. The additional water stored within the Storage Layer will help promote the establishment and development of surface vegetation, contribute to greater evapotranspiration, and reduce surface erosion; and,
- 12-inch thick Intermediate Cover Layer consisting of existing cover material and/or additional stockpiled Silty Sand or Clayey Sand (SM or SC or any combination thereof) material compacted to 75% of the Modified Proctor maximum dry density to provide additional water retention storage volume.

It should be noted that the TCEQ Municipal Solid Waste (MSW) Permitting Program uses a 25-inch average annual precipitation line as defined by Title 30 TAC §330.5(b)(1)(D) to delineate areas of the State defined as arid. El Paso lies to the west of the 25-inch average annual precipitation line and therefore has been deemed arid for the purposes of considering an alternative landfill design and modeling and constructing without model calibration.

4.2. Landfill Cells

Title 30 TAC §330.457(e)(1)

The Fort Bliss MSWLF is comprised of five distinct areas:

1. 1970's era inactive cells that consist of 30-foot deep trenches with two feet of clean soil cover. These cells cover an 80 acre area and are unlined and without leachate collection. The permit does not allow further placement of MSW on these cells. According to the March 1995 Final Closure Plan and Cost Estimate these 80 acres are closed; however, formal TCEQ approval documentation has not been located in the DOE or TCEQ files.
2. A three-acre Type 1 cell with final cover in place (non-Subtitle D) that complies with the closure plan and TCEQ closure requirements. TCEQ approval was received on February 24, 1999.
3. A 10.5-acre Type I active cell meeting Subtitle D requirements. This cell is lined and has a leachate collection system. This cell is nearing permitted capacity and is anticipated to be full by January 2012.
4. A 5-acre active Type IV construction debris cell. This cell is unlined and without leachate collection. This cell is also anticipated to reach capacity by July 2012.
5. Seven acres designated for landfill roads, access areas, gatehouse, etc.

4.3. 1970's Inactive Cells

The 1970's era inactive areas are covered with 24-inch thick clean soil, as indicated in the March 1995 Final Closure Plan and Cost Estimate sealed by Mr. John Karlsruher of Cardenas-Salcedo and Associates, Inc. These landfill areas are also indicated as closed in the May 1999 Final Cover Quality Control Plan for the 3-acre Type 1 cell. However, this area is described as in interim closure by Fort Bliss DPW-ENV and no TCEQ approval or Texas P.E. certification of closure has been found in TCEQ or Fort Bliss DPW-ENV records. Accordingly, the ET final cover system as described in Section 4.1 will be installed over these areas. The existing intermediate cover material will require clearing/grubbing and/or tilling, watering and regrading, and compaction as defined in Section 5 to meet the requirements of the intermediate cover component of the ET cover system.

The final grades of these 1970's era cells will be adjusted to create uniform pyrimdal shapes as summarized in Section 3. All cells will be crowned at the top to promote positive drainage off the landfill and preclude ponding of surface water when total fill height and expected subsidence are taken into consideration.

4.4. Non-Subtitle D Area (Type I)

The closure of the Non-Subtitle D Type I cell was approved by TCEQ on February 24, 1999. However, the ET final cover system will be installed over top of the approved final cover for site grading and drainage purposes.

4.5. Subtitle D Area (Type I)

The final cover for the Type I Subtitle D area will be the ET final cover system as described in Section 4.1. Final closure grades will be generally consistent with the March 2009 MOD grades and will form a landfill plateau with 2% top slopes and 25% side slopes.

4.6. Non-Subtitle D Area (Type IV)

The final cover for the Type IV Non-Subtitle D area will be the ET final cover system as described in Section 4.1. The final grading of the Non-Subtitle D cell will create a uniform pyramidal shape with 2% side slopes in all directions.

5. Construction Quality Assurance

5.1. Introduction

Title 30 TAC §330.457(e)(1)

Construction of the ET final cover system will be performed by using equipment that is suitable for completing the construction and achieving the desired grading, compaction and vegetative cover requirements.

5.2. Construction Quality Control Plan (CQCP)

This section addresses the construction of the soil components of the alternative ET final cover system and outlines the Construction Quality Control Plan (CQCP) to be implemented with regard to material selection and evaluation, laboratory test requirements, and field test requirements.

The primary soil parameters and construction specifications that will impact the performance of the ET final cover system are soil gradation, saturated hydraulic properties, and degree of compaction. The modeling and design of the ET cover system was based on these material and construction specification requirements. Therefore, the QA testing procedures presented herein will be required prior to and during the final closure construction to ensure that the ET final cover is constructed in accordance with the design intent and to maximize ET performance.

5.2.1. Source Material Evaluation

Material evaluations shall be performed on stockpiled or delivered material prior to and during construction to ascertain its acceptability for the intended purpose. All material shall be sampled and tested by the Contractor in accordance with the requirements specified in the following subsections and summarized in Table 5-1 below. Copies of the laboratory inspection testing results will be submitted to the Engineer of Record and will also be included in the Final Cover System Evaluation Report (FCSER).

Standards referenced in this Section are:

- ASTM D422, Test Method for Particle Size Analysis of Soils
- ASTM D1557, Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3)

- ASTM D2216, Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
- ASTM D3080, Test Method for Direct Shear Test of Soils Under Consolidated Drained Conditions
- ASTM D4318, Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
- ASTM D5084 – Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter
- ASTM D6836 - Standard Test Methods for Determination of the Soil Water Characteristic Curve for Desorption Using a Hanging Column, Pressure Extractor, Chilled Mirror Hygrometer, and/or Centrifuge
- ASTM D6938, Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

Table 5-1
Fort Bliss MSWLF ET Cover Source Material Evaluation

Material	Parameter	Test Method	Frequency	Acceptance Criteria
Vegetative Surface Layer Material	Modified Proctor	ASTM D1557	1 test per 10,000 CY	--
	Sieve and Hydrometer	ASTM D422		SC/SM
	Atterberg Limits	ASTM D4318		--
	Soil Water Characteristic Curve	ASTM D6836		$\Theta r \leq 0.12$ $\Theta s \geq 0.34$
	Saturated Hydraulic Conductivity	ASTM D5084		ksat ~ 10^{-4} to 10^{-5} cm/sec
	Moisture Content	ASTM D2216		--
	Direct Shear	ASTM D3080		$\Phi \geq 26°$
	Field Density and Moisture Content	ASTM D6938	2 tests per acre	Within ±2% of 75% Modified

Table 5-21 [CONT.]
Fort Bliss MSWLF ET Cover Source Material Evaluation

Storage Layer Material	Modified Proctor	ASTM D1557	1 test per 10,000 CY	--
	Sieve and Hydrometer	ASTM D422		SC/SM
	Atterberg Limits	ASTM D4318		--
	Soil Water Characteristic Curve	ASTM D6836		Θr ≤ 0.12 Θs ≥ 0.34
	Saturated Hydraulic Conductivity	ASTM D5084		ksat ~ 10^{-4} to 10^{-5} cm/sec
	Moisture Content	ASTM D2216		--
	Direct Shear	ASTM D3080		Φ ≥ 30°
	Field Density and Moisture Content	ASTM D6938	2 tests per acre	Within ±2% of 75% Modified
Capillary Break Layer Material	Modified Proctor	ASTM D1557	1 test per 10,000 CY	--
	Sieve Analysis	ASTM D422		SW
	Moisture Content	ASTM D2216		--
	Soil Water Characteristic Curve	ASTM D6836	1 test per 20,000 CY	--
	Saturated Hydraulic Conductivity	ASTM D5084		--
	Direct Shear	ASTM D3080		Φ ≥ 30
	Field Density and Moisture Content	ASTM D6938	2 tests per acre	Within ±5% of 90% Modified and ±5% of the optimum
Intermediate Cover Layer Material	Modified Proctor	ASTM D1557	1 test per 10,000 CY	--
	Sieve and Hydrometer	ASTM D422		SC/SM
	Atterberg Limits	ASTM D4318		--
	Soil Water Characteristic Curve	ASTM D6836		Θr ≤ 0.12 Θs ≥ 0.34
	Saturated Hydraulic Conductivity	ASTM D5084		ksat ~ 10^{-4} to 10^{-5} cm/sec
	Moisture Content	ASTM D2216		--
	Direct Shear	ASTM D3080		Φ ≥ 30°
	Field Density and Moisture Content	ASTM D6938	2 tests per acre	Within ±2% of 75% Modified

Table 5-31 [CONT.]
Fort Bliss MSWLF ET Cover Source Material Evaluation

Existing Intermediate Cover Layer Material	Modified Proctor	ASTM D1557	1 test per 10 acres	--
	Sieve and Hydrometer	ASTM D422		SC/SM
	Atterberg Limits	ASTM D4318		--
	Soil Water Characteristic Curve	ASTM D6836		$\Theta r \leq 0.12$ $\Theta s \geq 0.34$
	Saturated Hydraulic Conductivity	ASTM D5084		ksat ~ 10^{-4} to 10^{-5} cm/sec
	Moisture Content	ASTM D2216	1 test per 10,000 CY	--
	Direct Shear	ASTM D3080		$\Phi \geq 30°$
	Field Density and Moisture Content	ASTM D6938	2 tests per acre	Within ±2% of 75% Modified

5.2.2. Intermediate Cover Layer

5.2.2.1. Material Specification

The Intermediate Cover Layer will consist of twelve-inches of existing placed cover material or stock-piled cover material (SM or SC or any combination thereof) placed over the waste and compacted to approximately within ±2% of 75% of the Modified Proctor maximum dry density. Sensitivity simulations confirmed that compaction within ±2% of the desired compaction specification achieves sufficient performance of the ET final cover system.

5.2.2.2. Existing Intermediate Cover Material Construction Requirements

Across the 1970's era inactive cells, the Intermediate Cover Layer will likely consist of the existing intermediate cover soil placed in accordance with the Site Operating Plan. In general, over 24-inches of compacted intermediate cover material has been placed over these inactive cells. Over time, isolated patches of native vegetation have taken root across these calls. Therefore, the Contractor will be required to clear and grub all existing intermediate cover material of all vegetation, roots, and other deleterious materials using bulldozers, graders, tillers, or other suitable equipment to provide a smooth uniformly graded bare surface.

All existing intermediate cover material will require watering, re-working, and compaction as necessary to create an intermediate cover material subgrade consistent with the final cover requirements. Prior to final grading and compaction, the existing

intermediate cover material will be probed at 100-foot intervals to verify that a minimum of 12-inches of cover soil is in place and verify the existing in-place density. Where existing suitable intermediate cover material does not meet or cannot be re-worked to meet the final cover material or compaction requirements or does not measure the minimum of 12-inches in depth, additional stockpiled SM/SC cover material shall be backfilled, graded, and compacted to create a uniform bare surface of suitable intermediate cover material. Intermediate cover material may exceed the minimum 12-inches in thickness, where necessary.

5.2.2.3. Other Construction Requirements

Where existing intermediate cover material has not been installed, stockpiled intermediate cover SM/SC material will be placed as a single lift to achieve a minimum compacted thickness of 12-inches. All intermediate cover material (existing re-worked material and stockpiled backfill) will require static and/or vibratory compaction to meet the project compaction requirements of within ±2% of 75% of the Modified Proctor maximum dry density through the full 12-inch soil layer. Should in-place density exceed project requirements, intermediate cover material will be tilled to a minimum depth of 12-inches, watered, and re-compacted with appropriate energy to meet the project requirements. Surveying and grade stakes will be used to verify the final grades of the intermediate cover material.

5.2.2.4. Field QA Testing

To ensure performance of the constructed ET cap is similar to that modeled during design, the intermediate cover material will be sampled and tested at the minimum frequencies presented below prior to and during construction:

- Modified Proctor moisture/density testing (ASTM D1557) – Minimum frequency of 1 test per 10 acres of existing intermediate cover material or 1 test per 10,000 CY of stockpiled intermediate cover material installed
- Sieve and hydrometer analysis testing (ASTM D422) - Minimum frequency of 1 test per 10 acres of existing intermediate cover material or 1 test per 10,000 CY stockpiled intermediate cover material installed. Soils shall be classified as SM, SC, or any combination thereof to be considered acceptable for use in the final ET cover system.
- Atterberg limits testing (ASTM D4318) - Minimum frequency of 1 test per 10 acres of existing intermediate cover material or 10,000 CY stockpiled intermediate cover material installed
- Soil water characteristic curve (ASTM D6836) and saturated hydraulic parameter testing (ASTM D5084) - Minimum frequency of 1 test per 10 acres of existing intermediate cover material or 1 test per per 20,000 CY. Saturated hydraulic

conductivity shall be on the order of 10E-4 to 10E-5 cm/sec, saturated water content shall be greater than 0.34 and residual water content less than 0.12 to be considered acceptable for use in the final ET cover system.

- Moisture content testing (ASTM D2216) - Minimum frequency of 1 test per 10,000 CY of intermediate cover material for existing and/or installed intermediate cover material
- Direct shear testing (ASTM D3080) – Minimum frequency of 1 test per 10,000 CY of intermediate cover material for existing and/or installed intermediate cover material. Direct shear testing shall be performed at confining stresses of 250 psf, 500 psf, and 1,000 psf. Intermediate cover material shall exhibit a minimum internal angle of friction 30° to be considered acceptable for use in the final ET cover system.
- Field density and moisture content testing (ASTM D6938) – Minimum frequency of 2 tests per acre for existing and/or installed intermediate cover material

5.2.3. Capillary Break Layer

5.2.3.1. Material Specification

The Capillary Break Layer will be installed over the Intermediate Cover Layer as approved by the Engineer of Record and will consist of 6-inches of well-graded, fine to coarse grained sand (SW). Sand will be a fine granular material produced by the crushing of rock, gravel, or naturally produced by disintegration of rock and will be free of organic material, mica, loam, clay and other deleterious substances.

5.2.3.2. Construction Requirements

Capillary break layer material will be placed as one lift to achieve a minimum compacted thickness of six inches and compacted to within ±5% of 90% of the Modified Proctor maximum dry density. Sensitivity simulations confirmed that compaction within ±5% of the desired compaction specification achieves sufficient performance of the ET final cover system. Over-compacted material will be tilled and re-compacted. Material installed as part of the capillary break layer will be placed at ±5% of the optimum moisture content at the time of placement and will be covered with the overlying storage layer as soon as practical. Placement of capillary break layer material will not occur during rainfall events to prevent saturation and over-compaction. Surveying will be performed to verify the thickness of the capillary break layer.

5.2.3.3. Field QA Testing

To ensure performance of the constructed ET cap is similar to that modeled during design, the capillary break layer material will be sampled and tested at the minimum frequencies presented below during construction:

- Modified Proctor moisture/density testing (ASTM D1557) – Minimum frequency of 1 test per 10,000 CY of imported capillary break material
- Sieve analysis testing (ASTM D422) - Minimum frequency of 1 test per 10,000 CY of imported capillary break material
- Moisture content testing (ASTM D2216) - Minimum frequency of 1 test per 10,000 CY of imported capillary break material
- Soil water characteristic curve (ASTM D6836) and saturated hydraulic permeameter testing (ASTMD5084) - Minimum frequency of 1 test per 20,000 CY of imported capillary break material
- Direct shear testing (ASTM D3080) – Minimum frequency of 1 test per 20,000 CY of imported capillary break material. Direct shear testing shall be performed at confining stresses of 250 psf, 500 psf, and 1,000 psf. Capillary break material shall exhibit a minimum internal angle of friction 30° to be considered acceptable for use in the final ET cover system
- Field density and moisture content testing (ASTM D6938) – Minimum frequency of 2 tests per acre

5.2.4. Storage Layer

5.2.4.1. Material Specification

The Storage Layer will be installed over the capillary break layer as approved by the Engineer of Record and will consist of a minimum of 12-inches of stockpiled SM/SC material compacted to within ±2% of 75% of the Modified Proctor maximum dry density. Sensitivity simulations confirmed that compaction within ±2% of the desired compaction specification achieves sufficient performance of the ET final cover system. The soil will be inspected as placed to be free of vegetation, roots, debris, and rocks greater than 2-inches in diameter.

5.2.4.2. Construction Requirements

The Storage Layer will be placed as a single lift to achieve a minimum compacted thickness of 12-inches and compacted to within ±2% of 75% of the Modified Proctor maximum dry density. Over-compacted material will be tilled and recompacted. Surveying will be performed to verify the thickness of the storage layer.

5.2.4.3. Field QA Testing

To ensure performance of the constructed ET cap is similar to that modeled during design the storage layer material will be sampled and tested at the minimum frequencies presented below during construction:

- Modified Proctor moisture/density testing (ASTM D1557) – Minimum frequency of 1 test per 10,000 CY of stockpiled storage layer material
- Sieve and hydrometer analysis testing (ASTM D422) - Minimum frequency of 1 test per 10,000 CY of stockpiled storage layer material. Soils shall be classified as SM, SC, or any combination thereof to be considered acceptable for use in the final ET cover system.
- Atterberg limits testing (ASTM D4318) - Minimum frequency of 1 test per 10,000 CY of stockpiled storage layer material
- Soil water characteristic curve (ASTM D6836) and saturated hydraulic permeameter testing (ASTMD5084) - Minimum frequency of 1 test per 20,000 CY of stockpiled storage layer material. Saturated hydraulic conductivity shall be on the order of 10E-4 to 10E-5 cm/sec, saturated water content shall be greater than 0.34 and residual water content less than 0.12 to be considered acceptable for use in the final ET cover system.
- Direct shear testing (ASTM D3080) – Minimum frequency of 1 test per 20,000 CY of stockpiled storage layer material. Direct shear testing shall be performed at confining stresses of 250 psf, 500 psf, and 1,000 psf. Storage layer material shall exhibit a minimum internal angle of friction 30° to be considered acceptable for use in the final ET cover system
- Field density and moisture content testing (ASTM D6938) – Minimum frequency of 2 tests per acre

5.2.5. Vegetative Surface Layer

5.2.5.1. Material Specification

The vegetative Surface layer will be installed over the storage layer as approved by the Engineer of Record and will consist of a minimum of 12-inches of stockpiled SM/SC material compacted to within ±2% of 75% of the Modified Proctor maximum dry density. Sensitivity simulations confirmed that compaction within ±2% of the desired compaction specification achieves sufficient performance of the ET final cover system. The soil will be inspected as placed to be free of vegetation, roots, debris, and rocks greater than 2-inches in diameter. Where possible, stockpiled SM/SC material visually observed to contain a higher organic content will be reserved for use in the vegetative surface layer.

5.2.5.2. Construction Requirements

The Surface Layer will be placed as a single lift to achieve a minimum compacted thickness of 12-inches and compacted to within ±2% of 75% of the Modified Proctor maximum dry density. Over-compacted material will be tilled and recompacted. Material installed as part of the vegetative surface layer will be placed at ±2% of the optimum moisture content at the time of placement. Placement of vegetative surface layer layer material will not occur during rainfall events to prevent saturation and overcompaction. Surveying will be performed to verify the thickness and final grades of the vegetative surface layer.

The top 4-inches of the vegetative surface layer will be tilled perpendicular to the slope of the surface in preparation for seeding in accordance with Section 5.3.

5.2.5.3. Field QA Testing

To ensure performance of the constructed ET cap is similar to that modeled during design the vegetative surface layer material will be sampled and tested at the minimum frequencies presented below during construction:

- Modified Proctor moisture/density testing (ASTM D1557) – Minimum frequency of 1 test per 10,000 CY of stockpiled surface layer material
- Sieve and hydrometer analysis testing (ASTM D422) - Minimum frequency of 1 test per 10,000 CY of stockpiled surface layer material. Soils shall be classified as SM, SC, or any combination thereof to be considered acceptable for use in the final ET cover system.
- Atterberg limits testing (ASTM D4318) - Minimum frequency of 1 test per 10,000 CY of stockpiled surface layer material
- Moisture content testing (ASTM D2216) - Minimum frequency of 1 test per 10,000 CY of stockpiled surface layer material
- Soil water characteristic curve (ASTM D6836) and saturated hydraulic permeameter testing (ASTMD5084) - Minimum frequency of 1 test per 20,000 CY of stockpiled surface layer material. Saturated hydraulic conductivity shall be on the order of 10E-4 to 10E-5 cm/sec, saturated water content shall be greater than 0.34 and residual water content less than 0.12 to be considered acceptable for use in the final ET cover system.
- Direct shear testing (ASTM D3080) – Minimum frequency of 1 test per 20,000 CY of stockpiled surface layer material. Direct shear testing shall be performed at confining stresses of 250 psf, 500 psf, and 1,000 psf. Surface layer material shall exhibit a minimum internal angle of friction 26° to be considered acceptable for use in the final ET cover system

- Field density and moisture content testing (ASTM D6938) – Minimum frequency of 2 tests per acre

5.3. Vegetation Planting Plan

The purpose of this plan is to detail the procedures to be used for soil preparation and initial planting on the ET Cover. This plan sets forth use a specified native seed mix for permanent cover which includes the two target grass species from the genera *Aristida* and *Sporobolus* for permanent establishment, but also allows for use of non-native and cultivated seed mixes per TxDOT specifications which are designed for temporary cover to achieve soil stabilization in the event final grading is completed outside of the germination period for target species (May 15 – November).

5.3.1. Soil Preparation and Seeding

All seeds must conform to the requirements of the USDA rules and regulations set forth in the Federal Seed Act and Texas seed law. Utilization of local soils stockpiled on-site will constitute the 12-inch thick Vegetative Surface Layer. These soils consist of silty sands (SM) and clayey sands (SC) and will be compacted to 75% of the Modified Proctor maximum dry density prior to seedbed preparation as discussed in Section 5.2.5.

Seedbed preparation will start as soon as possible after completion of the Vegetative Surface Layer to the lines and grades specified in the construction plans. The vegetated area will be cultivated to a typical depth of 4-inches before placement of seed or seed mix. If temporary seeding is utilized, the area covered with temporary grass will be cultivated to a typical depth of 4 inches before application of permanent seeds.

Table 5-2 includes the schedule and species for seeding as well as the seed application rate of pure live seed (PLS) per acre. The schedule is subject to potentially change depending on the availability of grass species specified as well as due to unexpected climatic conditions during and immediately after final cover construction are encountered.

Table 5-2

Fort Bliss MSWLF ET Cover Seeding Schedule

Dates	Seed Type to Use	Seed Species to Use (Common Name)	Seed Species to Use (Latin Name)	Rates (lb Pure Live Seed/ac)
February 1 – May 15	Perennial (Native Species Seed Mix)	Green Sprangletop	*Leptochloa dubia*	0.3
		Red threeawn	***Aristida purpurea Nutt.***	0.4
		Mesa dropseed	***Sporobolus flexuosus***	0.9
		Blue Grama	*Bouteloua gracilis*	1.0
		Indian Ricegrass	*Oryzopsis hymenoides*	1.6
		Purple Prairieclover	*Dalea purpurea*	0.5
May 16 – August 31	Temporary Warm (Summer) Season (A Native Species and A Cultivated Species)	Buffalo Grass	*Buchloe dactyloides*	50
September 1 – November 30	Temporary Cool (Winter) Season (Introduced Species)	Plains Bristlegrass	*Setaria vulpiseta*	4.0

Plant seeding may utilize one or a combination of the following methods, as suggested by the Texas Department of Transportation *Specifications Book*.

1. Broadcast Seeding. Distribute seed/mixture uniformly over the areas shown on the plans using hand or mechanical distribution or hydro-seeding on top of the soil. When seed and water are to be distributed as a slurry during hydroseeding, apply the mixture to the area to be seeded within 30 minutes of placement of components in the equipment. Roll the planted area with a light roller or other suitable equipment. Roll sloped areas along the contour of the slope.

2. Straw or Hay Mulch Seeding. Use Broadcast Seeding method to plant seed. Immediately after planting the seed/mixture, apply straw or hay mulch uniformly over the seeded area. Apply straw mulch at 2 to 2.5 tons per acre. Apply hay mulch at 1.5 to 2 tons per acre. Use a tacking method over the mulched area.

3. Cellulose Fiber Mulch Seeding. Plant seed using broadcast seeding. Immediately after planting seed/mixture, apply cellulose fiber mulch uniformly over the seeded area at the following rates:
   - Clay soils with slopes of 3:1 or less – 2,000 lbs per acre
   - Clay soils with slopes greater than 3:1 – 2,300 lbs per acre
   - Sandy soils with slopes of 3:1 or less – 2,500 lbs per acre
   - Sandy soils with slopes greater than 3:1 – 3,000 lbs per acre

4. Drill Seeding. Using a pasture or rangeland type drill, plant seed/mixture uniformly over the area at a depth of 1/4 inch to 1/3 inch. Plant seed along the contour of the slopes.

5. Straw or Hay Mulching. Apply straw or hay mulch uniformly over the area as indicated on the plans. Apply hay mulch at 1.5 to 2 tons per acre. Apply straw at 2 to 2.5 tons per acre. Use a tacking method over the mulched area.

5.3.2. Fertilizer Recommendations

The installed vegetation layer will be tested for fertilizer need prior to seeding. Except for broadcast seeding, initial fertilization will occur prior to seeding. Fertilizer needs for the installed vegetation layer will be determined by collecting one soil sample per every 10 acres of installed vegetation layer, (for the purpose of this plan only one vegetation layer is proposed). Soil nutrient needs will be tested by a qualified agronomic testing laboratory (e.g. Texas A&M University Soil, Water and Forage Testing Laboratory). The laboratory testing report will determine macro and micro nutrient needs and may also contain suggestions for soil inoculants, organic matter, etc. for the installed vegetation layer. The nitrogen, phosphoric acid and potash ratio is 2:1:1, and will be applied at a rate of 100 pounds of nitrogen, 50 pounds of phosphoric acid and 50 pounds of potash per acre, unless laboratory testing results mandate higher rates. At a minimum, micronutrients will be applied at a minimum rate of 1 pound per acre of boron, calcium and magnesium.

Seed and fertilizer may be distributed simultaneously during Broadcast Seeding operations, provided each component is applied at the specified rate. When temporary and permanent seeding are both specified for the same area, apply half of the amount of fertilizer during temporary seeding operation and the other half during the permanent

seeding operation. Fertilization will occur at intervals of no more than six week after initial seeding and until vegetation is established. To prevent damage to established vegetation, turf type line equipment will be used to apply fertilizer.

Unless otherwise specified on the plans, use a fertilizer containing nitrogen, phosphoric acid and potash nutrients. Similar to urea-based and plastic resin-coated fertilizers, at least 50 percent of the nitrogen component must be of a slow release formulation unless otherwise dictated by the soils laboratory. The vegetation establishment contractor will ensure that fertilizer is in an acceptable condition for distribution in containers labeled with the analysis. Fertilizer is subject to testing by the Texas A&M Feed and Fertilizer Control Service in accordance with the Texas Fertilizer Law.

5.4. Vegetation Establishment Verification Plan

5.4.1. Introduction

The Vegetation Establishment Verification Plan will ensure that the vegetation is established consistent with the parameters used in the ET Alternative Final Cover Demonstration and includes the following subsections:

- Vegetation Establishment Period
- Maintenance Activities to be Completed During the Vegetation Establishment Period
- Vegetation Performance Specification

5.4.2. Vegetation Establishment Period

The maintenance period will start immediately after seeding is conducted and will continue until TCEQ approves the vegetation establishment verification. Vegetation will be considered established when a satisfactory population of mature plants belonging to the *Aristida* and/or *Sporobolus* genera is verified to cover no less than 10% of the ET final ground cover area with no more than 50% bare areas. A bare area is defined as zero plants within a square meter quadrant (~10.76 square feet). It is assumed that re-use of local stockpiled soils containing native plant seed stock will significantly aide in facilitating vegetative growth.

The vegetation establishment period begins after the Final Cover System Evaluation Report (see Section 5.5.1) is approved by TCEQ and ends when the Vegetation Establishment Report (see Section 5.5.2) is approved by TCEQ. The standard timeframe is 2 to 3 years. The facility will establish the vegetation consistent with the parameters specified in the Vegetation Planting Plan.

5.4.3. Maintenance Activities to be Completed during the Vegetation Establishment Period

The following maintenance activities ensure that the planted vegetation will meet the vegetation performance specification:

- Following application of perennial seed mix, if less than 10% vegetative ground coverage or greater than 50% bare areas are determined to exist, re-seeding of areas that will amount to achieving the 10% ground coverage with no more than 50% bare areas will need to be completed prior to May 15.
- Following application of a temporary seed mix, if less than 10% vegetative ground coverage or greater than 50% bare areas are determined to exist, re-seeding of areas that will amount to achieving the 10% ground coverage with no more than 50% bare areas will need to be completed prior to November 30 to avoid over-winter exposure of said bare areas.
- Temporary erosion protection measures will be installed, as necessary, if greater than 50% bare areas are determined to exist.
- Additional landfill gas extraction wells will be installed in any specific vegetative area where landfill gas poses a detrimental threat.
- Areas of significant differential settlement will be re-graded and re-seeded.
- Depending on the season, vegetation will be maintained and mowed as appropriate. No mowing will be allowed until grasses establish mature seeds.
- The facility will irrigate and fertilize the ET final cover area to stimulate and promote vegetative.
- Erosion and sediment controls will be added to areas that experience erosion.

5.4.4. Vegetation Performance Specification

The vegetation layer will be evaluated at the end of the vegetation establishment period by a Texas Licensed Professional Engineer to determine if the vegetation is established in accordance with the Evapotranspiration Cover Design Report. The performance specification for the vegetation layer is summarized herein:

- Vegetative Coverage – The vegetative coverage specification is based upon a demonstration of a satisfactory population of mature plants belonging to the *Aristida* and/or *Sporobolus* genera covering no less than 10% of the ET final ground cover area with no more than 50% bare areas larger than one square meter without a matured vegetative species.
- Root Penetration – The minimum root depth required of 12” is based on achieving 10% vegetative cover entirely comprised of *Aristida* and/or *Sporobolus* species as an input parameter for completing the UNSAT-H model demonstration. This root

depth will ensure that these two grass species are established and will survive drought conditions.

5.5. Documentation

5.5.1. Final Cover System Evaluation Report (FCSER)

Following the installation of the ET cover system, a Final Cover System Evaluation Report will be submitted certifying that the ET soils were constructed in accordance with the construction methods and test procedures in the Final Cover Quality Control Program. The FCSER will be signed and sealed by a Professional Engineer in the State of Texas and include, at a minimum:

- Completed report forms required by TCEQ
- Summary of construction activities
- Summary of the initial installation of vegetation
- Summary of all laboratory and field test results
- Drawings showing sample and test locations
- Field and laboratory test results
- As-built drawings
- A description of significant construction problems and the resolution of these problems
- A statement of compliance with the Final Cover Quality Control Program

The Final Cover Evaluation Report will be signed and sealed by the Professional Engineer, signed by the site operator, and submitted to the MSW Permits Section of Waste Permits Division of the TCEQ for acceptance. Upon acceptance of the Final Cover Evaluation Report, the vegetation establishment period will begin as noted in the Vegetation Establishment Verification Plan. After the acceptance of the Final Cover Evaluation Report and during the vegetation establishment period, the applicant will request closure of the site in accordance with this Report. Since the vegetation establishment period timeframe is 2 to 3 years, closure of the site will occur prior to the completion of the vegetation establishment period.

5.5.2. *Vegetation Establishment Verification Report*

At the end of the vegetation establishment period, a Vegetation Establishment Verification Report will be completed as described in the Vegetation Establishment Verification Plan. A quarterly report will be submitted to TCEQ during the vegetation establishment period. The quarterly report will include the status of vegetation

establishment activities (fertilizer application, watering, reseeding, etc.) and any other activities that are related to installed final cover or vegetation

The Vegetation Establishment Verification Report will be prepared and submitted to TCEQ for approval at the end of the vegetation establishment period. The report will be prepared by a Texas Licensed Professional Engineer and include the following:

- Documentation of the root penetration performance. A hand auger or drive cylinder will be driven at a frequency of every acre within vegetative cover areas consisting of *Aristida* and/or *Sporobolus* species to a depth of 12 inches to determine and verify the rooting depth. In addition, each core obtained will be examined by the certifying engineer to observe that the *Aristida* and/or *Sporobolus* roots are denser in the upper portion of the soul profile and extend to 12 inches in depth. Each sample location will be shown on design drawings.
- Documentation that the percent vegetative cover is in accordance with the ground cover and bare area determination procedures included in this plan. This documentation will include the engineers' assessment of the vegetation cover and photographs that document compliance with the performance specification.
- The certifying engineer will also provide a statement indicating that the vegetation layer of the ET final cover system has been maintained consistent with the parameters used in the UNSAT-H analysis.

6. Schedule for Closure Activities

The landfill closure schedule and other closure related activities shall follow the requirements of Title 30 TAC §330.457(f) and (g).

6.1. Closure Schedule

Title 30 TAC §330.457(e)(4)

An overall timetable for the closure of the Fort Bliss MSWLF is presented following this section. This schedule is based on the current BRAC realignment process at Fort Bliss and the regulatory closure requirements described in subsequent sections.

6.2. Final Contour Map

Title 30 TAC §330.457(e)(5)

A final contour map depicting the proposed final contours, top slopes, and side slopes, and proposed surface drainage features is provided as Sheet 3 in Appendix B of the permit modification application. The MSWLF is not within a 100-year flood plain.

6.3. Location of Plan

Title 30 TAC §330.457(f)(1)

Fort Bliss DPW-ENV shall maintain a copy of the closure plan in the operating record.

6.4. Written Notification

Title 30 TAC §330.457(f)(2)

No later than 45 days prior to the initiation of closure activities for any area or final closure of the facility, Fort Bliss shall provide written notification to the Executive Director of the intent to close the unit or facility and place this notice of intent in the operating record.

No later than 90 days prior to the initiation of a final facility closure, Fort Bliss 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 following information:

- Facility Name
- Facility Address
- Physical Location of the Facility
- The Permit Number
- Last Date of Intended Receipt of Waste.

6.5. Start of Final Closure Activities

Title 30 TAC §330.457(f)(3)

Fort Bliss shall begin final closure activities for each unit or facility no later than 30 days after the date on which the unit or facility receives the known final receipt of wastes or, if the unit or facility has remaining capacity and there is a reasonable likelihood that the unit or facility 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 Fort Bliss has taken and will continue to take all steps necessary to prevent threats to human health and the environment from the MSWLF.

6.6. Completion of Final Closure Activities

Title 30 TAC §330.457(f)(4)

Fort Bliss shall complete final closure activities for the unit or facility in accordance with the approved final closure plan within 180 days following the initiation or final closure activities. A request for an extension for the completion of final closure activities may be submitted to the Executive Director 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 MSWLF unit.

6.7. Certification

Title 30 TAC §330.457(f)(5)

Following final closure of the MSWLF unit or facility, the owner or operator shall submit to the Executive Director for review and approval a Final Cover System Evaluation Report (FCSER), a Vegetation Establishment Report, signed by an independent licensed professional engineer, verifying that final closure has been completed in accordance with the approved final 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.

6.8. Inspection Report

Title 30 TAC §330.457(f)(6)

Following receipt of the required final closure documents, as applicable, and an inspection report from the commission's district office verifying proper closure of the MSWLF unit or facility according to the approved final closure plan, the executive director may acknowledge the termination of operation and closure of the unit or facility and deem it properly closed.

6.9. Affidavit to the Public

Title 30 TAC §330.457(g)

Upon notification to the executive director, Fort Bliss 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 on closing for specific unit(s) or the entire facility and the prohibition against further receipt of waste materials after the stated date.

Within 10 days after completion of final closure of the MSWLF unit or facility, Fort Bliss shall submit to the executive director a certified copy of an "Affidavit to the Public" in accordance with the requirements of Title 30 TAC §330.19 and place a copy of the affidavit in the operating record. In addition, a certified notation of the deed to the facility property, or on some other instrument that is normally examined during title search, needs to be recorded. This is intended so that in perpetuity any potential purchaser of the property is notified that the land has been used as a landfill facility and use of the land is restricted.

Post-closure care maintenance specified in Title 30 TAC §330.463(b) (relating to Post-Closure Care Requirements) shall begin immediately upon the date of final closure as approved by the executive director.

6.10. Post-Closure Care

Following the professional engineer certification of the completion of closure as accepted by the Executive Director of the TCEQ Waste Permits Division, Fort Bliss DPW-ENV shall commence the 30-year post-closure care period. A Vegetation Establishment Report shall be submitted semi-annually during the cover vegetation start-up period indicating the type and quantity of vegetation established, the percent vegetative cover, and the vegetative root structure. If the type or quantity of vegetation or root structure does not meet specifications, then corrective action shall be taken to improve the vegetation consistent with the ET final cover design. Post-closure care requirements are discussed in the *Post Closure Plan.*

7. Closure Cost Estimate

Title 30 TAC §330.63(j)

As an agency of the Federal Government, Fort Bliss is not required to complete financial assurance mechanism requirements. Therefore, a closure cost estimate is not required per Title 30 TAC §37.8001.

FACILITY SURFACE WATER DRAINAGE REPORT

FORT BLISS FINAL CLOSURE DESIGN AND PERMIT MODIFICATION APPLICATION BLISS-A10-001

Revised March 19, 2012

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FACILITY SURFACE WATER DRAINAGE REPORT

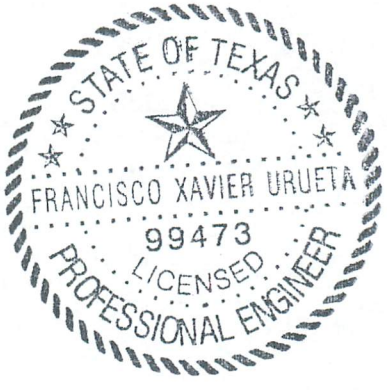
FORT BLISS MUNICIPAL SOLID WASTE LANDFILL FINAL CLOSURE DESIGN AND PERMIT MODIFICATION APPLICATION FORT BLISS, TEXAS

Zia Project No. BLISS-A10-001

Prepared for:
U.S. Army Corps of Engineers, Fort Worth District
819 Taylor Street
Fort Worth, Texas 76102

Prepared and Certified by:
I attest that this Report has been prepared in accordance with good engineering practices, including consideration of applicable industry standards, and with the requirements of Title 30 TAC §330.303. This document is released for the purpose of review. It is not to be used for construction or bidding purposes.

Certifying Engineer:	Francisco X. Urueta
State:	Texas
Registration Number:	99473
Signature:	
Certification Date:	3-16-12
Engineers Seal:	



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1.0 INTRODUCTION

The Fort Bliss Municipal Solid Waste Landfill (MSWLF) includes active Subtitle D Type I and Type IV landfill cells that are currently in use to serve the United States Army Air Defense Artillery Center and Fort Bliss area. Permitted types of solid wastes disposed of at the Fort Bliss MSWLF are non-hazardous solid waste from military operations, bulky items, grass and tree trimmings, refuse from litter cans, construction debris, classified waste (dry), dead animals, Regulated Asbestos Containing Material (RACM), and empty oil cans (1-quart and 5-gallon sizes). The MSWLF does not receive hazardous waste nor does it recover incoming waste.

The landfill area is comprised of five distinct areas:

- 1970's-era inactive cells that cover approximately 80-acres that are considered closed.
- An approximately 3-acre Type I cell with final cover in place (non-Subtitle D) that complies with the 1995 closure plan and TCEQ requirements.
- An approximately 10.5-acre Type I active cell meeting Subtitle D requirements (Subtitle D Cell).
- An approximately 5-acre Type IV construction and demolition (C&D) debris cell.
- Approximately 7 acres designated for landfill roads, access areas, guard shack/scale house, etc.

This Facility Surface Water Drainage Report has been completed to meet the requirements of Title 30 of the Texas Administrative Code Chapter 330.63(c) (30 TAC §330.63(c)) as part of the final closure and permit modification application for an alternative cover design and grading plan. This report was developed from the March 2009 Facility Surface Water Drainage Report by updating it to reflect the changes resulting from the alternative cover design and grading plan. This report replaces the March 2009 Facility Surface Water Drainage Report. This report illustrates that the proposed modification does not adversely alter the existing (permitted) drainage patterns and that these drainage patterns can be retained for the modification.

This report also serves as the surface water drainage report required by 30 TAC § Subchapter G. The facility design complies with the requirements of 30 TAC § 330.303 relating to management of run-on and runoff. The surface water drainage analysis for the Fort Bliss MSWLF is presented in Section 2. An Erosion and Sediment Control Plan is included in Section 3. Section 4 presents the maintenance and inspection requirements.

1.1 General Geology and Soils

The Fort Bliss MSWLF is underlain by Hueco Bolson deposits of tertiary age and typically are composed of unconsolidated to slightly consolidated interbedded sands, clay, silt, gravel, and caliche. Individual beds are not well defined and range in thickness from a fraction of an inch to about 100 feet. The general geology and soils details for the MSWLF site are provided in Attachment 6 of this report.

1.2 General Climate and Weather

The MSWLF is located in west Texas where desert conditions exist; therefore, surface water flow near the MSWLF is limited. Maximum daytime summer temperatures range between 90 and 105 degrees Fahrenheit (°F) and winter temperatures range from 55 to 60°F. The surrounding area receives less than 10 inches of rain per year and relative humidity is very low. Depending upon the intensity and duration of each precipitation event, the water delivered by the occurrence may infiltrate into the soil or become surface runoff. The infiltrated water may percolate downward to the water table or return to the atmosphere via evapotranspiration.

1.3 Surface Water Bodies

No surface water bodies exist at or near the MSWLF. All surface water runoff from the landfill will flow in the direction of the stormwater retention basin located approximately 2 miles south of the landfill, north of Fred Wilson Boulevard. The volume of runoff originating from the landfill and ultimately discharging to this retention basin will be dependent on the magnitude of the storm event and losses due to infiltration and evaporation along the 2 mile flow path. As demonstrated in Section 2.4, the proposed alternative cover design and grading plan will not significantly alter the peak discharges, runoff volumes, average flow depths, average flow velocities and discharge locations. Therefore, there will be no negative impact to the retention basins capacity, maintenance requirements, and outlet discharge. This storm water retention basin is located on the Fort Bliss Military Reservation and is managed by the Fort Bliss Storm Water Pollution Prevention Team. Structural control measures to reduce sediment are described in the 2011 Storm Water Pollution Prevention Plan (Attachment 5). Further discussion on the surface water drainage and erosion and sedimentation controls are given in Sections 2 and 3 respectively.

2.0 FACILITY SURFACE WATER DRAINAGE ANALYSIS

The final grading/drainage plan for the approximately 106 acre landfill was modified to incorporate the reduced cover design and provide more easily constructible ridges, swales and slopes than provided in the previous (2009) permit modification. However, the drainage concept remains consistent with the previously approved site plans and consists of mostly overland and shallow concentrated flows leading off the landfill side slopes. Swales provide flow paths for internal watersheds to the perimeter. There are four pairs of drainage swales located along the edges of the access roads entering the site form the north, east, and west. Surface water runoff flows off the landfill into shallow perimeter drainage ditches that discharge to the natural flow patterns of the surrounding area. In general, the perimeter drainage ditches discharge to the natural surrounding topography at the northwest, southwest and southeast corners of the landfill as shown on Sheet C-3 of Appendix D (Design Drawings) of the permit modification. These existing off-site discharge locations and contributing drainage areas will not significantly change as a result of the alternative cover design and grading plan. Therefore, the surrounding drainage patterns will not be adversely altered as a result of this alternative cover design and grading plan.

A hydrologic and hydraulic analysis was conducted on the final grading plan, shown on Sheet C-2 in Appendix D (Design Drawings) of the permit modification. The analysis incorporates the proposed alternative cover design and grading modifications to estimate the peak discharge and run-off volumes associated with the 25-year, 24-hour design storm event as required in 30 TAC §330.305I. The runoff volumes and peak discharges show that the drainage is not adversely affected and that the previously designated storm water control features (i.e. landfill drainage swales down the side slopes) remain adequate.

Appendix D (Design Drawings) of the permit modification application provides the drainage areas, cross-sectional areas, and swale grades used in the analysis.

Per the *TCEQ Guidelines for Preparing a Surface Water Drainage Report for a Municipal Solid Waste Facility* (RG-417), the Rational Method described in Chapter 5, Section 6 of the Texas Department of Transportation's Hydraulic Design Manual (TxDOT 2004) was used to calculate the peak discharge flows. Use of USDA Natural Resources Conservation Service (NRCC) Technical Release 55 (TR-55) method has been approved by the Texas Commission on Environmental Quality (TCEQ) Executive Director for the calculation of the runoff volumes. The values for runoff volume, peak discharge, and flow velocity calculated in this analysis are used to design the erosion and sediment controls and to confirm that the existing drainage patterns for the landfill will not be adversely affected because of these modifications.

2.1 Runoff Volume

The volume of runoff from the landfill cover is dependent on the anticipated amount of precipitation and potential abstractions (principally infiltration) which depend on the soil type, vegetative cover, and the hydraulic conditions of the soil and proposed cover material.

EVAPOTRANSPIRATION COVER DESIGN REPORT

FORT BLISS DESIGN AND PERMIT MODIFICATION APPLICATION BLISS-A10-001

Revised March 2012

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INTRODUCTION

The purpose of report is to present the approach and methodologies used during the design of the proposed evapotranspiration (ET) final cover system for the Fort Bliss Municipal Solid Waste Landfill (MSWLF). The MSWLF consists of the following distinct areas:

- An active 10.5-acre Type Subtitle D Cell
- A closed 3-acre Type 1 Non-Subtitle D cell (TCEQ closure approval received February 24, 1999)
- An active 5-acre Type IV C&D cell
- Approximately 80 acres of previously filled and closed areas
- Approximately 7 acres designated for landfill roads, access areas, and guard shack / scale house, etc.

Based on capacity estimations performed by Zia Engineering and Environmental Consultants (Zia) and current disposal rates provided by the Fort Bliss Environmental Division, the Subtitle D cell is expected to reach its capacity in the second quarter of FY 2012. At that time, the Subtitle D cell will be closed, followed shortly thereafter by the Type IV C&D cell. The permitted closure design for the Subtitle D Cell, the C&D Cell, and the previously filled and closed areas includes an 18 inch thick prescriptive layer with low permeability soil (i.e. clay) that is not readily available in the area and would need to be imported at a considerable expense.

The purpose of the proposed ET final cover system is to create a more cost-effective and sustainable landfill cover alternative that is equally protective of human health and the environment as the prescriptive closure design. The proposed ET cover system will utilize readily available fill material located on-site to create a layered soil cover designed to optimize water storage and evapotranspiration. This report discusses the feasibility and preliminary design requirements of an ET cover system at Fort Bliss and presents a demonstration of its performance.

The proposed ET cover system was designed in accordance with the draft Texas Commission on Environmental Quality (TCEQ) document Guidance for Requesting a Water Balance Alternative Final Cover for a Municipal Solid Waste Landfill (guidance document), revised November 17, 2010.

FEASIBILITY

According to the United States Environmental Protection Agency Fact Sheet on Evapotranspiration Cover Systems for Waste Containment, evapotranspiration cover systems are increasingly being considered for use at waste disposal sites in arid regions when equivalent performance to conventional final cover systems can be demonstrated. The TCEQ Municipal Solid Waste (MSW) Permitting Program uses a 25-inch average annual precipitation line as defined by 30 TAC §330.5(b)(1)(D) to delineate areas of the State defined as arid. El Paso lies to the west of the 25-inch average annual precipitation line and therefore has been deemed arid for considering alternative landfill designs. Additionally, over 60% of the precipitation in the El Paso region is received during the growing season, between March and August.

Numerous species of indigenous herbaceous and vascular vegetation inhabit the native soils at Fort Bliss. As such, the utilization of local soils stockpiled on-site and native plant species bodes well for the successful performance of an ET cap. Additionally, a balanced seed design of both herbaceous and vascular native plants has been chosen in an effort to promote and sustain evapotranspiration throughout the year.

During preliminary research, Malcolm Pirnie (MP) found that the Interstate Technology and Regulatory Council (ITRC) document titled Technical and Regulatory Guidance for Design, Installation, and Monitoring of Alternative Final Landfill Covers (December 2003) states that a range of 75%-85% compaction is best for ET cover systems. Hydraulic laboratory testing of the native material stockpiled on-site at 75% and 80% compaction was performed in December of 2008 by AMEC and indicates adequate water retention and saturated hydraulic conductivity parameters for use in an ET cover system, with a plant-available water content (difference between water content at field capacity and at wilting point) of 0.3. Additionally, a substantial portion of the landfill area currently contains in excess of 1.5-feet of interim cover material that will be incorporated into the ET cover system as supplemental intermediate cover material.

DESCRIPTION OF PROPOSED DESIGN

The proposed ET cover system, shown in **Figure 2**, will consist of a 3.5-foot layered soil cap and include the following components (from top of cover to top of waste):

- 12-inch thick Vegetative Surface Layer, consisting of stock-piled Silty Sand (SM) or Clayey Sand (SC) or any combination thereof compacted to 75% of the Modified Proctor maximum dry density and seeded. The Vegetative Surface Layer will serve as a medium for seed germination and plant growth as well as provide protection against erosion and desiccation.
- 12-inch thick Storage Layer, consisting of stock-piled SM or SC material or any combination thereof also compacted to 75% of the Modified Proctor maximum dry density (ASTM D 1557). The Storage Layer will provide approximately 11.3 cm of storage volume during wet weather periods to promote deep root growth while limiting infiltration to the underlying Capillary Break and Intermediate Cover materials.
- 6-inch thick Capillary Break Layer, consisting of well-graded, fine to coarse grained sand. Installation of the Capillary Break Layer will allow the fine-textured soil of the Storage Layer to store more water than a comparable layer without the capillary break due to the difference in the hydraulic conductivities of the two layers. The additional water stored within the Storage Layer will help promote the establishment and development of the surface vegetation. The increased vegetative cover will contribute to greater ET and reduce surface erosion from both wind and rain.
- 12-inch thick Intermediate Cover Layer, consisting of existing cover material and/or additional stock-piled SM or SC material or any combination thereof compacted to approximately 75% of the Modified Proctor maximum dry density (ASTM D 1557). The Intermediate Cover Layer will provide approximately 11.3 cm of additional water retention storage volume.

COMPUTER MODELING

The performance of the proposed ET cover system was predicatively modeled using UNSAT-H version 3.01 software, which is managed by the Hydrology Group at the Pacific Northwest National Laboratory. UNSAT-H is a one-dimensional model that simulates soil water infiltration, redistribution, evaporation, plant transpiration, and deep drainage. UNSAT-H is commonly used to evaluate and optimize performance of barrier designs. The following sections summarize input parameters, the source of those parameters, and major assumptions made in modeling the proposed ET cover system.

Options, Constants, and Limits

The input parameters noted below define the modeling period, the components of groundwater flow to be modeled, and the solution methods.

- IPLANT: The plant option was selected to include plants, as transpiration will be a critical component of the performance of the proposed ET cap system.
- NGRAV: The model was given a vertical orientation to model vertical infiltration through the proposed ET cap system
- IFDEND, IDTBEG, and IDTEND: The ending day of the simulation and the number of days that weather data was provided annually was set at 365.
- IYS and NYEARS: The model was set to run for a 30-year period. The first year of the simulation was set as 1981.
- ISTEAD: The model was set to solve in transient mode, utilizing variable historical weather data.
- NPRINT: The level of output was set for end of day and end of simulation summaries.
- ISMETH: The Crank-Nicholson solution method was specified based on guidance from the Pacific Northwest National Laboratory.
- KOPT: Soil hydraulic properties were defined by the van Genuchten parameters.
- KEST: The arithmetic mean was selected to calculate liquid conductivity at the midpoint between nodes.
- ITOPBC and LOWER: A flux surface boundary and unit gradient lower boundary condition was specified.
- IEVOPT and NFHOUR: The evaporation option was selected as evaporation will be a critical component of the performance of the proposed ET cap system. The option to generate hourly factors from a sine wave function for distribution of daily potential evapotranspiration was selected to calculate the surface boundary condition.
- HIRRI and HDRY: Minimum and maximum heads to which the soil can wet up and dry out were defined as 1 and 1 x 10^6 cm, respectively.
- RHA, IETOPT, ICLOUD, and IRAIN: Daily meteorological data from the National Oceanic and Atmospheric Administration (NOAA) was provided for the model.

Daily solar radiation values were synthetically generated using the Hydrologic Evaluation of Landfill Performance (HELP) model. Average relative humidity was also obtained from the HELP model for the El Paso, Texas region.

- IHYS and IHEAT: Hysteresis and heat flow were not simulated.
- IVAPOR: The option to model vapor flow was selected. Fayer and Gee (2004) have documented that vapor flow is a necessary process to be included in simulations of drainage in sandy soil in arid and semiarid climates.
- MATN: Four soil layers were modeled, as previously described in the Description of Proposed Design section.

Soil Property Information

The Natural Resources Conservation Service soil survey of the landfill site shows that two soil types exist across the Fort Bliss landfill site. One is a Hueco loamy fine sand down to 30" below grade (approximately 30% of the area) and the other a Copia-Nations complex fine sandy loam down to 30" below grade (approximately 70% of the area). Soil samples were collected in April of 2009 from the stockpiled material on-site for hydraulic laboratory testing by TRI Environmental Inc. in order to evaluate the water retention and saturated hydraulic conductivity parameters. The design of the ET cover system was based on the hydraulic properties of this soil sample of on-site material, which was collected from multiple locations within the landfill boundaries. Given the composite makeup of the laboratory sample, it is believed to be generally indicative of a blend of the two soil types on-site and therefore representative of the gradation and hydraulic performance of the existing on-site soils.

The sieve analysis of the composite soil sample indicated that the soil classifies as silty sand (SM) in accordance with ASTM D 2487. Additional site-specific sieve analysis data from 2008 was reviewed and confirmed that existing on-site soils are classified as silty sands (SM), clayey sands (SC), or other combinations thereof. The EPA published UNSODA Unsaturated Hydraulic Database (Leij, Alves, and van Genucthen, August 1996) indicates that soils that fall within similar USCS Classifications can be expected to perform similarly from a hydraulic standpoint.

The ITRC states that a range of 75%-85% compaction is best for ET cover systems. As such, the soil was prepared at 75% of the Modified Proctor (MP) maximum dry density (ASTM D 1557) for laboratory testing. The 75% compaction material was specified for the surficial Vegetative Surface Layer to promote vegetative growth, for the Storage Layer to increase water retention capacity, and the Intermediate Cover Layer to conservatively estimate the existing conditions of the interim cover material. Compaction requirements were based on the Modified Proctor maximum dry density to more accurately simulate compaction of the landfill area by modern construction equipment and methods. It should be noted that, due to the low fines content of the available fill on-site, minimal variance (i.e. 5%) between the Standard and Modified Proctor maximum dry densities is expected. As such, estimated equivalent compaction requirements based on the Standard Proctor maximum dry density (i.e. 80%) can be specified as well. Hydraulic properties of the Capillary Break Layer were estimated using typical parameter values of van Genuchten models for sand from Leij, Alves, and van Genuchten (1996).

The Mualem-van Genuchten conductivity model was used with an exponent of the pore interaction term of 2, as recommended in the UNSAT-H User's Manual. The hydraulic properties of the proposed ET cover system materials are summarized below. Laboratory data is included in Appendix A.

Layers 1 and 2 – Stockpiled SM/SC Material at 75% MP Compaction Density

- THET - Saturated water content: 0.372
- THTR – Residual water content: 0.1025
- VGA – Van Genuchten α coefficient: 0.020
- VGN - Van Genuchten n coefficient: 1.560
- SK – Saturated hydraulic conductivity: 0.504 cm/hr (1.4×10^{-4} cm/sec)

Layer 3 – Capillary Break Layer of Well-Graded Clean Sand

- THET - Saturated water content: 0.43
- THTR – Residual water content: 0.045
- VGA – Van Genuchten α coefficient: 0.145
- VGN - Van Genuchten n coefficient: 2.68
- SK – Saturated hydraulic conductivity: 29.7 cm/hr (8.25×10^{-3} cm/sec)

Layer 4 – Stockpiled SM/SC Material and Regraded Intermediate Cover Material at 75% MP Compaction Density

- THET - Saturated water content: 0.372
- THTR – Residual water content: 0.1025
- VGA – Van Genuchten α coefficient: 0.020
- VGN - Van Genuchten n coefficient: 1.560
- SK – Saturated hydraulic conductivity: 0.504 cm/hr (1.4×10^{-4} cm/sec)

Initial Conditions

Initial suction head values were estimated using the soil water characteristic curves generated during hydraulic laboratory testing. The suction head values, summarized below, assume that the soil will be placed with ±2% of the optimum water content for the given compaction requirements.

- Layer 1 and 2: 1.0×10^{4} cm
- Layer 3: 1.0×10^{2} cm
- Layers 4: 1.0×10^{4} cm

Plant Information

Transpiration will be a contributing component of the performance of the proposed ET cover system. For the purposes of this preliminary ET model, a conservative 10% coverage of vegetative growth over the area was assumed. Vegetative growth of the final design of the proposed ET cover system will consist of a balanced mixture of native herbaceous and vascular plants. Dr. Rafael Corral of the Fort Bliss Environmental Division and Leah Markiewitz with Zia provided an optimum vegetative design to utilize indigenous species of the area such as mesa dropseed and red threeawn.

The plant information for mesa dropseed and red threeawn required for UNSAT-H simulations was not readily available through our research efforts. Due to the difficulty in finding root data, the rooting depth of the indigenous species in our vegetative design was estimated using seasonal cheatgrass data published by Harris (1967). Cheatgrass contains very shallow, fibrous roots which makes it an ideal plant choice for plant growth with a shallow soil depth requirement. The indigenous species mentioned above were chosen due to their similar fibrous roots and fairly shallow growth patterns described through the studies of Robert P. Gibbens and James M. Lenz (2001) at the Jornada Experimental Range in Las Cruces, New Mexico (**Figure 1**). Additionally, these plants extend out horizontally which will allow for additional erosion control (Gibbens & Lenz, 2001) (**Figure 2**). Due to the rooting similarities, our vegetative experts felt using cheatgrass plant information for the purposes of modeling transpiration was a reasonable choice considering the limited plant information available.

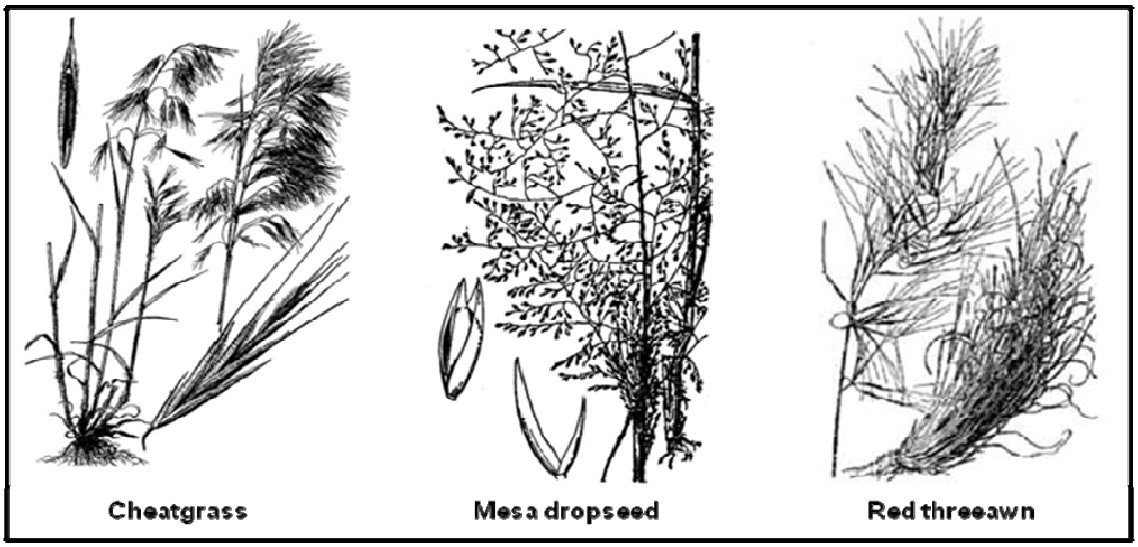

Figure 1: Rooting Depth Comparison

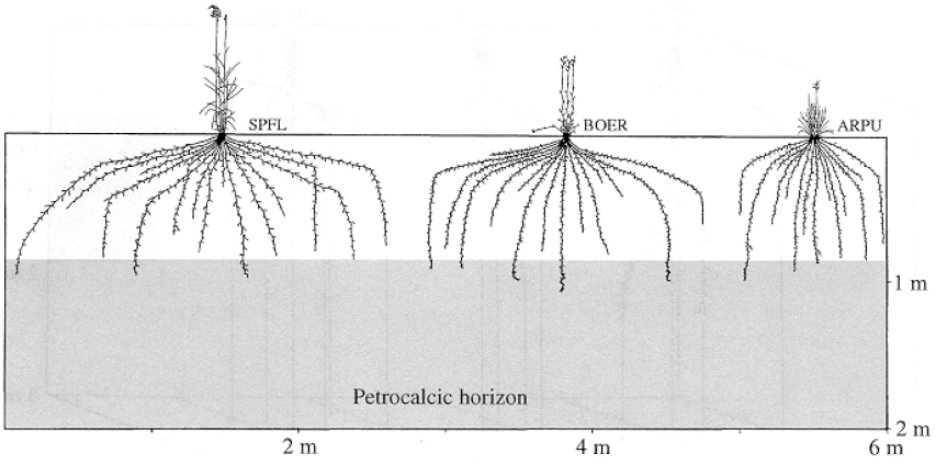

Figure 1. Mesa dropseed and red threeawn rooting system

Potential transpiration and evaporation were generated from empirical cheatgrass data published by Hinds (1975). The HELP model was consulted to define the growing season of the El Paso region, between March and August. The HELP model was also consulted to define the plant water uptake parameters. The influence of landfill gas on vegetative growth was modeled by limiting maximum root growth to within the top 12-inches of the Vegetative Support Layer only.

Boundary Conditions

The boundary conditions required for the model include general site-specific data and daily meteorological data. Daily meteorological input data includes maximum and minimum temperature, dew point, solar radiation, average wind speed, cloud cover, and daily precipitation. Data was obtained for the El Paso International Airport weather station from the National Oceanic and Atmospheric Administration (NOAA). The El Paso International Airport weather station is located approximately 4.4 nautical miles south of the landfill.

DEMONSTRATION OF PERFORMANCE

The TCEQ set two performance criteria for the demonstration of performance of an ET cover system, as summarized below:

- Less than 4 millimeters per year of drainage from the base of the ET cover system
- Modeled runoff less than 10% of the annual water applied.

Table 1 summarizes annual results of the 30-year simulation of the proposed ET cover system. It should be noted that the model is conservative in that transpiration was modeled based on 10% coverage of vegetative growth and incorporates influences of landfill gas. The data presented in **Table 1** demonstrates that the proposed ET cover system meets the TCEQ drainage performance criteria over the 30-year modeling period. Furthermore, the model's performance over years 24 through 28, which on average received 40% more precipitation than the annual average, demonstrate the ability of the proposed cover system to perform under variable weather conditions. The runoff ratio exceeds the TCEQ Performance Criteria of 10% by 1% during the floods of 2006, but it should be noted that 2006 was the wettest year on record in the El Paso region.

Figure 3 shows the annual storage requirement of the proposed ET cover system compared to the available storage capacity of the cover system design. It can be seen that the annual storage requirement never exceeds 53% of the overall storage capacity.

The sensitivity of the model was evaluated by varying input parameters, including time-stop factors; initial suction head conditions, and solution types. To verify the assumption that soils that fall within similar USCS Classifications can be expected to perform similarly from a hydraulic standpoint, van Genuchten parameters were back-calculated from the 2008 on-site sieve analysis data by methods published by Aubertin (2003) and compared to the laboratory-reported composite sample values. Additionally, estimates of typical unsaturated hydraulic properties for similar soil textures reported in the UNSODA manual were considered for consistency verification. All referenced values were of the same order of magnitude as the laboratory-reported data, indicating that the on-site soils can be expected to perform similarly. Layer thicknesses were also varied in order to develop the proposed cover system design. The

laboratory reported the gradation and hydraulic properties of the composite on-site soil for varying compaction rates in an effort to identify the optimal ET cover section and compaction requirements. Therefore, quality control and quality assurance (QA/QC) testing requirements prior to and during the final landfill closure construction were focused on the gradation, hydraulic properties (saturated hydraulic conductivity, saturated water content, residual water content), and compaction of the ET final cover soil to ensure that the ET final cover will be constructed in accordance with the design intent to maximize ET performance.

Once the optimum layer thickness and compaction requirements were determined, additional simulations were run at varying compactions and van Genuchten to identify a range of acceptance during construction (Additional simulations for compaction range are attached as Appendix E). Parameter values of native soil were interpolated using known data for 75% and 80% compaction and simulations were run at 73% and 77% compaction (Interpolation results are attached). Results for 73% compaction consistently meet drainage Performance Criteria and meet the runoff Performance Criteria in 26 of the 30 years. Results for 77% compaction meet drainage Performance Criteria in 28 of the 30 years and meet the runoff Performance Criteria in 29 of the 30 years. Additional simulations also showed an acceptable saturated hydraulic conductivity on the range of from 10E-4 to 10E-5, a minimum saturated water content of 0.34 and a maximum residual water content of 0.12. These results provide significant confidence in the performance of the cap over a ±2% compaction range. QA/QC procedures requiring the evaluation of material prior to use and compaction testing after placement on the cap will ensure native soil used in the construction of the ET Cap meets the requirements set forth in this document.

The performance of the cover system design presented in this Preliminary Design Report was determined to be stable with respect to variable non-boundary condition and/or initial condition input parameters. The design-specific input parameters were conservatively developed to accurately portray the anticipated conditions during the construction and performance of the cover system.

ATTACHMENTS

Table 1 – Proposed ET Cover System Performance Demonstration Summary

Figure 2 – Schematic of Proposed ET Cover System
Figure 3 - Storage Requirement / Capacity Comparison

Appendix A - UNSAT-H Input File
Appendix B - UNSAT-H Output Data
Appendix C - Hydraulic Parameter Lab Testing Data
Appendix D - Meteorological Data
Appendix E –Additional UNSAT-H Simulations