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13 June 2014

Mr. David Dippel, P.G.
MC-124
Texas Commission on Environmental Quality
MSW Permits Section, Waste Permits Division
P.O. Box 13087
Austin, Texas 78711-3087

**Subject: Supplemental Application Revisions**
**Fairbanks Landfill – Harris County**
**Municipal Solid Waste (MSW) – Permit Application No. 1565B**
**Major Permit Amendment Application**
**Tracking Nos. 17465613 & 17978769; CN602560930/RN100218544**

Dear Mr. Dippel:

On behalf of USA Waste of Texas Landfills, Inc., Geosyntec Consultants (Geosyntec) has prepared this letter to request supplemental revisions on the above-referenced permit amendment application. These changes are as discussed with the Texas Commission on Environmental Quality's (TCEQ) on 9 June 2014. The accompanying revisions to the affected permit application items are attached to this letter. Additionally, Pages 1 and 9 of the Part I Form, which includes the applicant's certification statement for this submittal, are provided at the end of this letter.

## REQUESTED REVISIONS

The requested revisions are described below. Additionally, the resulting replacement pages to the permit amendment application are enclosed with this letter to replace the previously submitted versions of the applicable pages. These revisions have an updated date reflecting the revision. A working copy is also attached to this submittal that uses an underline/strikethrough format, in order to mark the revised text, to highlight the revision and facilitate the TCEQ's review.

### Attachment 3D.4.2 – Ballast Uplift Calculations

This submittal provides a revised Attachment 3D.4.2, to completely replace the previous version. The previously submitted version of the ballast calculations included a component of uplift resistance due to the lateral earth pressure of the clay liner. For this submittal, the lateral earth pressure component of uplift resistance has been removed from the calculation. The revised uplift calculations are more conservative as a result (i.e., they require slightly more ballast to offset the lack of lateral resistance).

### Attachment 4 – Geology Report

This submittal revises Page 4-28 of Attachment 4, to remove the redundant phrase "from the Layer II sand". This is to correct an inadvertent typographical error that caused redundant phrasing.

**Attachment 5 – Groundwater Monitoring Plan**

This submittal revises Page 5-1 of Attachment 5, to remove the redundant phrase "from the Layer II sand". This is to correct the same inadvertent typographical error as discussed above for Attachment 4.

**Attachment 6 – Landfill Gas Management Plan**

This submittal revises Page 6-17 of Attachment 6. The revision adds TCEQ MSW Permits Section to the list of parties to be notified in the event of a gas monitoring exceedance. The page has also been revised to clarify the ways that the notice can be made (e.g., via email, telephone, etc.). Finally, this page has also been revised to clarify that the TCEQ parties being notified will satisfy the MSW rule requirement to notify the Executive Director of the TCEQ.

**PART I FORM AND CERTIFICATION STATEMENT**

As mentioned, Pages 1 and 9 of the Part I Form are being submitted with this response. Page 9, the Signature Page, provides the certification statement signed by the applicant's responsible official.

**CLOSURE**

One original and three (3) copies of this submittal are being provided to the TCEQ MSW Permits Section in Austin. An electronic copy of this submittal has also been posted to the internet at the same URL as the initial posting of the application. Additionally, a copy of this submittal is being placed in the Fairbanks Branch Library for public viewing, to accompany the initial application already placed in that library. Geosyntec trusts that the above responses to TCEQ's comments provide the necessary information requested by TCEQ to complete their technical review of the permit amendment application. If you have any questions regarding the information presented in this letter, please do not hesitate to contact the undersigned by telephone at (512) 451-4003, or by E-mail at sgraves@geosyntec.com.

Sincerely,

Scott M. Graves, P.E.
Associate, Geosyntec Consultants, Inc.

Copy to: Mr. Charles Rivette, P.E., USA Waste of Texas Landfills, Inc.
Mr. Steve Jacobs, USA Waste of Texas Landfills, Inc.

TXL0263/Geosyntec Cover Ltr Jun 2014 Supp Revisions Fairbanks Expansion.docx

# PART I FORM UPDATES

# (includes Applicant's Certification Statement)

The pages that follow are updates to the Part I Form which include the applicant's certification statement for this submittal.

# Texas Commission on Environmental Quality

## Part I Form

**New Permit/Registration and Amendment Applications for an MSW Facility**

### 1. Reason for Submittal

☐ Initial Submittal ☒ Notice of Deficiency (NOD) Response

### 2. Authorization Type

☒ Permit ☐ Registration

### 3. Application Type

☐ New
☒ Major Amendment
☐ Major Amendment (Limited Scope)

### 4. Application Fees

☐ Pay by Check ☒ Online Payment

If paid online, e-Pay Confirmation Number: 582EA000148778

### 5. Application URL

Is the application submitted for Type I Arid Exempt (AE) and/or Type IV AE facility?

☐ Yes ☒ No

If the answer is "No", provide the URL address of a publicly accessible internet web site where the application and all revisions to that application will be posted.
http://www.wm.com/wm/texas/permits.asp

### 6. Application Publishing

Party Responsible for Publishing Notice:

☐ Applicant ☐ Agent in Service ☒ Consultant

## Signature Page

I, Steve Jacobs, Director of Disposal Operations,
(Site Operator (Permittee/Registrant)'s Authorized Signatory) (Title)

certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Signature: ______________ Date: 6-13-14

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TO BE COMPLETED BY THE OPERATOR IF THE APPLICATION IS SIGNED BY AN AUTHORIZED REPRESENTATIVE FOR THE OPERATOR

I, ______________, hereby designate ______________
(Print or Type Operator Name) (Print or Type Representative Name)

as my representative and hereby authorize said representative to sign any application, submit additional information as may be requested by the Commission; and/or appear for me at any hearing or before the Texas Commission on Environmental Quality in conjunction with this request for a Texas Water Code or Texas Solid Waste Disposal Act permit. I further understand that I am responsible for the contents of this application, for oral statements given by my authorized representative in support of the application, and for compliance with the terms and conditions of any permit which might be issued based upon this application.

______________
Printed or Typed Name of Operator or Principal Executive Officer

______________
Signature

---

SUBSCRIBED AND SWORN to before me by the said Steve Jacobs
On this 13th day of June, 2014
My commission expires on the 27th day of July, 2016
Jill Beardsley
Notary Public in and for Texas
Travis County, Texas
(Note: Application Must Bear Signature & Seal of Notary Public)

NOTARY PUBLIC STATE OF TEXAS
JILL BEARDSLEY
My Commission Expires
July 27, 2016

# REDLINE/STRIKETHOUGH PAGES

To facilitate TCEQ's review, the attached pages present a "redline/strikethough" version of the proposed text revisions to the permit amendment application. Note that due to re-pagination of the redline/strikethrough version, the page numbers may not match the final page numbers in the "clean" (replacement page) version.

# ATTACHMENT 3D.4.2

# BALLAST UPLIFT CALCULATION

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Written by: | **H. Douglas~~J. McNash~~** | Date: | **6~~11~~/2~~9~~/201~~2~~4** | Reviewed & Revised by: | **S. Graves** | Date: | **6/10~~5/2~~/2014** |
| Client: | **USAWTXL** | Project: | **Fairbanks Landfill Expansion** | Project No.: | **TXL0263** | Phase No.: | **06** |

**BALLAST UPLIFT CALCULATION**
**FAIRBANKS LANDFILL**

FOR PERMIT PURPOSES ONLY;
CALCULATION PAGES 1
THROUGH 11~~3~~

GEOSYNTEC CONSULTANTS, INC.
TX ENG. FIRM REGISTRATION NO. F-1182

## 1. INTRODUCTION

The purpose of this calculation package is to calculate the thickness of ballast required to resist uplift pressures on the liner system due to the presence of perched groundwater within Stratum II.

## 2. METHODOLOGY

The Texas Commission on Environmental Quality (TCEQ) recommends a minimum factor of safety ($FS_{min}$) against liner system uplift of 1.2 if no ballast is required or if soils are used as ballast. Alternatively, if waste is selected as ballast, the required long-term $FS_{min}$ is 1.5. The required thickness of ballast on the liner system to achieve these $FS_{min}$ values can be calculated by the following steps:

- Select critical points for evaluation of a cell (i.e., sector) (based on local groundwater conditions with respect to landfill base and/or side slope elevations), top of liner, and critical subsurface strata. Evaluate the elevations of the seasonal high groundwater table (SHGT) (synonymous with the "historical high" groundwater levels). Or, use observed groundwater levels if conditions are intermittent and not represented by a continuous water table.

- Select the required long-term factor of safety against uplift (1.2 or 1.5) depending on the ballast material.

- Calculate the maximum hydrostatic uplift force, $U_N$, acting normal to the liner ~~(see free body diagram in Figure 3D.4.2-1)~~ at each point:

$$U_N = \gamma_w \times H_{wt}$$

where: $\gamma_w$ = unit weight of water; $H_{wt}$ = vertical distance from the liner to the seasonal high groundwater table.

- Evaluate the unit weight of the ballast materials (soil and/or waste):

When possible, the total unit weight of the soil ballast layers should be verified by laboratory or field data. If these data are not available, the following unit weights may be used:

Waste - total unit weight of the waste used in uplift stability calculations For municipal solid waste, TCEQ requires in 30 TAC §330.337(h)(2) that the unit weight of waste used as ballast material be selected as 1,200 pounds per cubic yard, or 44 pounds per cubic foot. Since this landfill is a Type IV and will not have MSW, but rather will have a construction and demolition (C&D) type of waste, it is likely that the waste will be even denser (heavy). However, for conservatism, 44 pounds per cubic foot will be used as the unit weight of waste in these calculations.

Protective Cover - Assume loose dumped unit weight of protective cover soil as 70% of the typical in-situ unit weight. If material is lightly compacted during placement, 80% of the typical in-situ or standard Proctor maximum unit weight may be used. From these guidelines and the anticipated light compaction during placement (e.g., dozer), a value of 90 pounds per cubic foot was selected for the unit weight of protective cover material.

Compacted Clay Liner – The recompacted clay liner material will be compacted to 95% dry density. A value of 115.6 pcf was selected for computing the resistance to uplift by the compacted clay liner. Note that this value is slightly lower than the value used in the slope stability analyses in Attachment 3D.2. The lower unit weight selected here is conservative in terms of this uplift calculation.

- Calculate the resisting force, $R_N$, provided by recompacted clay liner and protective cover soils acting normal to the liner ~~(see free body diagram in Figure 3D.4.2-1)~~ at each point:

  $$\cancel{R_N =} R_{\cancel{V}N} \cancel{\times \cos\beta + R_H \times \sin\beta} = \Sigma(\gamma_i \times T_i) \times \cos\beta \cancel{+ \Sigma(K_o \times \gamma_i \times T_i) \times \sin\beta}$$

  where: $R_{\cancel{V}N}$ = normal~~vertical~~ resisting force; ~~$R_H$ = horizontal resisting force;~~ $\gamma_i$ = total unit weight of the i^th ballast component above the liner; $T_i$ = vertical thickness of the i^th ballast component above the liner~~; $K_0$ = coefficient of static earth pressure provided by the liner (as shown in Figure 3D.4.2-2 (Holtz and Kovacs, 1981))~~; and β = the slope of the liner system. ~~It is noted that the lateral earth pressure from the liner and protective soil at the calculation point provide the resisting force against uplift.~~

- Calculate the provided FS without ballast at each point:

  $$FS = R_N / U_N = \cancel{[}\Sigma(\gamma_i \times T_i) \times \cos\beta \cancel{+ \Sigma(K_o \times \gamma_i \times T_i) \times \sin\beta]} / (\gamma_w \times H_{wt})$$

  If the provided FS is greater than or equal to $FS_{min}$, then no ballast is required. If FS is less than the $FS_{min}$, then ballast is required.

- If ballast is required, calculate the required thickness, $T_i$, of the ballast materials~~ assuming that only the vertical pressure of the ballast contributes to the additional resistance against uplift~~:

  $$\Sigma(\gamma_i T_i) \times\cancel{*} \cos\beta = ((FS_{min} \times\cancel{*} U_N) - R_N)$$

## 3. CALCULATIONS

The following section presents the calculations to evaluate the required thickness of ballast to resist uplift for two potential ballast materials: Waste-as-Ballast (Case I) and Soil-as-Ballast (Case II). Geologic cross sections were developed for the site and are provided in the Geology Report (Part III, Attachment 4), which give an indication of where the water-bearing zone that will encounter the sidewall liner system in places is located (i.e., Stratum II). The base liner system grading plan and final cover grading plan are presented in Part III, Attachment 3, Drawings 3-2 and 3-3, respectively. Finally, a map of the historical high groundwater elevations in Stratum II is presented in the Liner Quality Control Plan (LCQP) in Attachment 3C. The historical high groundwater elevations in Stratum II are used to calculate the uplift forces. A generic cross section that portrays an example layout of the typical situation is provided in Figure 3D.4.2-1.

The liner in the southwestern part of landfill (Sector R) is selected as the critical case for design as this location has the highest elevation difference between the SHGT and the liner base grades. A representative typical/idealized cross section of the landfill liner at this worst-case location is provided in Figure 3D.4.2-2~~3~~ of this calculation package. As shown in Figure 3D.4.2-2~~3~~, the bottom of Stratum II (perched water bearing stratum) is located at elevation 60 ft MSL, and will encounter the liner sidewall. Therefore, hydrostatic uplift was evaluated along the 3 horizontal: 1 vertical (3H:1V) liner side slope at the Stratum II and Stratum III interface. At this location, the historical high groundwater table elevation is 86 ft MSL. The height of the water table in this area is calculated as:

$$H_{wt} = 86\ ft\ MSL - 60\ ft\ MSL = 26\ ft$$

The uplift force on the 3H:1V liner side slopes (β = 18.43°) is computed as:

$$U_N = (H_{wt} \times \gamma_w) = (26\ ft \times 62.4\ pcf) = 1622.4\ psf$$

The pre-ballast resisting force is evaluated based on resistance available from a 3-ft thick compacted clay liner with 1-ft of protective cover. The resisting force ~~is a combination of horizontal and vertical components and~~acts normal to the liner and is computed as follows:

$R_N = \Sigma(\gamma i \times Ti) \times \cos\beta \cancel{+ \Sigma(K0 \times \gamma i \times Ti) \times \sin\beta}$

$R_N = \cancel{[}(115.6\ pcf \times 3\ ft + 90.0\ pcf \times 1\ ft) \times \cos(18.43°)\cancel{] + [1\text{-}\sin(18°)] \times (115.6\ pcf \times 3\ ft + 90.0\ pcf \times 1\ ft) \times \sin(18.43°)}$

$R_N = \cancel{509.8}\,414.4\ psf$

~~where, the coefficient of static earth pressure ($K_0$) is defined as 1-sinϕ; and ϕ was selected as 18° for recompacted clay liner for the purposes of this computation.~~

The calculated factor of safety without ballast is:

$FS = R_N / U_N = 414.4\cancel{509.8}\ psf / 1622.4\ psf = 0.26\cancel{31}$

Therefore, ballast will be required to resist calculated uplift pressures from Stratum II along the liner of this evaluated location in Sector R. If waste is selected as the ballast material (Case I), sufficient ballast should be placed to achieve a $FS_{min}$ equal to 1.5 against uplift. The thickness of waste to be used as ballast ($T_{wb}$) material is calculated as:

$T_{wb} = ((FS_{min} \times U_N) - R_N) / (\gamma_{wb} \times \cos\beta)$

$T_{wb} = ((1.5 \times 1622.4\ psf) - 414.4\cancel{509.8}\ psf) / (44\ pcf \times \cos(18.43°)) = 48.4\cancel{46.1}\ ft$

Therefore, the required thickness of waste if used as ballast in Sector R where it encounters Stratum II along the sidewall is 49~~7~~.0 ft (rounded up).

Similarly, if soil material is selected as ballast (Case II), sufficient ballast should be placed to achieve a $FS_{min}$ equal to 1.2 against uplift. The thickness of soil ballast ($T_{sb}$) is calculated as:

$T_{sb} = ((FS_{min} \times U_N) - R_N) / (\gamma_{sb} \times \cos\beta)$

$T_{sb} = ((1.2 \times 1622.4\ psf) - 414.4\cancel{509.8}\ psf) / (90\ pcf \times \cos(18.43°)) = 17.9\cancel{16.8}\ ft$

Therefore, the required thickness of soil material if soil is used as ballast in Sector R where it encounters Stratum II along the sidewall is 18~~7~~.0 ft (rounded up).

## 4. RESULTS

Design calculations as shown above were conducted for the north portion of Sector Q, the south portion of Sector Q, Sector R, Sector S, and Sector T (i.e., the proposed sectors that have not yet been constructed). The calculations for required thickness of ballast required in each sector are summarized in Table 3D.4.2-1. Since the base (floor) of the landfill liner will be keyed-in to the clayey Stratum III and groundwater is not expected to encounter the floor of the landfill, the computations presented herein are performed at the intersection of Stratum II and the liner side slopes, using the same methodology presented above.

## 5. CONCLUSIONS

Uplift and ballast computations were performed for various cells at Fairbanks landfill based on the SHGT elevation, the extent of Stratum II, and the landfill base grades. An underdrain system (i.e., pressure relief/dewatering system) will be used to control groundwater prior to sufficient ballast being in-place. When waste placement is high enough, it will serve as ballast to counteract uplift forces on the sidewall. The required thickness of ballast for the applicable landfill sectors is provided in Table 3D.4.2-1. Note that the calculations were performed for two cases - using either soil or waste as ballast - although it is expected that waste will be used as ballast. It is also noted that the required thickness of ballast refers to the ballast necessary to resist uplift forces at the intersection of the base of Stratum II with the sidewall (i.e., at the deepest/worst-case point).

As landfill waste filling progresses, the actual waste thickness will exceed the minimum required thickness of waste-ballast (See Figure 3D.4.2-2~~3~~). This demonstrates that waste may be used as ballast, without the need to be supplemented by additional soil ballast placement.

As discussed in the Liner Quality Control Plan (LQCP), an underdrain will be provided in areas where the liner encounters Stratum II. The underdrain will be operated until the thickness of ballast (waste) placed within each cell reaches the required thickness to resist uplift with an adequate calculated factor of safety. Furthermore, placement of ballast will be documented in a Ballast Evaluation Report (BER) in accordance to the LQCP.

## ~~6. REFERENCES~~

~~Holtz, R.D. and W.D. Kovacs, (1981). “An Introduction to Geotechnical Engineering”, Prentice Hall, Inc., New Jersey, pp. 225-226, 519.~~

# TABLES

- **Table 3D.4.2-1. Summary of Uplift and Ballast Calculation Results**

Written by: **H. Douglas~~J. McNash~~** Date: **6~~11~~/2~~9~~/201~~2~~4** Reviewed & Revised by: **S. Graves** Date: **6/10~~5/2~~/2014**

Client: **USAWTXL** Project: **Fairbanks Landfill Expansion** Project No.: **TXL0263** Phase No.: **06**

**Table 3D.4.2-1. Summary of Uplift and Ballast Calculation Results**

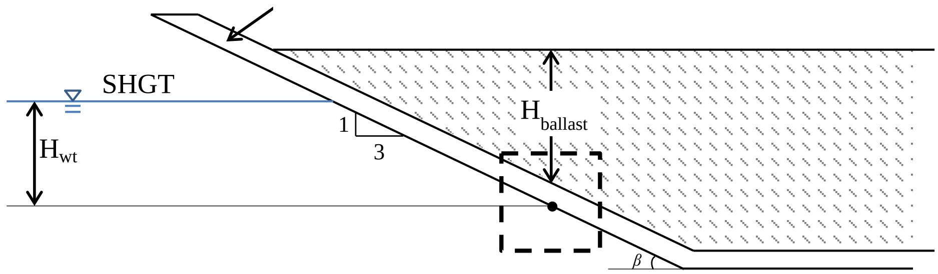
| **Cell No.** | **Base Elev.** | **Stratum II Elev.** | **SHGT Elev.** [1] | **$H_{wt}$** | **$U_{\cancel{N}}$** | **$R_{\cancel{V}}$** | **FS**[2] | **$T_{wb}$**[3] | **$T_{sb}$**[4] | **$FS_{wb}$**[5] | **$FS_{sb}$**[6] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Units | ft msl | ft msl | ft msl | ft | psf | psf | - | ft | ft | - | - |
| Sector Q (north) | 70.0 | 58.0 | 85.0 | 15.0 | 936.0 | 414.4~~436.8~~ | 0.44~~54~~ | 24~~2~~.0 | 9~~8~~.0 | 1.51~~58~~ | 1.26~~31~~ |
| Sector Q (south) | 60.0 | 60.0 | 79.5 | 19.5 | 1216.8 | 414.4~~436.8~~ | 0.34~~42~~ | 34~~2~~.0 | 1~~2~~3.0 | 1.51~~8~~ | 1.25~~31~~ |
| Sector R | 55.0 | 60.0 | 86.0 | 26.0 | 1622.4 | 414.4~~436.8~~ | 0.26~~31~~ | 49~~7~~.0 | 18~~7~~.0 | 1.52~~9~~ | 1.20~~26~~ |
| Sector S | 55.0 | 60.0 | 84.0 | 24.0 | 1497.6 | 414.4~~436.8~~ | 0.28~~34~~ | 44~~2~~.0 | 17~~6~~.0 | 1.50~~7~~ | 1.25~~30~~ |
| Sector T | 55.0 | 59.5 | 81.0 | 21.5 | 1341.6 | 414.4~~436.8~~ | 0.31~~38~~ | 39~~6~~.0 | 1~~3~~4.0 | 1.52~~6~~ | 1.20~~5~~ |

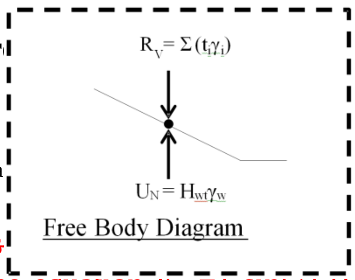
Notes:

1. SHGT = Seasonally High Groundwater Table (synonymous with historical high groundwater levels).
2. Factor of Safety without ballast material.
3. Thickness of Waste Ballast ($T_{wb}$) material (rounded up to nearest 1 ft) above the Stratum II Elevation needed to provide $FS_{min}$ of 1.5. **[Use this column to select the required minimum thickness of waste that would provide sufficient ballast to warrant ceasing operation of the underdrain system at that sector/location – provided that this is confirmed and documented in the requisite BER submittal.]**
4. Thickness of Soil Ballast ($T_{sb}$) material above the Stratum II Elevation (rounded up to nearest 1 ft) needed to provide $FS_{min}$ of 1.2.
5. Factor of Safety with $T_{wb}$ of waste ballast material.
6. Factor of Safety with $T_{sb}$ of soil ballast material.

# FIGURES

- **Figure 3D.4.2-1: Example ~~Free Body Diagram~~Layout at Liner Side Slope**
- ~~**Figure 3D.4.2-2: Excerpts from Holtz and Kovacs (1981) on Lateral Earth Pressure**~~
- **Figure 3D.4.2-2~~3~~. Typical/Idealized Cross-Section**




**Figur... ~~Body Diagram~~ Layout at Liner Side Slope**

Notes:

1. $H_{balla...}$ ... (waste or soil) above the calculation point on the liner ...
2. ~~$K_o$ is ... th pressure of the clay liner material and is defined by the equation $K_o$ = 1-sin($\phi$) (Holtz and Kovacs, 1981); where $\phi$ was selected as 18° for this computation.~~
~~3.~~2. SHGT = Seasonally High Groundwater Table (synonymous with historical high groundwater levels).

## 7.6 RELATIONSHIP BETWEEN HORIZONTAL AND VERTICAL STRESSES

You may recall from hydrostatics that the pressure in a liquid is the same in any direction—up, down, sideways, or at any inclination, it doesn't matter. However this is not true in soils. Rarely in natural soil deposits is the horizontal stress in the ground equal exactly to the vertical stress. In other words, the stresses in situ are not necessarily hydrostatic. We can express the ratio of the horizontal to vertical stress in the ground as

$$\sigma_h = K\sigma_v \tag{7-18}$$

where $K$ is an *earth pressure coefficient*. Since the ground water table can fluctuate and the total stresses can change, the coefficient $K$ is *not* a constant for a particular soil deposit. However, if we express this ratio in terms of effective stresses, we take care of the problem of a variable water table, or

$$\sigma'_h = K_o\sigma'_v \tag{7-19}$$

$K_o$ is a very important coefficient in geotechnical engineering. It is called the *coefficient of lateral earth pressure at rest*. It expresses the stress conditions in the ground in terms of *effective stresses*, and it is independent of the location of the ground water table. Even if the depth changes, $K_o$ will be a constant as long as we are in the same soil layer and the density remains the same. However this coefficient is very sensitive to the geologic and engineering stress history, as well as to the densities of the overlying soil layers (see for example, Massarsch, et al., 1975). The value of $K_o$ is important in stress and analyses, in assessing the shearing resistance of particular soil layers, and in such geotechnical problems as the design of earth-retaining structures, earth dams and slopes, and many foundation engineering problems.

The $K_o$ in natural soil deposits can be as low as 0.4 or 0.5 for sedimentary soils that have never been preloaded or up to 3.0 or greater for some very heavily preloaded deposits. Typical values of $K_o$ for different geologic conditions are given in Chapter 11.

~~**Figure 3D.4.2-2: Excerpts from Holtz and Kovacs (1981) on Lateral Earth Pressure**~~

The best known equation for estimating $K_o$ was derived by Jáky (1944, 1948), which is a theoretical relationship between $K_o$ and the angle of internal friction $\phi'$, or

$$K_o = 1 - \sin\phi' \tag{11-6}$$

This relationship, as shown in Fig. 11.14, seems to be an adequate predictor of $K_o$ for normally consolidated sands. Since most of the points lie between 0.35 and 0.5 for these sands, $K_o$ of 0.4 to 0.45 would be a reasonable average value to use for preliminary design purposes.

~~Figure 3D.4.2-2: Excerpts from Holtz and Kovacs (1981) on Lateral Earth Pressure (Continued)~~

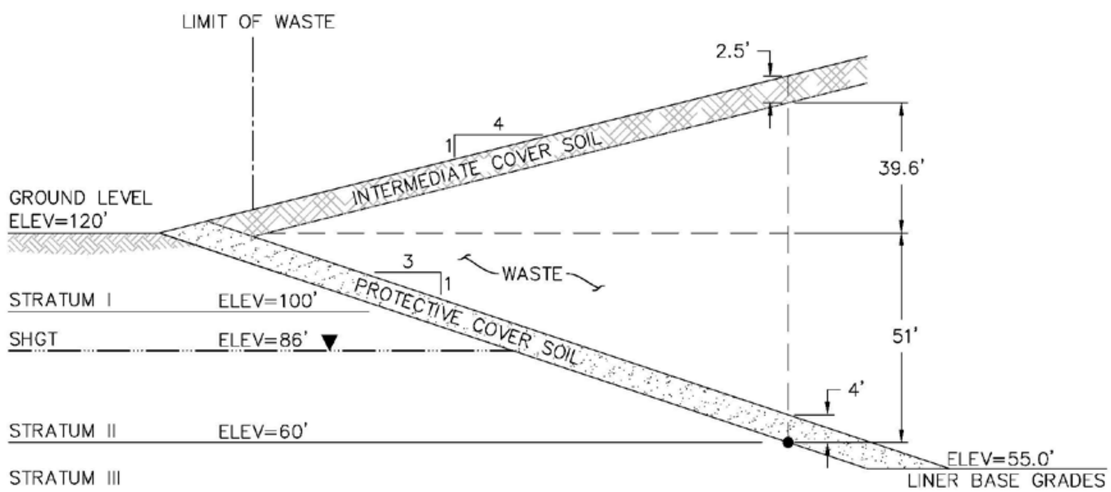



**Figure 3D.4.2-2~~3~~: Typical/Idealized Cross-Section**

Note: This figure demonstrates that the typical waste filling operation to final permitted waste grades will provide over 90-ft of waste thickness above the critical sidewall location at the base of Stratum II. The calculations indicate that about 46~~7~~-ft of waste ballast is required to provide a sufficient factor of safety against uplift in Sector R. This shows that through the course of waste filling, sufficient waste will be placed to resist uplift under the calculated conditions.

# FAIRBANKS LANDFILL
# HARRIS COUNTY, TEXAS
# TCEQ PERMIT NO. MSW 1565B

## PERMIT AMENDMENT APPLICATION

## PART III – SITE DEVELOPMENT PLAN
## ATTACHMENT 4
## GEOLOGY REPORT

Prepared for

**USA WASTE OF TEXAS LANDFILLS, INC.**
**A WASTE MANAGEMENT COMPANY**

August 2013
Revised March 2014
Revised May 2014

Revised June 2014

STATE OF TEXAS
JOHN MICHAEL SNYDER
GEOLOGY
595
LICENSED
PROFESSIONAL GEOSCIENTIST

6-10-2014

Biggs & Mathews Environmental, Inc.
Firm Registration No. 50222

Prepared by


**BIGGS & MATHEWS ENVIRONMENTAL**
1700 Robert Road, Suite 100 • Mansfield, Texas 76063 • 817-563-1144

TEXAS BOARD OF PROFESSIONAL ENGINEERS
FIRM REGISTRATION NO. F-256

TEXAS BOARD OF PROFESSIONAL GEOSCIENTISTS
FIRM REGISTRATION NO. 50222

**Table 4-9**
**Hydraulic Conductivity Values**
**Fairbanks Landfill**

| Monitoring Well No. | Hydraulic Conductivity (cm/sec) | Rising/Falling Head |
|---|---|---|
| **Layer II** | | |
| MW-1A | $1.0 \times 10^{-3}$ | Rising Head |
| MW-1A | $8.5 \times 10^{-4}$ | Falling Head |
| MW-2A | $5.6 \times 10^{-4}$ | Rising Head |
| MW-2A | $6.0 \times 10^{-4}$ | Rising Head |
| MW-2A | $7.0 \times 10^{-4}$ | Falling Head |
| MW-7A | $7.5 \times 10^{-4}$ | Rising Head |
| MW-7A | $1.2 \times 10^{-3}$ | Rising Head |
| Geometric Mean Layer II | $7.84 \times 10^{-4}$ | |
| **Layer IV – Uppermost Aquifer** | | |
| P-3B | $2.6 \times 10^{-4}$ | Falling Head |
| P-3B | $5.2 \times 10^{-4}$ | Rising Head |
| P-4B | $3.0 \times 10^{-3}$ | Falling Head |
| P-4B | $3.3 \times 10^{-3}$ | Rising Head |
| P-5B | $1.9 \times 10^{-4}$ | Falling Head |
| P-5B | $1.7 \times 10^{-4}$ | Rising Head |
| Geometric Mean Layer IV | $5.92 \times 10^{-4}$ | |

## 6.3 Site Hydrogeology

Since the 1998 permit amendment application for the site, Layer II has been identified as the uppermost groundwater zone rather than the uppermost aquifer. Layer IV has been consistently identified as the uppermost aquifer in groundwater monitoring reports submitted to the TCEQ since that time and is referred to as the uppermost aquifer. The identification of Layer IV as the uppermost aquifer is appropriate because the Layer II sand was historically excavated for sand mining purposes resulting in dewatering of this stratum. This dewatering frequently created dry monitoring wells. In addition, Layer II occurs only in the sidewalls of the facility whereas Layer IV underlies the entirety of the waste fill excavation. Layer IV has been unaltered by excavation activities, and is present beneath the entire excavation, and monitoring wells in this zone routinely have groundwater to be sampled.

Because the Layer II sand has been removed ~~from the Layer II sand~~ at the downgradient south and east sides of the site and replaced by reconstructed clay sidewalls and backfilled material, it would not be possible to obtain representative groundwater samples from Layer II as required by 30 TAC 330.403. Details of the constructed fill can be found in Section 5 of the LQCP (Part III, Attachment 3C and in Attachment 3A, Drawings 3-6 through 3-11).

# FAIRBANKS LANDFILL
# HARRIS COUNTY, TEXAS
# TCEQ PERMIT NO. MSW 1565B

## PART III – SITE DEVELOPMENT PLAN
## ATTACHMENT 5
## GROUNDWATER MONITORING PLAN

Prepared for

**USA WASTE OF TEXAS LANDFILLS, INC.**
**A WASTE MANAGEMENT COMPANY**

August 2013
Revised March 2014
Revised May 2014

Revised June 2014

STATE OF TEXAS
JOHN MICHAEL SNYDER
GEOLOGY
595
LICENSED
PROFESSIONAL GEOSCIENTIST

6-10-2014

Biggs & Mathews Environmental, Inc.
Firm Registration No. 50222

Prepared by

**BIGGS & MATHEWS ENVIRONMENTAL**
1700 Robert Road, Suite 100 • Mansfield, Texas 76063 • 817-563-1144

TEXAS BOARD OF PROFESSIONAL ENGINEERS
FIRM REGISTRATION NO. F-256

TEXAS BOARD OF PROFESSIONAL GEOSCIENTISTS
FIRM REGISTRATION NO. 50222

# 1 SITE HYDROGEOLOGY

## 1.1 Hydrogeologic Units

Since the 1998 permit amendment application for the site, Layer II has been identified as the uppermost groundwater zone rather than the uppermost aquifer. Layer IV has been consistently identified as the uppermost aquifer in groundwater monitoring reports submitted to the TCEQ since that time and is referred to as the uppermost aquifer. The identification of Layer IV as the uppermost aquifer is appropriate because the Layer II sand was historically excavated for sand mining purposes resulting in dewatering of this stratum. This dewatering frequently created dry monitoring wells. In addition, Layer II occurs only in the sidewalls of the facility whereas Layer IV underlies the entirety of the waste fill excavation. Layer IV has been unaltered by excavation activities, and is present beneath the entire excavation, and monitoring wells in this zone routinely have groundwater to be sampled.

Because the Layer II sand has been removed ~~from the Layer II sand~~ at the downgradient south and east sides of the site and replaced by reconstructed clay sidewalls and backfilled material, it would not be possible to obtain representative groundwater samples from Layer II as required by 30 TAC 330.403. Details of the constructed fill can be found in Section 5 of the LQCP (Part III, Attachment 3C and in Attachment 3A, Drawings 3-6 through 3-11).

Furthermore, because the Layer II sand is (or will be) substantially removed from this site and no Layer II sand remains at the downgradient east and south perimeter of the site, Layer IV is the uppermost aquifer at the site.

### 1.1.1 Layer II Groundwater Zone

As described in Section 4.4, site stratigraphy is divided into five geologic units: Layer I (surficial sand, silt, and clay), Layer II (sand), Layer III (clay), Layer IV (sand) and Layer V (clay). The uppermost groundwater zone at the site is the Layer II sand unit. Water levels measured in site monitoring wells and exploratory borings indicate that groundwater in the upper Layer II sand unit occurs under generally unconfined, water-table conditions and is confined or retarded at its lower limit by the underlying Layer III clay. The original thickness of Layer II ranged from approximately 20 to 40 feet and had an average thickness of approximately 35 feet.

Open excavations on the site and adjacent properties have been excavated for sand mining and waste filling operations. Over most of the existing site the Layer II sand has been removed. When the excavation for the proposed waste area is complete Layer II will have been removed across much of the existing site and the proposed expansion area (see Attachment 4, Figure 4C-9, 4F-2, and 4F-3). Groundwater levels in Layer II are affected by natural dewatering related to evaporation in the open excavation.

*Prepared for:*

**USA Waste of Texas Landfills, Inc.**

# PERMIT AMENDMENT APPLICATION
# PART III – SITE DEVELOPMENT PLAN
# ATTACHMENT 6

# LANDFILL GAS MANAGEMENT PLAN

## FAIRBANKS LANDFILL
## MSW PERMIT NO. 1565B
## HOUSTON, HARRIS COUNTY, TEXAS

*Prepared by:*


Geosyntec consultants

Texas Board of Professional Engineers Firm Registration No. F-1182

3600 Bee Caves Road, Suite 101

Austin, Texas 78746

(512) 451-4003



Submitted August 2013

Revised March 2014

Revised May 2014

Revised June 2014

c. If the initial detection is verified to be an exceedance, the following parties shall be notified of the situation via one of the following - email, telephone, fax, letter, or other forms of communication:
   - The Manager of the MSW Permits Section of TCEQ's Waste Permits Division in Austin;
   - TCEQ Region 12;
   - the local Fire Department and Harris County Public Health and Environmental Services; and
   - neighboring landowners within 500-ft of the exceedance location.

   By making the TCEQ notifications identified above, this will constitute providing notice to the TCEQ Executive Director in accordance with 30 TAC 330.371(c)(1).

2. Within Seven Days of Verified Exceedance. A record of the methane gas levels detected and a description of the immediate actions taken to protect human health will be placed in the Site Operating Record.

3. Within 60 Days of Verified Exceedance.
   a. A detailed evaluation will be made to determine the potential source and extent of the methane gas migration. A Remediation Plan will be prepared and must be submitted to the TCEQ Executive Director. The Remediation Plan will present the results of the detailed evaluation, along with the remedial measures taken, which may include additional monitoring, source control t (e.g., installation of gas vent(s)) a passive interceptor trench/barrier system, active building ventilation systems,), etc.
   b. The Remediation Plan will incorporate remediation performance monitoring. The remediation performance monitoring will be conducted on a monthly basis at the affected gas monitoring location(s) and will submitted to TCEQ, until methane concentrations in the affected gas monitoring location(s) are below the allowable limits specified at the beginning of this section for six (6) consecutive months.

As allowed by 30 TAC §330.371(d), alternate schedules to those given above may be established by the TCEQ Executive Director.

# REPLACEMENT PAGES

The items that follow are to completely replace the previous versions of those pages.

# ATTACHMENT 3D.4.2

# BALLAST UPLIFT CALCULATION

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Written by: | H. Douglas | Date: | 6/2/2014 | Reviewed & Revised by: | S. Graves | Date: | 6/10/2014 |
| Client: | USAWTXL | Project: | Fairbanks Landfill Expansion | Project No.: | TXL0263 | Phase No.: | 06 |

# BALLAST UPLIFT CALCULATION
# FAIRBANKS LANDFILL

6/10/2014

STATE OF TEXAS
SCOTT M. GRAVES
86557
LICENSED
PROFESSIONAL ENGINEER

FOR PERMIT PURPOSES ONLY

GEOSYNTEC CONSULTANTS, INC.
TEXAS ENG. FIRM REGISTRATION NO. F-1182

CALCULATION PAGES 1 THROUGH 11

## 1. INTRODUCTION

The purpose of this calculation package is to calculate the thickness of ballast required to resist uplift pressures on the liner system due to the presence of perched groundwater within Stratum II.

## 2. METHODOLOGY

The Texas Commission on Environmental Quality (TCEQ) recommends a minimum factor of safety ($FS_{min}$) against liner system uplift of 1.2 if no ballast is required or if soils are used as ballast. Alternatively, if waste is selected as ballast, the required long-term $FS_{min}$ is 1.5. The required thickness of ballast on the liner system to achieve these $FS_{min}$ values can be calculated by the following steps:

- Select critical points for evaluation of a cell (i.e., sector) (based on local groundwater conditions with respect to landfill base and/or side slope elevations), top of liner, and critical subsurface strata. Evaluate the elevations of the seasonal high groundwater table (SHGT) (synonymous with the "historical high" groundwater levels). Or, use observed groundwater levels if conditions are intermittent and not represented by a continuous water table.

- Select the required long-term factor of safety against uplift (1.2 or 1.5) depending on the ballast material.

- Calculate the maximum hydrostatic uplift force, $U_N$, acting normal to the liner at each point:

$$U_N = \gamma_w \times H_{wt}$$

where: $\gamma_w$ = unit weight of water; $H_{wt}$ = vertical distance from the liner to the seasonal high groundwater table.

- Evaluate the unit weight of the ballast materials (soil and/or waste):

When possible, the total unit weight of the soil ballast layers should be verified by laboratory or field data. If these data are not available, the following unit weights may be used:

Waste - total unit weight of the waste used in uplift stability calculations For municipal solid waste, TCEQ requires in 30 TAC §330.337(h)(2) that the unit weight of waste used as ballast material be selected as 1,200 pounds per cubic yard, or 44 pounds per cubic foot. Since this landfill is a Type IV and will not have MSW, but rather will have a construction and demolition (C&D) type of waste, it is likely that the waste will be even denser (heavy). However, for conservatism, 44 pounds per cubic foot will be used as the unit weight of waste in these calculations.

Protective Cover - Assume loose dumped unit weight of protective cover soil as 70% of the typical in-situ unit weight. If material is lightly compacted during placement, 80% of the typical in-situ or standard Proctor maximum unit weight may be used. From these guidelines and the anticipated light compaction during placement (e.g., dozer), a value of 90 pounds per cubic foot was selected for the unit weight of protective cover material.

Compacted Clay Liner – The recompacted clay liner material will be compacted to 95% dry density. A value of 115.6 pcf was selected for computing the resistance to uplift by the compacted clay liner. Note that this value is slightly lower than the value used in the slope stability analyses in

Attachment 3D.2. The lower unit weight selected here is conservative in terms of this uplift calculation.

- Calculate the resisting force, $R_N$, provided by recompacted clay liner and protective cover soils acting normal to the liner at each point:

  $$R_N = \Sigma(\gamma_i \times T_i) \times \cos\beta$$

  where: $R_N$ = normal resisting force; $\gamma_i$ = total unit weight of the $i^{th}$ ballast component above the liner; $T_i$ = vertical thickness of the $i^{th}$ ballast component above the liner; and $\beta$ = the slope of the liner system.

- Calculate the provided FS without ballast at each point:

  $$FS = R_N / U_N = \Sigma(\gamma_i \times T_i) \times \cos\beta / (\gamma_w \times H_{wt})$$

  If the provided FS is greater than or equal to $FS_{min}$, then no ballast is required. If FS is less than the $FS_{min}$, then ballast is required.

- If ballast is required, calculate the required thickness, $T_i$, of the ballast materials:

  $$\Sigma(\gamma_i\, T_i) \times \cos\beta = ((FS_{min} \times U_N) - R_N)$$

## 3. CALCULATIONS

The following section presents the calculations to evaluate the required thickness of ballast to resist uplift for two potential ballast materials: Waste-as-Ballast (Case I) and Soil-as-Ballast (Case II). Geologic cross sections were developed for the site and are provided in the Geology Report (Part III, Attachment 4), which give an indication of where the water-bearing zone that will encounter the sidewall liner system in places is located (i.e., Stratum II). The base liner system grading plan and final cover grading plan are presented in Part III, Attachment 3, Drawings 3-2 and 3-3, respectively. Finally, a map of the historical high groundwater elevations in Stratum II is presented in the Liner Quality Control Plan (LCQP) in Attachment 3C. The historical high groundwater elevations in Stratum II are used to calculate the uplift forces. A generic cross section that portrays an example layout of the typical situation is provided in Figure 3D.4.2-1.

The liner in the southwestern part of landfill (Sector R) is selected as the critical case for design as this location has the highest elevation difference between the SHGT and the liner base grades. A representative typical/idealized cross section of the landfill liner at this worst-case location is provided in Figure 3D.4.2-2 of this calculation package. As shown in Figure 3D.4.2-2, the bottom of Stratum II (perched water bearing stratum) is located at elevation 60 ft MSL, and will encounter the liner sidewall. Therefore, hydrostatic uplift was evaluated along the 3 horizontal: 1 vertical (3H:1V) liner side slope at the Stratum II and Stratum III interface. At this location, the historical high groundwater table elevation is 86 ft MSL. The height of the water table in this area is calculated as:

$$H_{wt} = 86\ ft\ MSL – 60\ ft\ MSL = 26\ ft$$

The uplift force on the 3H:1V liner side slopes (β = 18.43°) is computed as:

$$U_N = (H_{wt} \times \gamma_w) = (26\ ft \times 62.4\ pcf) = 1622.4\ psf$$

The pre-ballast resisting force is evaluated based on resistance available from a 3-ft thick compacted clay liner with 1-ft of protective cover. The resisting force acts normal to the liner and is computed as follows:

$$R_N = \Sigma(\gamma i \times Ti) \times \cos\beta$$

$$R_N = (115.6\ pcf \times 3\ ft + 90.0\ pcf \times 1\ ft) \times \cos(18.43°)\ R_N = 414.4\ psf$$

The calculated factor of safety without ballast is:

$$FS = R_N / U_N = 414.4\ psf / 1622.4\ psf = 0.26$$

Therefore, ballast will be required to resist calculated uplift pressures from Stratum II along the liner of this evaluated location in Sector R. If waste is selected as the ballast material (Case I), sufficient ballast should be placed to achieve a $FS_{min}$ equal to 1.5 against uplift. The thickness of waste to be used as ballast ($T_{wb}$) material is calculated as:

$$T_{wb} = ((FS_{min} \times U_N) - R_N) / (\gamma_{wb} \times \cos\beta)$$
$$T_{wb} = ((1.5 \times 1622.4\ psf) - 414.4\ psf) / (44\ pcf \times \cos(18.43°)) = 48.4\ ft$$

Therefore, the required thickness of waste if used as ballast in Sector R where it encounters Stratum II along the sidewall is 49.0 ft (rounded up).

Similarly, if soil material is selected as ballast (Case II), sufficient ballast should be placed to achieve a $FS_{min}$ equal to 1.2 against uplift. The thickness of soil ballast ($T_{sb}$) is calculated as:

$$T_{sb} = ((FS_{min} \times U_N) - R_N) / (\gamma_{sb} \times \cos\beta)$$
$$T_{sb} = ((1.2 \times 1622.4\ psf) - 414.4\ psf) / (90\ pcf \times \cos(18.43°)) = 17.9\ ft$$

Therefore, the required thickness of soil material if soil is used as ballast in Sector R where it encounters Stratum II along the sidewall is 18.0 ft (rounded up).

## 4. RESULTS

Design calculations as shown above were conducted for the north portion of Sector Q, the south portion of Sector Q, Sector R, Sector S, and Sector T (i.e., the proposed sectors that have not yet been constructed). The calculations for required thickness of ballast required in each sector are summarized in Table 3D.4.2-1. Since the base (floor) of the landfill liner will be keyed-in to the clayey Stratum III and groundwater is not expected to encounter the floor of the landfill, the computations presented herein are performed at the intersection of Stratum II and the liner side slopes, using the same methodology presented above.

## 5. CONCLUSIONS

Uplift and ballast computations were performed for various cells at Fairbanks landfill based on the SHGT elevation, the extent of Stratum II, and the landfill base grades. An underdrain system (i.e., pressure relief/dewatering system) will be used to control groundwater prior to sufficient ballast being in-place. When waste placement is high enough, it will serve as ballast to counteract uplift forces on the sidewall. The required thickness of ballast for the applicable landfill sectors is provided in Table 3D.4.2-1. Note that the calculations were performed for two cases - using either soil or waste as ballast - although it is expected that waste will be used as ballast. It is also noted that the required thickness of ballast refers to the ballast necessary to resist uplift forces at the intersection of the base of Stratum II with the sidewall (i.e., at the deepest/worst-case point).

As landfill waste filling progresses, the actual waste thickness will exceed the minimum required thickness of waste-ballast (See Figure 3D.4.2-2). This demonstrates that waste may be used as ballast, without the need to be supplemented by additional soil ballast placement.

As discussed in the Liner Quality Control Plan (LQCP), an underdrain will be provided in areas where the liner encounters Stratum II. The underdrain will be operated until the thickness of ballast (waste) placed within each cell reaches the required thickness to resist uplift with an adequate calculated factor of safety. Furthermore, placement of ballast will be documented in a Ballast Evaluation Report (BER) in accordance to the LQCP.

# TABLES

- **Table 3D.4.2-1. Summary of Uplift and Ballast Calculation Results**

Written by: **H. Douglas** Date: **6/2/2014** Reviewed & Revised by: **S. Graves** Date: **6/10/2014**

Client: **USAWTXL** Project: **Fairbanks Landfill Expansion** Project No.: **TXL0263** Phase No.: **06**

**Table 3D.4.2-1. Summary of Uplift and Ballast Calculation Results**

| **Cell No.** | **Base Elev.** | **Stratum II Elev.** | **SHGT Elev.** [1] | $\mathbf{H_{wt}}$ | **U** | **R** | **FS**[2] | $\mathbf{T_{wb}}$[3] | $\mathbf{T_{sb}}$[4] | $\mathbf{FS_{wb}}$[5] | $\mathbf{FS_{sb}}$[6] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Units | ft msl | ft msl | ft msl | ft | psf | psf | - | ft | ft | - | - |
| Sector Q (north) | 70.0 | 58.0 | 85.0 | 15.0 | 936.0 | 414.4 | 0.44 | 24.0 | 9.0 | 1.51 | 1.26 |
| Sector Q (south) | 60.0 | 60.0 | 79.5 | 19.5 | 1216.8 | 414.4 | 0.34 | 34.0 | 13.0 | 1.51 | 1.25 |
| Sector R | 55.0 | 60.0 | 86.0 | 26.0 | 1622.4 | 414.4 | 0.26 | 49.0 | 18.0 | 1.52 | 1.20 |
| Sector S | 55.0 | 60.0 | 84.0 | 24.0 | 1497.6 | 414.4 | 0.28 | 44.0 | 17.0 | 1.50 | 1.25 |
| Sector T | 55.0 | 59.5 | 81.0 | 21.5 | 1341.6 | 414.4 | 0.31 | 39.0 | 14.0 | 1.52 | 1.20 |

Notes:

1. SHGT = Seasonally High Groundwater Table (synonymous with historical high groundwater levels).
2. Factor of Safety without ballast material.
3. Thickness of Waste Ballast ($T_{wb}$) material (rounded up to nearest 1 ft) above the Stratum II Elevation needed to provide $FS_{min}$ of 1.5. **[Use this column to select the required minimum thickness of waste that would provide sufficient ballast to warrant ceasing operation of the underdrain system at that sector/location – provided that this is confirmed and documented in the requisite BER submittal.]**
4. Thickness of Soil Ballast ($T_{sb}$) material above the Stratum II Elevation (rounded up to nearest 1 ft) needed to provide $FS_{min}$ of 1.2.
5. Factor of Safety with $T_{wb}$ of waste ballast material.
6. Factor of Safety with $T_{sb}$ of soil ballast material.

# FIGURES

- **Figure 3D.4.2-1: Example Layout at Liner Side Slope**
- **Figure 3D.4.2-2. Typical/Idealized Cross-Section**

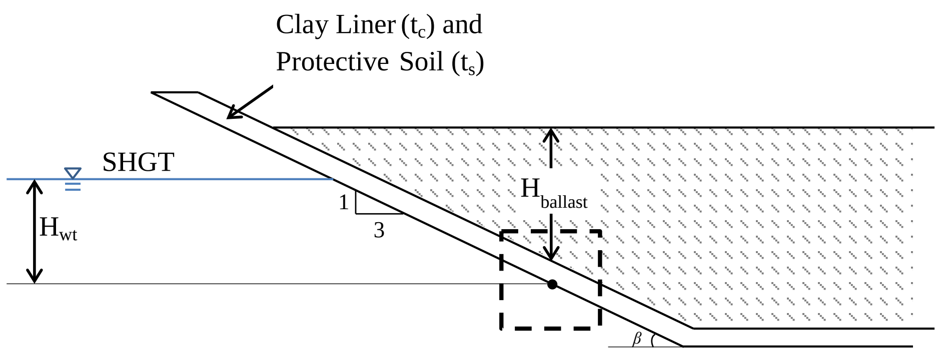



**Figure 3D.4.2-1: Example Layout at Liner Side Slope**

Notes:

1. $H_{ballast}$ is the thickness of ballast (waste or soil) above the calculation point on the liner side slopes.
2. SHGT = Seasonally High Groundwater Table (synonymous with historical high groundwater levels).

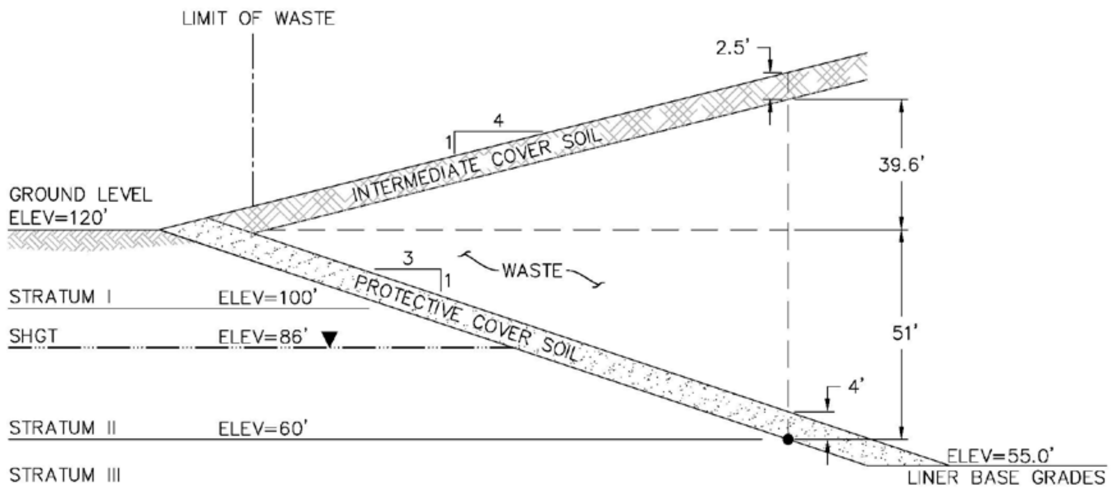



**Figure 3D.4.2-2: Typical/Idealized Cross-Section**

Note: This figure demonstrates that the typical waste filling operation to final permitted waste grades will provide over 90-ft of waste thickness above the critical sidewall location at the base of Stratum II. The calculations indicate that about 46-ft of waste ballast is required to provide a sufficient factor of safety against uplift in Sector R. This shows that through the course of waste filling, sufficient waste will be placed to resist uplift under the calculated conditions.

# FAIRBANKS LANDFILL
# HARRIS COUNTY, TEXAS
# TCEQ PERMIT NO. MSW 1565B

## PERMIT AMENDMENT APPLICATION

## PART III – SITE DEVELOPMENT PLAN
## ATTACHMENT 4
## GEOLOGY REPORT

Prepared for

**USA WASTE OF TEXAS LANDFILLS, INC.**
**A WASTE MANAGEMENT COMPANY**

August 2013
Revised March 2014
Revised May 2014

Revised June 2014

STATE OF TEXAS
JOHN MICHAEL SNYDER
GEOLOGY
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6-10-2014

**Biggs & Mathews Environmental, Inc.**
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Prepared by

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## CONTENTS (Continued)

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## CONTENTS (Continued)

**Table 4-9**
**Hydraulic Conductivity Values**
**Fairbanks Landfill**

| Monitoring Well No. | Hydraulic Conductivity (cm/sec) | Rising/Falling Head |
|---|---|---|
| **Layer II** | | |
| MW-1A | $1.0 \times 10^{-3}$ | Rising Head |
| MW-1A | $8.5 \times 10^{-4}$ | Falling Head |
| MW-2A | $5.6 \times 10^{-4}$ | Rising Head |
| MW-2A | $6.0 \times 10^{-4}$ | Rising Head |
| MW-2A | $7.0 \times 10^{-4}$ | Falling Head |
| MW-7A | $7.5 \times 10^{-4}$ | Rising Head |
| MW-7A | $1.2 \times 10^{-3}$ | Rising Head |
| Geometric Mean Layer II | $7.84 \times 10^{-4}$ | |
| **Layer IV – Uppermost Aquifer** | | |
| P-3B | $2.6 \times 10^{-4}$ | Falling Head |
| P-3B | $5.2 \times 10^{-4}$ | Rising Head |
| P-4B | $3.0 \times 10^{-3}$ | Falling Head |
| P-4B | $3.3 \times 10^{-3}$ | Rising Head |
| P-5B | $1.9 \times 10^{-4}$ | Falling Head |
| P-5B | $1.7 \times 10^{-4}$ | Rising Head |
| Geometric Mean Layer IV | $5.92 \times 10^{-4}$ | |

## 6.3 Site Hydrogeology

Since the 1998 permit amendment application for the site, Layer II has been identified as the uppermost groundwater zone rather than the uppermost aquifer. Layer IV has been consistently identified as the uppermost aquifer in groundwater monitoring reports submitted to the TCEQ since that time and is referred to as the uppermost aquifer. The identification of Layer IV as the uppermost aquifer is appropriate because the Layer II sand was historically excavated for sand mining purposes resulting in dewatering of this stratum. This dewatering frequently created dry monitoring wells. In addition, Layer II occurs only in the sidewalls of the facility whereas Layer IV underlies the entirety of the waste fill excavation. Layer IV has been unaltered by excavation activities, and is present beneath the entire excavation, and monitoring wells in this zone routinely have groundwater to be sampled.

Because the Layer II sand has been removed at the downgradient south and east sides of the site and replaced by reconstructed clay sidewalls and backfilled material, it would not be possible to obtain representative groundwater samples from Layer II as required by 30 TAC 330.403. Details of the constructed fill can be found in Section 5 of the LQCP (Part III, Attachment 3C and in Attachment 3A, Drawings 3-6 through 3-11).

# FAIRBANKS LANDFILL
# HARRIS COUNTY, TEXAS
# TCEQ PERMIT NO. MSW 1565B

## PART III – SITE DEVELOPMENT PLAN
## ATTACHMENT 5
## GROUNDWATER MONITORING PLAN

Prepared for

**USA WASTE OF TEXAS LANDFILLS, INC.**
**A WASTE MANAGEMENT COMPANY**

August 2013
Revised March 2014
Revised May 2014

Revised June 2014


6-10-2014

Biggs & Mathews Environmental, Inc.
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# CONTENTS



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6-10-2014

**Biggs & Mathews Environmental, Inc.**
Firm Registration No. 50222

# GROUNDWATER MONITORING SYSTEM DESIGN CERTIFICATION

## General Site Information

| | |
|---|---|
| Site: | Fairbanks Landfill |
| Site Location: | Harris County, Texas |
| MSW Permit Application No.: | 1565B |

## Qualified Groundwater Scientist Statement

I, Michael Snyder, am a licensed professional geoscientist in the State of Texas and a qualified groundwater scientist as defined in 30 TAC §330.3. I have reviewed the groundwater monitoring system and supporting data contained herein. In my professional opinion, the groundwater monitoring system is in compliance with the groundwater monitoring requirements specified in 30 TAC §330.401 through §330.421. This system has been designed for specific application to the Fairbanks Landfill (Permit Application No. MSW 1565B). The only warranty made by me in connection with this document is that I have used that degree of care and skill ordinarily exercised under similar conditions by reputable members of my profession, practicing in the same or similar locality. No other warranty, expressed or implied, is intended.

Firm/Address: Biggs and Mathews Environmental, Inc.
1700 Robert Road, Suite 100
Mansfield, Texas 76063

STATE OF TEXAS
JOHN MICHAEL SNYDER
GEOLOGY
595
LICENSED
PROFESSIONAL GEOSCIENTIST

Signature: John Michael Snyder, P.G.
No. 595-Texas

6-10-2014

Biggs & Mathews Environmental, Inc.
Firm Registration No. 50222

Date: ______________________

# 1 SITE HYDROGEOLOGY

## 1.1 Hydrogeologic Units

Since the 1998 permit amendment application for the site, Layer II has been identified as the uppermost groundwater zone rather than the uppermost aquifer. Layer IV has been consistently identified as the uppermost aquifer in groundwater monitoring reports submitted to the TCEQ since that time and is referred to as the uppermost aquifer. The identification of Layer IV as the uppermost aquifer is appropriate because the Layer II sand was historically excavated for sand mining purposes resulting in dewatering of this stratum. This dewatering frequently created dry monitoring wells. In addition, Layer II occurs only in the sidewalls of the facility whereas Layer IV underlies the entirety of the waste fill excavation. Layer IV has been unaltered by excavation activities, and is present beneath the entire excavation, and monitoring wells in this zone routinely have groundwater to be sampled.

Because the Layer II sand has been removed at the downgradient south and east sides of the site and replaced by reconstructed clay sidewalls and backfilled material, it would not be possible to obtain representative groundwater samples from Layer II as required by 30 TAC 330.403. Details of the constructed fill can be found in Section 5 of the LQCP (Part III, Attachment 3C and in Attachment 3A, Drawings 3-6 through 3-11).

Furthermore, because the Layer II sand is (or will be) substantially removed from this site and no Layer II sand remains at the downgradient east and south perimeter of the site, Layer IV is the uppermost aquifer at the site.

### 1.1.1 Layer II Groundwater Zone

As described in Section 4.4, site stratigraphy is divided into five geologic units: Layer I (surficial sand, silt, and clay), Layer II (sand), Layer III (clay), Layer IV (sand) and Layer V (clay). The uppermost groundwater zone at the site is the Layer II sand unit. Water levels measured in site monitoring wells and exploratory borings indicate that groundwater in the upper Layer II sand unit occurs under generally unconfined, water-table conditions and is confined or retarded at its lower limit by the underlying Layer III clay. The original thickness of Layer II ranged from approximately 20 to 40 feet and had an average thickness of approximately 35 feet.

Open excavations on the site and adjacent properties have been excavated for sand mining and waste filling operations. Over most of the existing site the Layer II sand has been removed. When the excavation for the proposed waste area is complete Layer II will have been removed across much of the existing site and the proposed expansion area (see Attachment 4, Figure 4C-9, 4F-2, and 4F-3). Groundwater levels in Layer II are affected by natural dewatering related to evaporation in the open excavation.

*Prepared for:*
**USA Waste of Texas Landfills, Inc.**

# PERMIT AMENDMENT APPLICATION
# PART III – SITE DEVELOPMENT PLAN
# ATTACHMENT 6

# LANDFILL GAS MANAGEMENT PLAN

# FAIRBANKS LANDFILL
# MSW PERMIT NO. 1565B
# HOUSTON, HARRIS COUNTY, TEXAS

*Prepared by:*


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6/10/2014

STATE OF TEXAS
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FOR PERMIT PURPOSES ONLY

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**TABLES**



**DRAWINGS**



STATE OF TEXAS
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**APPENDICES**

c. If the initial detection is verified to be an exceedance, the following parties shall be notified of the situation via one of the following - email, telephone, fax, letter, or other forms of communication:
    - The Manager of the MSW Permits Section of TCEQ's Waste Permits Division in Austin;
    - TCEQ Region 12;
    - the local Fire Department and Harris County Public Health and Environmental Services; and
    - neighboring landowners within 500-ft of the exceedance location.

    By making the TCEQ notifications identified above, this will constitute providing notice to the TCEQ Executive Director in accordance with 30 TAC §330.371(c)(1).

2. <u>Within Seven Days of Verified Exceedance</u>. A record of the methane gas levels detected and a description of the immediate actions taken to protect human health will be placed in the Site Operating Record.

3. <u>Within 60 Days of Verified Exceedance</u>.
    a. A detailed evaluation will be made to determine the potential source and extent of the methane gas migration. A Remediation Plan will be prepared and must be submitted to the TCEQ Executive Director. The Remediation Plan will present the results of the detailed evaluation, along with the remedial measures taken, which may include additional monitoring, source control t (e.g., installation of gas vent(s)) a passive interceptor trench/barrier system, active building ventilation systems,), etc.
    b. The Remediation Plan will incorporate remediation performance monitoring. The remediation performance monitoring will be conducted on a monthly basis at the affected gas monitoring location(s) and will submitted to TCEQ, until methane concentrations in the affected gas monitoring location(s) are below the allowable limits specified at the beginning of this section for six (6) consecutive months.

As allowed by 30 TAC §330.371(d), alternate schedules to those given above may be established by the TCEQ Executive Director.