Part III
Attachment III-D
Appendix III-D.8

ALTERNATIVE FINAL COVER DEMONSTRATION

Pescadito Environmental Resource Center
MSW-2374
Webb County, Texas

PESCADITO
ENVIRONMENTAL RESOURCE CENTER

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Prepared for:
Rancho Viejo Waste Management, LLC
1116 Calle del Norte
Laredo, TX 78041

Prepared by:
CB&I Environmental and Infrastructure, Inc.

12005 Ford Rd, Suite 600
Dallas, TX 75234

9-18-2015

STATE OF TEXAS
MICHAEL W. ODEN
67165
REGISTERED PROFESSIONAL ENGINEER

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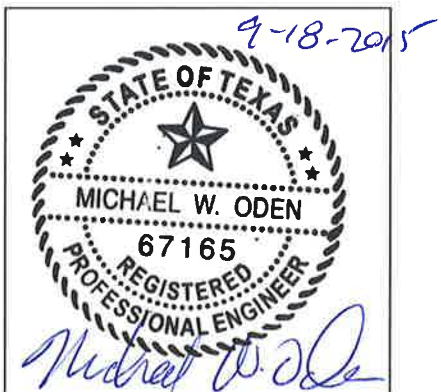

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1.0 INTRODUCTION

A water balance (WB) alternative final cover system (AFC) is proposed to be used at the Pescadito Environmental Resource Center (PERC) (MSW No. 2374). This final cover will consist of an erosion control layer and infiltration layer that provide the capacity to store water until it can be removed through evaporation and transpiration. This ability to store water within the final cover minimizes percolation or infiltration of stormwater into underlying waste material, thereby reducing the volume of leachate generated at the facility. Vegetation or other appropriate material will be established on top of the erosion control layer to minimize soil loss but has not been utilized in the model to reduce infiltration.

Type I Landfills are typically designed with compacted clay liners (CCL) and geomembrane barrier layers. This document presents the design of the AFC and a demonstration that this design provides equivalent performance to a CCL/geomembrane final cover configuration based on standards recognized by the TCEQ. This final cover system has been designed in accordance with 30 TAC 330.457(d) and TCEQ's "Guidance for Requesting a Water Balance Alternative Final Cover for a Municipal Solid Waste Landfill" (Revised January 27, 2012).

Pursuant to 30 TAC 330.457(d), an AFC may be approved if it meets the following performance standards:

1. The final cover achieves an equivalent reduction in infiltration as a clay-rich soil cover layer specified in 30 TAC 330.457(a)(1) and (2)
2. The final cover provides equivalent protection from wind and water erosion as the erosion layer specified in 30 TAC 330.457(a)(3)

2.0 ALTERNATE FINAL COVER SYSTEM DESIGN

This proposed AFC will consist of the following layers, as shown on drawings provided in **Appendix III-D.3**:

- Vegetation (or other appropriate material)
- 7 inch thick erosion layer.
- 30 inch thick infiltration layer

Vegetation or other appropriate material will be used to minimize erosion, slow stormwater velocities, and provide transpiration of the AFC. The erosion layer serves to protect the infiltration layer and shed water from the waste mass. The infiltration layer is used to temporarily store atmospheric waters prior to evapotranspiration in order to minimize infiltration into the waste mass, as all infiltrated waters must be handled as leachate.

It is noted that the TCEQ requires a minimum thickness of 6 inches for the erosion control layer. However, an additional inch was added to account for erosion loss, as further described in **Appendix III.C**. The purpose of the infiltration layer is to store moisture that percolates through the erosion control layer until it can be removed through evaporation and transpiration.

Due to the fact that vegetation is not required for infiltration control and is solely for erosion and stormwater velocity control, a detailed planting plan typically associated with transpirative properties is not necessary. However, plantings are anticipated to be selected based on climatic and regional consideration with input drawn from the U.S. Department of Agriculture's publications on local and county soil and vegetation types. A coverage rate of 70 percent will be targeted.

3.0 EQUIVALENCY DEMONSTRATION REQUIREMENTS

TCEQ regulations at 330.457(d) states "(d) The executive director may approve an alternative final cover design that:

> *"(1) a cover achieves an equivalent reduction in infiltration as the clay-rich soil cover layer specified in subsection (a)(1) or (2) of this section; and"*

HELP models were developed to simulate an approximately 3-foot thick water balance soil cover (AFC) and to determine the infiltration through the AFC. Models were based on properties of available on-site soil materials. For the purpose of analyzing the AFC, models were run for bare ground, i.e., Leaf Area Index (LAI) = 0 and also for very minimal vegetation, i.e., LAI=1.0 to demonstrate the impacts of even very small amounts of vegetation on the water balance. Bare ground models rely solely on evaporation and storage in the erosion and infiltration layers. These models are shown as AFC_WB13 (III-D.8-1A) and AFC_WB19 (III-D.8-1B) in **Appendix III-D.8-1**. The AFC modeling shows an equivalent or greater, reduction in infiltration as the clay-rich soil cover layer specified in 330.457(d)(1). To illustrate the equivalency, two models of the prescriptive final cover were run. The first model matched the prescriptive final cover specified in 330.457(d). This model is included in **Appendix III-D.8-1** as PRE_FC3 (III-D.8-1C). The second prescriptive cover model used the more common configuration of a composite final cover recognized by TCEQ which has the FML over the infiltration layer. This model is included as PRE_FC4 (III-D.8-1D).

4.0 SOIL LOSS DUE TO EROSION

TCEQ has dictated in 30 TAC § 330.305(e) that the proposed surface water protection and erosion control practices must maintain low non-erodible velocities, minimize soil erosion losses below permissible levels, and provide long term, low maintenance geotechnical stability to the final cover. In addition, 30 TAC § 330.305(d) (2) states that the applicant must provide adequate data demonstrating that the top surfaces and embankment slopes of the landfill units shall be designed to minimize erosion and soil loss through the use of appropriate side slopes, and other structural and non-structural controls, as necessary. Soil loss due to erosion for the top surfaces and embankment slopes of final cover has been calculated using the NRCS Universal Soil Loss Equation.

A soil loss evaluation was completed using the Universal Soil Loss Equation and found to be less than 3 tons/acre/year. Peak velocities along the cover were evaluated and found to be at nonerodible rates (less than 5 ft/sec). In addition, all final landform stormwater management controls have been evaluated and found to provide adequate performance for conveying the 25-year, 24-hour and 100-year, 24-hour storms without overtopping or producing erodible velocities. Please refer to **Attachment III-C** for these evaluations.

A geotechnical stability analysis was conducted for the facility using the AFC configuration. Demonstration that the AFC is stable for the long-term conditions is provided in **Appendix III-D.5**.

5.0 HELP MODEL

The USEPA Hydrologic Evaluation of Landfill Performance (HELP) Model version 3.07 was selected to model the AFC. The program was developed by the U.S. Army Engineer Waterways Experiment Station (WES) to conduct water balance analysis of landfills, cover systems and solid waste disposal and containment facilities. The HELP model is an unsaturated flow, water balance model that uses site-specific climate, soil and design data to simulate landfill conditions over a specified time period.

The HELP 3.07 Model is a water storage routing-based model for unsaturated flow. The HELP model uses historical data, weather generation, or the manual input for the precipitation data. The SCS curve number or modified SCS curve number methods are used for calculating runoff. The model takes into account vertical drainage and/or lateral drainage through the layers. The model also uses inputs regarding solute transport, plant growth, root growth distribution and density. The soil properties for the model can be based on HELP default layers or can be changed to reflect site conditions. The characteristics of the soil layers entered into the model include: thickness, total porosity, field capacity, wilting point, and saturated hydraulic conductivity. Geomembrane properties that are entered into the model area the thickness and the saturated hydraulic conductivity, along with parameters relating to the installation quality of the geomembrane.

5.1 Input Parameters

The HELP model input parameters for the modeled scenarios are described in the following sections. The input parameters were determined based on the proposed landfill design details, 30 TAC Chapter 330 requirements, site-specific data collected during geotechnical site investigations, local weather data and local industry experience.

5.1.1 Evapotranspiration Data

Evapotranspiration data was generated by HELP from Brownsville, Texas data within the model. Brownsville was selected as the nearest and most representative location of the site from the available locations within the HELP model. The evaporative zone depth was set to thickness of the AFC and the Prescriptive Cover, which are 37 inches and 25 inches respectively.

The leaf area index was set to 1 (poor stand of grass) for AFC_WB13, which would be expected to occur from volunteer vegetation after placement of the soil. The leaf area index was set to 0 (bare ground) in the HELP Model for all other modeled scenarios.

5.1.2 Climate Data

In Laredo, Texas the weather is semi-arid during the summer and mild during the winter. The climate data was synthetically generated using coefficients for Brownsville, Texas. The default temperature and precipitation coefficients were modified by using data obtained from the NOAA

Climate Online Database for the last 45 years (1968-2013) at the weather station located in Laredo, Texas.

Table III-D.8-1: HELP Climate Data Inputs summarizes the precipitation and temperature values input in the HELP model.

Table III-D.8-1:
HELP Climate Data Inputs

Month	Avg Precip (in)	Avg Temp (°F)
1	0.82	56.5
2	0.86	61.0
3	0.88	68.8
4	1.37	76.0
5	2.65	82.0
6	2.68	86.5
7	1.93	87.9
8	2.29	87.9
9	3.09	82.9
10	2.41	75.4
11	1.07	65.5
12	0.91	57.7

5.1.3 Runoff Potential

The closed conditions model assumes a runoff potential for 100% of the surface area, since the final landform will be constructed and maintained to effectively control stormwater runoff and minimize ponding of water on top of the final cover.

5.1.4 Runoff Curve Number

A runoff curve number of 92 was selected to be the same as that used in the Stormwater and Drainage Analysis in **Attachment III.C**.

5.1.5 Soil Layers

Two hydraulic conductivities were evaluated for the erosion layer and infiltration layer of the AFC, the first used hydraulic conductivities of $1x10^{-5}$ cm/sec, which is the same as the prescriptive cover, while the second used hydraulic conductivities of $1x10^{-6}$ cm/sec, which would be achieved through a slight compaction of the soils available on-site. The hydraulic conductivity for each of the prescriptive cover scenarios was modeled at $1x10^{-5}$ cm/sec for both the erosion layer and the infiltration layer. The HELP defaults for Total Porosity, Field Capacity, Wilting Point and Saturated Hydraulic Conductivity were used for each default soil layer.

Although vegetation may be used for erosion control for the AFC, the HELP Model evaluation assumes there will be no planted vegetation on the final cover.

5.1.6 HELP Model Input Summary

The table below summarizes the input values that were entered into the HELP model for the Alternative Final Cover scenario.

Table III-D.8-2: HELP Model Input Parameters				
	AFC Model Runs		Prescriptive Cover Model Runs	
Parameter	AFC_WB13	AFC_WB19	PRE_FC3	PRE_FC4
General Design and Evapotranspiration Data				
Number of Years Modeled	30	30	30	30
Runoff Curve Number	92	92	92	92
Area Allowing Runoff (%)	100	100	100	100
Evaporative Zone Depth (in)	37	37	25	7
Maximum Leaf Area Index	1	0	0	0
Average Annual Wind Speed (mph)	11.6	11.6	11.6	11.6
Erosion Layer				
Layer No.	1	1	1	1
Layer Type	Vertical Percolation (Type 1)	Vertical Percolation (Type 1)	Vertical Percolation (Type 1)	Vertical Percolation (Type 1)
Thickness (in)	7	7	7	7
Hydraulic Conductivity (cm/sec)	$1.0X10^{-5}$	$1.0X10^{-6}$	$1.0X10^{-5}$	$1.0X10^{-5}$
Geomembrane Liner				
Layer No.	N/A	N/A	N/A	2
Layer Type				Flexible Membrane Liner (Type 4)
Thickness (in)				0.06
Hydraulic Conductivity (cm/sec)				$2x10^{-12}$
Infiltration Layer				
Layer No.	2	2	2	3
Layer Type	Vertical Percolation (Type 1)	Vertical Percolation (Type 1)	Vertical Percolation (Type 1)	Vertical Percolation (Type 1)
Thickness (in)	30	30	18	18
Hydraulic Conductivity (cm/sec)	$1x10^{-5}$	$1.0x10^{-6}$	$1x10^{-5}$	$1x10^{-5}$
Geomembrane Liner				
Layer No.	N/A	N/A	3	N/A
Layer Type			Flexible Membrane Liner (Type 4)	
Thickness (in)			0.06	
Hydraulic Conductivity (cm/sec)			$2x10^{-12}$	

5.1.7 HELP Model Results

The results of the HELP model are summarized in the table below. The average annual percolation for the bottom-most layer for each final cover figuration is shown in **Table III-D.8-3**. As can be seen, average annual percolation through either of the AFC configurations is less than either of the prescriptive cover configurations.

Table III-D.8-3: HELP Model Results

Model File Name	Average Annual Percolation	
	in/year	mm/year
AFC_WB13	0.00243	0.061722
AFC_WB19	0.01509	0.383286
PRE_FC3	0.0689	1.744726
PRE_FC4	0.07511	1.907794

6.0 ALTERNATIVE FINAL COVER QUALITY CONTROL PLAN

The AFC will be constructed in accordance with the Final Cover Quality Control Plan (FCQ) found in **Appendix III-D.9**. The FCQPC will provide guidance for the materials, equipment, and construction methods to be used for final cover construction and the cover testing, evaluation and reporting procedures.

7.0 CONCLUSION

In accordance with TCEQ regulations at 330.457(d)(1) both of the AFCs modeled achieve an equivalent reduction in infiltration compared to the two prescriptive cover scenarios modeled. Therefore, the AFC design provides appropriate protection from infiltration and associated leachate generation.

As demonstrated in **Attachment III.C** the proposed surface water protection and erosion control practices will maintain non-erodible velocities and will minimize soil erosion losses to less than 3 tons/acre/year. All final cover and stormwater management controls have been evaluated and been determined to provide adequate performance for all storms up to the 100-year storm without resulting in erodible velocities without adequate erosion protection.

A geotechnical analysis of the AFC has determined that it will function with appropriate factors of safety, as shown in **Appendix III-D.5**.

The AFC will be constructed in accordance with the Final Cover Quality Control Plan (FCQ) found in **Appendix III-D.9**. The FCQ will provide guidance for the materials, equipment, and construction methods to be used for final cover construction and the cover testing, evaluation and reporting procedures.

WATER BALANCE ALTERNATIVE FINAL COVER

ATTACHMENT III-D.8-1 – HELP 3.07 OUTPUTS

ATTACHMENT III-D.8-2 - REFERENCES