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19 April 2021

Mr. Steve Odil
MC-124
Texas Commission on Environmental Quality (TCEQ)
MSW Permits Section, Waste Permits Division
12100 Park 35 Circle
Austin, Texas 78753

Subject: Response to Information Request
Permit Modification (with Notice) Request
Mesquite Creek Landfill, MSW Permit No. 66B
New Braunfels, Comal and Guadalupe Counties, Texas
Tracking No. 25969093; RN100218676/CN600127856

Dear Mr. Odil:

On behalf of Waste Management of Texas, Inc. (WMTX), Geosyntec Consultants (Geosyntec) has prepared this letter in response to the information request (comments) on the above-referenced permit modification request transmitted in a 7 April 2021 E-mail from the Texas Commission on Environmental Quality (TCEQ) to Waste Management of Texas, Inc. (WMTX).

RESPONSE TO COMMENTS

TCEQ's comments are presented below in italicized type, with responses immediately following the comments in regular type. Additionally, where applicable, resulting replacement pages 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 TCEQ's review.

Comment 1: *The submittal indicates that proposed changes will decrease Unit 2 stability based on numerous new calculated factors of safety (Fs). Address the following.*

a. Provide support for a 1.00 factors of safety (FS) for the liner system. Attachment 4, page 4-30 indicates that the calculated FS for liner system stability prior to waste placement will decrease from 1.01 to 1.00.

b. Provide support for the new value of 7,000 pounds per square inch cohesion now used for Stratum IV, as indicated in Appendix 4-F on page 4F-7.

c. Provide design requirements for the soil buttress referenced in page 4F-10 and the achieved FS. In Appendix 4F, page 4F1-10 provides the calculation of the 1.00 for the FS. Existing text next to this calculation indicates that "soil buttress required for stability."

Response to Comment 1:

a. Attachment 4, page 4-30 indicates that the target minimum calculated factor of safety using large-displacement strengths is 1.0 for short-term conditions. This design criterion was already established in approved Permit No. 66B, and no changes are proposed under this modification. This large-displacement strength (also referred to as "residual strength") factor of safety was selected based on industry standard liner design recommendations by Stark and Choi (2004) "Peak Versus Residual Interface Strengths for Landfill Liner and Cover Design". Also note that TCEQ's Technical Guideline No. 3 (TG-3) for Nonhazardous Industrial Solid Waste Landfills – although not specifically applicable to this MSW facility – also includes the statement that "*The safety factor of other potential conditions, including development of residual strength, should be at least 1.0*." The newly reported result as part of this requested permit modification meets the required stability criterion. For the foregoing reasons, no changes have been made.

b. Previous analyses in the permit application modeled Stratum IV as a clay (same as Stratum III) for simplicity. With a taller/deeper slope, a more realistic/representative section was modeled to account for the actual stratigraphy of Stratum III and IV. From Attachment 4 (Geology Report), Table 4-7, Stratum IV has measured undrained shear strength values of 113,000 pounds per square foot (psf), 37,900 psf, and 75,000 psf with a calculated average undrained shear strength of 75,000 psf. Therefore, the Stratum IV undrained shear strength value of 7,000 psf selected for analysis is highly conservative as it is approximately one order of magnitude less than the average of measured strengths. Table 4-7 of the Geology Report is already referenced as the data source in the requested permit modification; therefore, no changes have been made.

c. The term "soil buttress" is not a distinct feature to be designed/constructed but rather refers to the protective cover soil at the toe of the slope. This wedge of protective cover soil at the toe of slope provides resistance against sliding in the veneer stability calculation, which is based on the Giroud et al. (1995) method. It is not a separate feature or requirement. The unnecessary "soil buttress" terminology in the Appendix 4F has been removed for clarity, and replacement pages are provided with this response.

Comment 2: *Changes that will affect stormwater drainage include elimination of Unit 3 and contour changes to Unit 2 that will create more 3:1 grade side slopes. Also, according to Attachment 6, Figure 6-11, changes have been made to Unit 1 perimeter drainage channels. Address the following*

a. Clarify what changes are proposed on Figure 6-11, as the entire table is clouded.

b. The modification must demonstrate that changes proposed do not adversely alter drainage patterns approved under Permit No. 66A, based on discharge rate, discharge velocity, and total discharge volume at each outfall. Outfall analyses are not provided. In Attachment 6J, Table 6J-2 shows significant increases to velocities and volumetric flow rates in final cover and perimeter channels. Total discharge volumes are not discussed. It is not clear that these changes will not result in adverse changes at outfalls. Modify *appropriate sections of the application to update the sections on the demonstration of no adverse change. If not, expand Attachment 6J to adequately demonstrate that this is not necessary.*

Response to Comment 2:

a. The only change to the "clouded" table on Figure 6-11 was to delete the rows of the table for Channel segments RD1 through RD7 and RE1 through RE4. These segments were associated with Unit 3, and thus have been deleted from the table in conjunction with this proposed modification. To facilitate review, a photocopy of the previous version of this table on Figure 6-11 is attached to this response letter, and has been manually marked to show the deleted rows.

b. This comment was discussed with TCEQ during a teleconference on 14 April 2021 in order to clarify the approach that was taken, as contained in the initial submittal of this permit modification request, to make the demonstration regarding the drainage patterns. As discussed, the information presented in Table 6J-1 in Attachment 6J makes comparisons of runoff rates, runoff volumes, and times to peak discharge between the "Base Case" (which refers to the final cover layout currently reflected in approved Permit No. 66B before submittal of this modification) and the "Supplemental Case" (which refers to the revised layout associated with this requested permit modification). Table 6J-1 presents results of analyses at "Points of Interest" (which refers to on-site locations that receive stormwater runoff from the areas affected by this modification but before the runoff enters the on-site ponds). The logic of this approach was that, if it could be shown that there are negligible differences at the Points of Interest between the Base Case and Supplemental Case, this would serve as an adequate demonstration that the drainage patterns have not been altered (adversely, or otherwise). Inspection of Table 6J-1 reveals this to be the case. Accordingly, no additional analyses are necessary, but the narrative text of Attachment 6J has been revised to better-explain this approach.

PERMIT MODIFICATION FORM AND CERTIFICATION STATEMENT

Pages 1 and 5 of the Permit Modification Form are being submitted with this response. Page 5, the Signature Page, provides the certification statement signed by the applicant's responsible official.

CLOSING

One original and two copies of this submittal are being provided to the TCEQ MSW Permits Section in Austin. Also, one copy has been sent directly to TCEQ Region 13 Office, as indicated on the distribution list at the end of this letter. 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.
Senior Principal

Copy to: Mr. Cameron Lopez, TCEQ Region 13 Office
Mr. Chuck Rivette, WMTX
Mr. Jayson Lang, WMTX

PHOTOCOPY OF CURRENT PERMITTED SCHEDULE OF PERIMETER DRAINAGE CHANNELS ON FIGURE 6-11 (APPROVED 2006)

(table has been manually marked to show deleted rows)

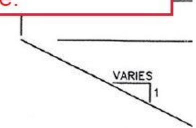
Photocopy of current-permitted Figure 6-11 (approved 2006)

PERIMETER DRAINAGE CHANNEL SCHEDULE–UNITS 1 AND 3

CHANNEL SEGMENT	CHANNEL SHAPE	CHANNEL SLOPE (%)	CHANNEL DIMENSIONS (MINIMUM) LENGTH (FT)	BOTTOM WIDTH (FT)	DEPTH (FT)	SIDE SLOPES	TOP WIDTH (FT)	25–YEAR PEAK FLOW (CFS)	25–YEAR PEAK DEPTH (FT)	25–YEAR PEAK VELOCITY (FT/S)	TRACTIVE STRESS (PSF)	LINING
RA1	TRAPEZOIDAL	0.5	673.77	8	4	0.33	32	243.84	3.05	4.65	0.95	TYPE 1
RA2	TRAPEZOIDAL	0.81	490.86	8	4	0.33	32	153.95	2.17	4.9	1.09	TYPE 2
RA3	TRAPEZOIDAL	2.62	261.27	4	3	0.33	22	112.02	1.71	7.15	2.8	TYPE 2
RA4	TRAPEZOIDAL	4.4	977.24	4	3	0.33	22	112.02	1.52	8.65	4.16	TYPE 2
RA5	TRAPEZOIDAL	3.02	224.73	4	3	0.33	22	112.02	1.66	7.53	3.12	TYPE 2
RA6	TRAPEZOIDAL	1.05	310.09	4	3	0.33	22	19.1	0.9	3.18	0.59	TYPE 1
RB1	TRAPEZOIDAL	1.04	383	8	2	0.10/0.25	36	26.9	0.73	2.81	0.47	TYPE 1
RB2	TRAPEZOIDAL	1.58	253	8	2	0.10/0.25	36	26.9	0.65	3.27	0.65	TYPE 1
RD1	TRAPEZOIDAL	2.88	89.41	8	2	0.33/0.25	22	19.5	0.5	4.03	0.89	TYPE 1
RD2	TRAPEZOIDAL	5.53	102.62	8	2	0.33/0.25	22	19.5	0.41	5.01	1.42	TYPE 2
RD3	TRAPEZOIDAL	6.4	307.87	8	2	0.33/0.25	22	19.5	0.4	5.26	1.58	TYPE 2
RD4	TRAPEZOIDAL	3.92	215.5	8	2	0.33/0.25	22	19.5	0.46	4.47	1.11	TYPE 2
RD5	TRAPEZOIDAL	0.38	305.7	8	2	0.33/0.25	22	19.5	0.87	2.02	0.21	TYPE 1
RD6	TRAPEZOIDAL	1.15	70.2	8	2	0.33/0.25	22	19.5	0.64	2.95	0.46	TYPE 1
RD7	TRAPEZOIDAL	2.41	213.99	8	2	0.33/0.25	22	19.5	0.52	3.79	0.79	TYPE 1
RE1	TRAPEZOIDAL	1.26	220.65	8	2	0.33/0.25	22	9.8	0.42	2.43	0.33	TYPE 1
RE2	TRAPEZOIDAL	5.01	132.06	8	2	0.33/0.25	22	9.8	0.28	3.82	0.89	TYPE 1
RE3	TRAPEZOIDAL	12.23	187.62	8	2	0.33/0.25	22	9.8	0.22	5.1	1.67	TYPE 2
RE4	TRAPEZOIDAL	4.83	156.5	8	2	0.33/0.25	22	9.8	0.29	3.78	0.87	TYPE 1
RF1	TRAPEZOIDAL	3.73	230	4	4	0.33	28	48	1.04	6.48	2.42	TYPE 2
RF2	TRAPEZOIDAL	5.1	218	4	4	0.33	28	48	0.96	7.26	3.06	TYPE 2
RF3	TRAPEZOIDAL	3.72	202	4	4	0.33	28	48	1.04	6.48	2.42	TYPE 2
RF4	TRAPEZOIDAL	0.95	554	4	4	0.33	28	48	1.46	3.93	0.86	TYPE 1

LINING TYPE 1 IS NATIVE VEGETATION. LINING TYPE 2 IS TURF REINFORCEMENT MAT AND NATIVE VEGETATION HAVING AN ALLOWABLE TRACTIVE STRESS GREATER THAN THAT SHOWN. ALTERNATE LINING MATERIAL MAY BE SUBSTITUTED, GIVEN THAT IT HAS A MANNING'S COEFFICIENT LESS THAN OR EQUAL TO THAT ASSUMED IN THE CALCULATIONS AND HAS AN ALLOWABLE TRACTIVE STRESS GREATER THAN 1 PSF.
SEE DRAWING 6–4 FOR CHANNEL DESIGNATIONS

These rows deleted for 2021 Permit Mod. Remaining table rows remain the same.



TCEQ PERMIT MODIFICATION APPLICATION FORM UPDATE PAGES

(includes Applicant's Certification Statement)

Facility Name: Mesquite Creek Landfill
Permittee/Registrant Name: Waste Management of Texas, Inc.
MSW Authorization #: 66B
Initial Submittal Date: 03/02/2021
Revision Date: 04/19/2021

Texas Commission on Environmental Quality

Permit/Registration Modification and Temporary Authorization Application Form for an MSW Facility

1. Reason for Submittal

☐ Initial Submittal ☒ Notice of Deficiency (NOD) Response

2. Authorization Type

☒ Permit ☐ Registration

3. Application Type

☒ Modification with Public Notice ☐ Modification without Public Notice
☐ Temporary Authorization (TA) ☐ Modification for Name Change/Transfer

4. Application Fees

☐ Pay by Check ☒ Online Payment

If paid online, enter ePay Trace Number: 582EA000423110

5. Application URL

Is the application submitted for a permit/registration modification with public notice?

☒ Yes ☐ No

If the answer is "Yes", enter the URL address of a publicly accessible internet web site where the application and all revisions to that application will be posted in the space provided: http:// www.wm.com/wm/permits-texas/permits.jsp

6. Confidential Documents

Does the application contain confidential documents?

☐ Yes ☒ No

If "Yes", cross-reference the confidential documents throughout the application and submit as a separate attachment in a binder clearly marked "CONFIDENTIAL."

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: [signature] Date: 4-19-21

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 19th day of April, 2021
My commission expires on the 6th day of May, 2025

[signature]
Notary Public in and for
Travis County, Texas
(Note: Application Must Bear Signature & Seal of Notary Public)

NOTARY PUBLIC STATE OF TEXAS
SUHAIR BENOIT
Notary ID #126892013
My Commission Expires
May 6, 2025

MARKED (REDLINE/STRIKETHROUGH) PAGES

To facilitate TCEQ's review, the attached pages present a "redline/strikethrough" version of the following items, showing the proposed revisions:

- Part III, Attachment 4, Appendix 4F, Appendix 4F-1 Veneer Slope Stability Analysis (Pages 4F1-1, 4F1-2, and 4F1-8 – 4F1-10)

- Part III, Attachment 6, Attachment 6J, (Cover Page, Table of Contents, and Pages 6J-1 – 6J-7)

APPENDIX 4F-1

VENEER SLOPE STABILITY ANALYSIS

VENEER SLOPE STABILITY ANALYSIS

FOR PERMIT PURPOSES ONLY.
SEALED FOR FEBRUARY AND APRIL 2021 REVISIONS ONLY.

INTRODUCTION

The purpose of this calculation package is to present the veneer slope stability analysis of the liner system of Unit 2 and the final cover system of Units 1 and 2 of the Waste Management of Texas (WMTX) Mesquite Creek Landfill. The liner system will be constructed on 3 horizontal to 1 vertical (3H:1V) excavation side slopes. Since liner system stability represents an interim condition for the period between the liner system installation and waste placement against the liner system, the target minimum calculated factor of safety is 1.25. The final cover system will be constructed on 3H:1V waste slopes. Since final cover system stability represents a long-term condition, the target minimum calculated factor of safety is 1.5. For all cases of veneer stability considered herein, the target minimum calculated factor of safety using large-displacement strengths is 1.0 for liner systems and 1.15 for final cover systems.

The approach taken herein is to assume representative minimum peak and large displacement secant effective-stress friction angles for the liner system and final cover system interfaces, and then calculate the maximum height that protective cover can be placed on the liner or cover system for a selected target factor of safety. The results of the analysis are incorporated into the SLQCP (Attachment 10 of the Site Development Plan (SDP)) and the FCQCP (Attachment 12 to the SDP).

METHOD

An analysis of veneer stability considers noncircular wedge-type potential slip surfaces that extend along a liner system or final cover system. The critical interface for a liner system or cover system that incorporates geosynthetics typically occurs along an interface between a geosynthetic and an adjacent geosynthetic or soil.

The finite slope factor of safety equation, as formulated by Giroud et al. (1995), is:

Written by:	R. El-Sherbiny/ L. Peve	Date:	05 21 /10 /044~~1~~ /10 /15~~4~~ (YY/MM/DD)	Reviewed by:	B. Gross/ S. Graves	Date:	05 21 /11 /044~~2~~ /11 /16~~2~~ ~~4~~ (YY/MM/DD)
Client:	WMTX	Project:	Mesquite Creek Landfill	Project/Proposal No.:	GT3435	Task No:	04

A table of increment placement heights for the protective cover and corresponding minimum interface friction angles of the liner system to achieve the target calculated factors of safety for both short-term and long-term stability is presented below. Compliance with placement heights from the long-term stability analysis with drained soil conditions is required if the protective cover is to be exposed for a period sufficient for soil drainage. The incremental placement height may be adjusted based on the results of the site-specific interface tests (i.e., taller or shorter increment heights may be used depending on the measured interface friction angle). Based on the results of the calculations, a minimum peak secant interface friction angle of 21.1° and a large displacement secant friction angle of 16.8° is specified at a normal stress of 500 psf for the tallest 3H:1V liner system side slope.

1. Using peak interface friction angle:

1.i. Undrained soil condition:

$$FS = \frac{\tan 21.1°}{\tan 18.4°} + \left[\frac{1}{(120)(2)}\right]\left[\frac{\frac{1}{\sin 18.4° \cos 18.4°}}{1 - \tan 18.4° \tan 0°}\right]\frac{(400)(2)}{(106)}$$

FS = 1.16 + 0.10 = 1.26~~ (stable (FS = 1.16 >1) without soil buttress)~~

1.ii. Drained soil condition:

$$FS = \frac{\tan 21.1°}{\tan 18.4°} + \left[\frac{\frac{\tan 25°}{2 \sin 18.4° \cos^2 18.4°}}{1 - \tan 18.4° \tan 25°}\right]\frac{(2)}{(106)}$$

$$+ \left[\frac{1}{(120)(2)}\right]\left[\frac{\frac{1}{\sin 18.4° \cos 18.4°}}{1 - \tan 18.4° \tan 25°}\right]\frac{(250)(2)}{(106)}$$

FS = 1.16 + 0.02 + 0.07 = 1.25~~(stable (FS = 1.16 >1) without soil buttress)~~

2. Using large-displacement interface friction angle:

2.i. Undrained soil condition:

$$FS = \frac{\tan 16.8°}{\tan 18.4°} + \left[\frac{1}{(120)(2)}\right]\left[\frac{\frac{1}{\sin 18.4° \cos 18.4°}}{1 - \tan 18.4° \tan 0°}\right]\frac{(400)(2)}{(106)}$$

FS = 0.90 + 0.10 = 1.0~~ (soil buttress required for stability)~~

2.ii. Drained soil condition:

$$FS = \frac{\tan 16.8°}{\tan 18.4°} + \left[\frac{\frac{\tan 25°}{2 \sin 18.4° \cos^2 18.4°}}{1 - \tan 18.4° \tan 25°}\right]\frac{(2)}{(106)}$$

$$+ \left[\frac{1}{(120)(2)}\right]\left[\frac{\frac{1}{\sin 18.4° \cos 18.4°}}{1 - \tan 18.4° \tan 25°}\right]\frac{(250)(2)}{(106)}$$

FS = 0.90 + 0.02 + 0.08 = 1.0~~(soil buttress required for stability)~~

Incremental Placement Heights for Liner System Protective Cover that Result in a Minimum Calculated Factor of Safety of 1.25.

δ (degrees)	Maximum Protective Cover Incremental Placement Height, h (ft) (3H:1V Slope)	
	Undrained soil condition	**Drained soil condition**
18	40	36
19	51	46
20	70	65
20.1	73	67
21.1	120	106
22	296	271

Final Cover System (3H:1V Side Slopes, δ_{peak}=21.3°, $\delta_{Large\ disp}$=16.0°, β=18.4°, h = 30')

Calculated factors of safety for both short-term and long-term stability of the final cover system are presented below. Based on the results of the calculations, a minimum peak secant interface friction angle of 21.3° and a large displacement secant friction angle of 16.0° is specified at a normal stress of 500 psf to achieve the target factors of safety for the tallest 3H:1V final cover system side slope.

1. Using peak interface friction angle:

1.i. Undrained soil condition:

$$FS = \frac{\tan 21.3°}{\tan 18.4°} + \left[\frac{1}{(120)(2)}\right]\left[\frac{\frac{1}{\sin 18.4° \cos 18.4°}}{1 - \tan 18.4° \tan 0°}\right]\frac{(400)(2)}{(30)}$$

FS = 1.17 + 0.37 = 1.54~~(soil buttress required for stability)~~

1.ii. Drained soil condition:

Written by:	R. El-Sherbiny/ L. Peve	Date:	05 21	/10 /041	/10 /154	Reviewed by:	B. Gross/ S. Graves	Date:	05 21	/11 /042	/11 /162 4
			YY	MM	DD				YY	MM	DD

Client: WMTX Project: Mesquite Creek Landfill Project/Proposal No.: GT3435 Task No: 04

$$FS = \frac{tan\ 21.3°}{tan\ 18.4°} + \left[\frac{\frac{tan\ 25°}{2\ sin\ 18.4°\ cos^2\ 18.4°}}{1 - tan\ 18.4°\ tan\ 25°}\right]\frac{(2)}{(30)} + \left[\frac{1}{(120)(2)}\right]\left[\frac{\frac{1}{sin\ 18.4°\ cos\ 18.4°}}{1 - tan\ 18.4°\ tan\ 25°}\right]\frac{(250)(2)}{(30)}$$

FS = 1.17 + 0.06 + 0.27 = 1.51 ~~(soil buttress required for stability)~~

2. Using large-displacement interface friction angle

2.i. Undrained soil condition:

$$FS = \frac{tan\ 16.0°}{tan\ 18.4°} + \left[\frac{1}{(120)(2)}\right]\left[\frac{\frac{1}{sin\ 18.4°\ cos\ 18.4°}}{1 - tan\ 18.4°\ tan\ 0°}\right]\frac{(400)(2)}{(30)}$$

FS = 0.86 + 0.37 = 1.23 ~~(soil buttress required for stability)~~

2.ii. Drained soil condition:

$$FS = \frac{tan\ 16.0°}{tan\ 18.4°} + \left[\frac{\frac{tan\ 25°}{2\ sin\ 18.4°\ cos^2\ 18.4°}}{1 - tan\ 18.4°\ tan\ 25°}\right]\frac{(2)}{(30)} + \left[\frac{1}{(120)(2)}\right]\left[\frac{\frac{1}{sin\ 18.4°\ cos\ 18.4°}}{1 - tan\ 18.4°\ tan\ 25°}\right]\frac{(250)(2)}{(30)}$$

FS = 0.86 + 0.06 + 0.27 = 1.20 ~~(soil buttress required for stability)~~

CONCLUSIONS

For the analyses using peak strengths herein, GeoSyntec selected target minimum calculated factors of safety of 1.25 for the liner system and 1.5 for the final cover system. A specified minimum peak secant interface friction angle of 21.1° for the liner system was selected to achieve the target minimum calculated factor of safety (at a normal stress of 500 psf) for the tallest liner slope at the facility. For the liner system, the slope stability analysis shows that the calculated maximum incremental cover placement height varies with the minimum secant interface friction angle. With the specified minimum interface friction angle of 21.1°, the calculated maximum protective cover placement height is 106 ft for 3H:1V side slopes, which is equal to the highest side slope for Unit 2. For all cases, the incremental placement height may be adjusted based on the results of the site-specific interface tests and the table presented above. For the final cover system, the calculated factor of safety is approximately 1.51 for a minimum peak secant interface

Prepared for Applicant:

Waste Management of Texas, Inc.
1000 Kohlenberg Lane
New Braunfels, Texas 78130
(830) 625-7894

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

SUPPLEMENTAL HYDROLOGY AND HYDRAULICS EVALUATION

MESQUITE CREEK LANDFILL
NEW BRAUNFELS,
COMAL AND GUADALUPE COUNTIES, TEXAS
MSW PERMIT NO. 66B

Prepared by:

Geosyntec consultants
Texas Board of Professional Engineers Firm Registration No. F-1182
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Austin, Texas 78757
(512) 451-4003

Initial Submittal – 24 February 2021
Revised – 19 April 2021

TABLE OF CONTENTS

SUPPLEMENTAL HYDROLOGY AND HYDRAULICS EVALUATION

PURPOSE

This Supplemental Hydrology and Hydraulics Evaluation (Supplemental Report) has been prepared to accompany a permit modification application dated February 2021 to request revisions to the landfill layout, thus necessitating an assessment of the potential effects on the facility drainage plan. More specifically, the permit modification proposes to eliminate Unit 3 (which has never been constructed) from the permit, and to compensate for this loss of airspace, make adjustments to the Unit 2 base and final cover grades. The changes to the Unit 2 final cover grades are minor, and by comparing the previously approved final cover grades to the new proposed grades (e.g., on Part III, Attachment 6 (Storm Water Plan), Drawing 6-1), it is evident that they are "*de minimis*" in terms of drainage patterns on the final cover and overall site surface water management. However, to check and affirm this, this Supplemental Report (i) evaluates the post-development drainage conditions under the proposed minor revisions; and (ii) verifies that no changes are necessary to the existing surface water management system design established in the Storm Water Plan. Specific objectives of this Supplemental Report are to:

- describe how the proposed changes may affect some of the hydrologic elements and drainage features of the currently permitted facility;
- conduct an updated post-development drainage hydrologic analysis;
- compare the updated post-development discharges resulting from this modification to the post-development discharges ~~under~~ reflected in the final cover layout of the approved~~current~~ P~~p~~ermit No. 66B design conditions before submittal of this modification, to demonstrate that the proposed minor changes will not adversely impact or otherwise change to any significant degree the discharges from the site; and
- analyze and demonstrate that the hydraulic sizing of affected surface water conveyances established in the Storm Water Plan of the current permit are still met as-designed.

Note that the post-development hydrologic modeling was performed using the latest available "Atlas 14" rainfall data (National Oceanic and Atmospheric Administration (NOAA), Atlas 14, 2018) and agency guidance. To compare "apples-to-apples", both the currentas-permitted post-development condition and the proposed revised post-development condition from this 2021 modification were re-modeled with the latest Atlas 14 rainfall data.

OVERVIEW OF PROPOSED MODIFICATIONS TO THE SURFACE WATER MANAGEMENT SYSTEM

Unit 3 is proposed to be removed from the permit, and as a result, surface water runoff from the Unit 3 area will continue to route to the same unnamed tributary of Mesquite Creek following drainage patterns consistent with natural conditions.

The Unit 2 area is proposed to be modified by (i) reducing the final cover top-deck slope from 5% to 2% (the peak landfill elevation of 690-ft MSL remains unchanged); and (ii) slightly extending the 3(horizontal):1(vertical) (3H:1V) side slopes to intersect the updated 2% top-deck surface, shifting the alignment of the crest formed by the final cover top-deck and side slopes inward. Side slope benches and downchute channels have been slightly extended to tie in with the adjusted top-deck.

The Unit 2 landfill footprint area is unchanged, and accordingly the total acreage associated with surface water runoff routing off the Unit 2 area is unchanged as well. Surface water will continue to be routed in the same manner as described in the Storm Water Plan.

The configuration of all features in the Unit 2 area that are downstream of the top-deck downchute channels (i.e., perimeter channels, culverts, and storm water detention ponds) are not be affected by the proposed final cover grading revisions.

SUPPLEMENTAL HYDROLOGY MODELING

This supplemental hydrology modeling evaluates the post-development drainage patterns at the site, comparing the results of the Base Case versus the Supplemental Case. The "Base Case" refers to the final cover layout currently reflected in approved Permit No. 66B before submittal of this modification, and as such, is an evaluation ofes the post-development model presented in the Storm Water Plan.; and tThe "Supplemental Case" refers to the revised layout associated with this permit modification, and as such, is an evaluation of a post-development model of the revised layout resulting from this modificationincorporates the changes associated with the Permit Mod. The analyses presented herein both (Base Case and Supplemental Case) incorporate the latest available Atlas 14 rainfall data and agency guidance. This was done to generate results that would be compatible for comparison purposes (i.e., "apples-to-apples").

Updated Hydrologic Parameters

The hydrologic methodology and parameter selection in this Supplemental Report are consistent with those described in the Storm Water Plan, except for the following updates to simplify the model to focus on the areas being changed.

- All nodes in the Unit 1 and Unit 3 areas not discharging to the comparison point of interest referred to herein as "Point A" (i.e., regions of the Unit 1 and Unit 3 area unimpacted by the removal of Unit 3) are removed from the simplified model. Point A is the appropriate point of interest for this area because it is situated at the point where stormwater runoff is received from the Unit 3 area affected by this modification, before it continues to pass downstream. In other words, it is the uppermost node in the hydrology model that captures the removal of Unit 3 and ~~is selected as~~thus is the relevant ~~a~~ point of comparison between the Base Case and Supplemental Case to assess whether there are changes in the runoff characteristics.
- At Unit 2, the four low points along the perimeter drainage system (junctions J-1 through J-4) are the appropriate points of interest for these areas because they are situated at points where stormwater runoff is received from Unit 2 areas affected by this modification, before it continues to pass downstream into storm water ponds. In other words, these are the uppermost nodes in the hydrology model that encapsulate proposed modifications associated with Unit 2, and thus are relevant points of comparison between the Base Case and Supplemental Case to assess whether there are changes in the runoff characteristics. ~~All nodes in the Unit 2 area downstream of the perimeter drainage system (i.e., all regions of the Unit 2 area that are not in contact with the modified Unit 2 final cover system) are removed from the simplified model. The four low points along the perimeter drainage system (junctions J-1 through J-4) are the uppermost nodes in the hydrology model that encapsulate all proposed modifications and are selected as points of comparison between the Base Case and Supplemental Case.~~
- The 24-hour, 2-year storm and 24-hour, 25-year storm are updated to 4.06 inches 8.90 inches, respectively. Rainfall values are based on region-specific data published by the NOAA (2018), as presented in Appendix 6J-1.
- Time of concentration calculations are performed on all subbasins according to the 24-hour, 2-year rainfall depth of 4.06 inches. Time of concentration calculations for all nodes are calculated with a maximum sheet flow length of 100 feet to reflect the latest Texas Department of Transportation guidance (TXDOT, 2019).
- The latest version of HEC-HMS (Version 4.7, 2020) is utilized. Kinematic Wave Routing is used for all reaches with index flows that are determined iteratively

using guidance from the US Army Corps of Engineers (USACE, 2018) by setting the index flow for a given reach equal to half of the peak discharge from the 24-hour, 25-year event routing into the reach.

Hydrologic Parameter Considerations Specific to the Supplemental Case

The Supplemental Case is altered relative to the Base Case to account for the proposed changes, with the following considerations.

- Subbasins associated with Unit 3 (Subbasin-12 through Subbasin-16) were replaced with Subbasin-12-16, which routes directly into Point A and has an equivalent area to Subbasins-12 through Subbasin-16 combined. A curve number of 80 was selected, consistent with the current permit, to represent undeveloped conditions and a time of concentration was calculated according to the natural condition grades established in the Storm Water Plan .
- No reaches, subbasins, discharge points, or junctions were added.
- Acreages and times of concentration were recomputed for the slightly-adjusted subbasin layout associated with the Unit 2 final cover area to reflect the changes to the top-deck slope and crest alignment mentioned in the previous section.
- Combined acreages routing to each downchute are comparable to the Base Case. Slight variations in acreages are attributed to the side slope bench system being adjusted to tie into the modified Unit 2 crest alignment.

Results of the Supplemental Hydrology Analysis

Basin delineations for the Base Case are presented on Drawing 6-3 of the Storm Water Plan (i.e., the post-development plan, as currently permitted). Basin delineations at Unit 2 for the Supplemental Case are shown on a figure contained in Appendix 6J-2 of this document. Also, the combined exterior boundaries formed by Subbasin-12 and Subbasin-15 on Drawing 6-3 incorporates the boundary used to define Subbasin-12-16 for the Unit 3 area of the Supplemental Case. Other basin delineations for the Supplemental Case are shown in Appendix 6J-2.

Time of concentration calculations are included as Appendix 6J-3. Hydrographs for each of the five assessment points comparing the two supplemental cases are included as Appendix 6J-4. HEC-HMS results for the supplemental cases are included as Appendix 6J-5 and summarized in Table 6J-1.

TABLE 6J-1
HEC-HMS RESULTS FOR THE 24-HOUR, 25-YEAR DESIGN EVENT

	Location	BASE CASE	SUPPLEMENTAL CASE

Assessment Point of Interest		Peak Discharge (CFS)	Time to Peak (Hours)	Runoff Volume (ACRE-FT)	Peak Discharge (CFS)	Time to Peak (Hours)	Runoff Volume (ACRE-FT)
J-1	Low Point at Unit 2 Perimeter Channel	331	12.2	29.5	315	12.2	29.5
J-2	Low Point at Unit 2 Perimeter Channel	140	12.1	11.9	136	12.1	12.1
J-3	Low Point at Unit 2 Perimeter Channel	65	12.1	5.4	65	12.1	5.4
J-4	Low Point at Unit 2 Perimeter Channel	131	12.1	11.2	124	12.1	11.1
A	Low Point at Unit 3	2565	12.6	452.9	2570	12.6	452.4

As discussed, the purpose of the analyses whose results are summarized above in Table 6J-1 is to assess stormwater runoff characteristics at the relevant points of interest under Base Case (initial design layout of approved Permit No. 66B before submittal of this modification) and Supplemental Case (revised layout associated with this permit modification) conditions. Inspection of Table 6J-1 reveals that the Ccalculated peak discharges, times to peak discharge, runoff volumes, and hydrographs at each assessment point of interest are comparable for the modified and currently permitted configuration of the site, demonstrating that the proposed revisions do not affect post-development drainage conditions in any material way.

SUPPLEMENTAL HYDRAULIC ANALYSIS AND RESULTS

This supplemental hydraulic analysis evaluates the final cover surface water conveyances affected by the proposed revisions, comparing the results of the Base Case versus the Supplemental Case. The analysis was performed for affected final cover drainage terraces, benches, top-deck channels, and downchute channels (consistent with design methodology of Attachment 6C of the Storm Water Plan). Note that the perimeter channels for the Unit 2 area, designed in Attachment 6E of the Storm Water Plan, have no proposed modifications but were also included in this Supplemental Report because they are connected to features proposed to be revised. The purpose of this evaluation is to demonstrate that the revised features continue to meet the hydraulic design requirements established in the Storm Water Plan, which include:

- conveyance of the 24-hour, 25-year storm with adequate freeboard; and
- selection of channel lining materials with a permissible tractive stress greater than the calculated tractive stress.

Hydraulic Parameter Considerations Specific to the Supplemental Analysis

The Supplemental Case was updated relative to the Base Case with following considerations.

- For final cover drainage features, peak discharges are established in Attachment 6C of the Storm Water Plan using a linear regression plot of HEC-HMS subbasins associated with final cover landfill areas. This relationship was recalculated as 6.64 cfs/acre multiplied by the number of acres draining to a given component using data from the Supplemental Case, as shown in Appendix 6J-6.
- Subbasins developed for the Supplemental Case were further delineated to evaluate individual reaches of each final cover surface water feature and determine the critical cases for design as a function of acreage and flowline slope. The naming convention for these drainage areas was carried over from Attachment 6C of the Storm Water Plan. Drainage areas associated with the critical cases for the modified condition are shown on the figure in Appendix 6J-7.
- For perimeter channels, peak flow rates for subbasins developed for the HEC-HMS model of the Supplemental Case that correspond to the Unit 2 perimeter channel reaches (nodes R201 through R215) were used to evaluate each respective reach.

Results of the Supplemental Hydraulic Analysis

Results of the hydraulic analysis for the final cover drainage features are included as Appendix 6J-8 and summarized in Table 6J-2. Results of the hydraulic analysis for the perimeter channels are included as Appendix 6J-9 and summarized below in Table 6J-3. Calculated flow depths allow for conveyance of the 25-yr peak flow with 0.5 feet of freeboard or more using the currently permitted channel design. Calculated tractive stresses are below the maximum permissible tractive stresses for the channel lining materials selected in current permit. Bracketed values represent the results of this supplemental report and unbracketed values represent results from the current permit.

TABLE 6J-2
FINAL COVER HYDRAULIC ANALYSIS RESULTS

Channel Type	25-Yr Peak Flow Rate (ft^3/s)	25-Yr Peak Flow Depth (ft)	25-Yr Peak Flow Velocity (ft/s)	25-Yr Peak Tractive Stress (lb/ft^2)	Channel Lining Material
Top-deck Terrace, ≤2.0% Slope	23.5 [26.10]	0.80 [0.72]	3.25 [1.88]	1.00 [0.36]	Grass Lining
Top-deck Terrace, >2.0% Slope	17.4 [n/a]	0.69 [n/a]	3.27 [n/a]	1.07 [n/a]	Turf Reinforcement Mat

Side Slope Bench, ≤3.0% Slope	16.9 [18.2]	0.93 [0.95]	3.56 [3.65]	1.16 [1.19]	Turf Reinforcement Mat
Side Slope Bench, >3.0% Slope	15.8 [18.1]	0.76 [0.80]	4.94 [5.08]	2.37 [2.43]	Turf Reinforcement Mat
Top-deck Channel	50.1 [32.3]	0.68 [0.95]	6.30 [5.08]	1.91 [2.49]	Turf Reinforcement Mat
Downchute Channel	96.7 [113.7]	0.57 [0.62]	12.49 [13.17]	10.08 [10.91]	Reno Mattress

TABLE 6J-3
PERIMETER CHANNEL HYDRAULIC ANALYSIS RESULTS

Channel Segment Designation	25-Yr Peak Flow Rate (ft^3/s)	25-Yr Peak Flow Depth (ft)	25-Yr Peak Flow Velocity (ft/s)	25-Yr Peak Tractive Stress (lb/ft^2)	Proposed Channel Lining Material(1)
R201	15.9 [17.8]	0.59 [0.61]	3.66 [3.74]	0.81 [0.85]	Type 1
R202	16 [17.9]	0.46 [0.49]	5.05 [5.20]	1.59 [1.67]	Type 2
R203	8 [8.1]	0.43 [0.42]	2.77 [2.73]	0.48 [0.47]	Type 1
R204	105.2 [128.1]	1.35 [1.48]	7.49 [7.88]	3.13 [3.44]	Type 2
R205	21 [22.4]	1.00 [1.03]	2.33 [2.37]	0.31 [0.32]	Type 1
R206	8.0 [10.2]	0.43 [0.48]	2.78 [2.98]	0.49 [0.55]	Type 1
R207	8.0 [7.8]	0.50 [0.49]	2.27 [2.25]	0.32 [0.31]	Type 1
R208	23.9 [26.3]	0.59 [0.61]	5.51 [5.60]	1.84 [1.90]	Type 2
R209	24.0 [26.4]	0.73 [0.76]	4.18 [4.30]	1.04 [1.09]	Type 2
R210	20.0 [22.4]	0.79 [0.83]	3.09 [3.17]	0.56 [0.59]	Type 1
R211	19.9 [22.4]	0.56 [0.58]	4.94 [5.07]	1.49 [1.56]	Type 2
R212	19.9 [22.4]	0.53 [0.56]	5.21 [5.35]	1.67 [1.75]	Type 2
R213	99.4 [129.2]	1.61 [1.81]	5.41 [5.79]	1.61 [1.81]	Type 2
R214	174.6 [218.3]	1.87 [2.07]	7.5 [7.94]	3.03 [3.35]	Type 2
R215	174.3 [218]	1.61 [1.78]	9.5 [10.07]	4.96 [5.50]	Type 2

(1) Lining Type 1 is native vegetation. Lining Type 2 is Turf Reinforcement Mat and native vegetation having an allowable tractive stress greater than that shown.

UNMARKED REVISED PAGES

(REPLACEMENT PAGES)

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

- Part III, Attachment 4, Appendix 4F, Appendix 4F-1 Veneer Slope Stability Analysis (Pages 4F1-1, 4F1-2, and 4F1-8 – 4F1-10)
- Part III, Attachment 6, Attachment 6J, (Cover Page, Table of Contents, and Pages 6J-1 – 6J-7)

Written by:	J. Lang/ L. Peve	Date:	05 21 (YY)	/10 /04 (MM)	/11 /15 (DD)	Reviewed by:	B. Gross/ S. Graves	Date: 05 21 (YY) /11 /04 (MM) /11 /16 (DD)
Client:	WMTX	Project:	Mesquite Creek Landfill			Project/Proposal No.:	GT3435	Task No: 03

APPENDIX 4F-1

VENEER SLOPE STABILITY ANALYSIS

Written by:	R. El-Sherbiny/ L. Peve	Date:	05 21 (YY) /10 /04 (MM) /10 /15 (DD)	Reviewed by:	B. Gross/ S. Graves	Date:	05 21 (YY) /11 /04 (MM) /11 /16 (DD)
Client:	WMTX	Project:	Mesquite Creek Landfill	Project/Proposal No.:	GT3435	Task No:	04

VENEER SLOPE STABILITY ANALYSIS

STATE OF TEXAS
SCOTT M. GRAVES
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4/19/2021

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INTRODUCTION

The purpose of this calculation package is to present the veneer slope stability analysis of the liner system of Unit 2 and the final cover system of Units 1 and 2 of the Waste Management of Texas (WMTX) Mesquite Creek Landfill. The liner system will be constructed on 3 horizontal to 1 vertical (3H:1V) excavation side slopes. Since liner system stability represents an interim condition for the period between the liner system installation and waste placement against the liner system, the target minimum calculated factor of safety is 1.25. The final cover system will be constructed on 3H:1V waste slopes. Since final cover system stability represents a long-term condition, the target minimum calculated factor of safety is 1.5. For all cases of veneer stability considered herein, the target minimum calculated factor of safety using large-displacement strengths is 1.0 for liner systems and 1.15 for final cover systems.

The approach taken herein is to assume representative minimum peak and large displacement secant effective-stress friction angles for the liner system and final cover system interfaces, and then calculate the maximum height that protective cover can be placed on the liner or cover system for a selected target factor of safety. The results of the analysis are incorporated into the SLQCP (Attachment 10 of the Site Development Plan (SDP)) and the FCQCP (Attachment 12 to the SDP).

METHOD

An analysis of veneer stability considers noncircular wedge-type potential slip surfaces that extend along a liner system or final cover system. The critical interface for a liner system or cover system that incorporates geosynthetics typically occurs along an interface between a geosynthetic and an adjacent geosynthetic or soil.

The finite slope factor of safety equation, as formulated by Giroud et al. (1995), is:

A table of increment placement heights for the protective cover and corresponding minimum interface friction angles of the liner system to achieve the target calculated factors of safety for both short-term and long-term stability is presented below. Compliance with placement heights from the long-term stability analysis with drained soil conditions is required if the protective cover is to be exposed for a period sufficient for soil drainage. The incremental placement height may be adjusted based on the results of the site-specific interface tests (i.e., taller or shorter increment heights may be used depending on the measured interface friction angle). Based on the results of the calculations, a minimum peak secant interface friction angle of 21.1° and a large displacement secant friction angle of 16.8° is specified at a normal stress of 500 psf for the tallest 3H:1V liner system side slope.

1. Using peak interface friction angle:

1.i. Undrained soil condition:

$$FS = \frac{\tan 21.1°}{\tan 18.4°} + \left[\frac{1}{(120)(2)}\right]\left[\frac{\frac{1}{\sin 18.4° \cos 18.4°}}{1 - \tan 18.4° \tan 0°}\right]\frac{(400)(2)}{(106)}$$

FS = 1.16 + 0.10 = 1.26

1.ii. Drained soil condition:

$$FS = \frac{\tan 21.1°}{\tan 18.4°} + \left[\frac{\frac{\tan 25°}{2 \sin 18.4° \cos^2 18.4°}}{1 - \tan 18.4° \tan 25°}\right]\frac{(2)}{(106)} + \left[\frac{1}{(120)(2)}\right]\left[\frac{\frac{1}{\sin 18.4° \cos 18.4°}}{1 - \tan 18.4° \tan 25°}\right]\frac{(250)(2)}{(106)}$$

FS = 1.16 + 0.02 + 0.07 = 1.25

2. Using large-displacement interface friction angle:

2.i. Undrained soil condition:

$$FS = \frac{\tan 16.8°}{\tan 18.4°} + \left[\frac{1}{(120)(2)}\right]\left[\frac{\frac{1}{\sin 18.4° \cos 18.4°}}{1 - \tan 18.4° \tan 0°}\right]\frac{(400)(2)}{(106)}$$

FS = 0.90 + 0.10 = 1.0

2.ii. Drained soil condition:

$$FS = \frac{tan\,16.8°}{tan\,18.4°} + \left[\frac{\frac{tan\,25°}{2\,sin\,18.4°\,cos^2\,18.4°}}{1 - tan\,18.4°\,tan\,25°}\right]\frac{(2)}{(106)} + \left[\frac{1}{(120)(2)}\right]\left[\frac{\frac{1}{sin\,18.4°\,cos\,18.4°}}{1 - tan\,18.4°\,tan\,25°}\right]\frac{(250)(2)}{(106)}$$

FS = 0.90 + 0.02 + 0.08 = 1.0

Incremental Placement Heights for Liner System Protective Cover that Result in a Minimum Calculated Factor of Safety of 1.25.

δ (degrees)	Maximum Protective Cover Incremental Placement Height, h (ft) (3H:1V Slope)	
	Undrained soil condition	**Drained soil condition**
18	40	36
19	51	46
20	70	65
20.1	73	67
21.1	120	106
22	296	271

Final Cover System (3H:1V Side Slopes, δ_{peak}=21.3º, $\delta_{Large\ disp}$=16.0º, β=18.4º, h = 30')

Calculated factors of safety for both short-term and long-term stability of the final cover system are presented below. Based on the results of the calculations, a minimum peak secant interface friction angle of 21.3° and a large displacement secant friction angle of 16.0° is specified at a normal stress of 500 psf to achieve the target factors of safety for the tallest 3H:1V final cover system side slope.

1. Using peak interface friction angle:

1.i. Undrained soil condition:

$$FS = \frac{tan\,21.3°}{tan\,18.4°} + \left[\frac{1}{(120)(2)}\right]\left[\frac{\frac{1}{sin\,18.4°\,cos\,18.4°}}{1 - tan\,18.4°\,tan\,0°}\right]\frac{(400)(2)}{(30)}$$

FS = 1.17 + 0.37 = 1.54

1.ii. Drained soil condition:

$$FS = \frac{tan\,21.3°}{tan\,18.4°} + \left[\frac{\frac{tan\,25°}{2\,sin\,18.4°\,cos^2\,18.4°}}{1 - tan\,18.4°\,tan\,25°}\right]\frac{(2)}{(30)} + \left[\frac{1}{(120)(2)}\right]\left[\frac{\frac{1}{sin\,18.4°\,cos\,18.4°}}{1 - tan\,18.4°\,tan\,25°}\right]\frac{(250)(2)}{(30)}$$

FS = 1.17 + 0.06 + 0.27 = 1.51

2. Using large-displacement interface friction angle

2.i. Undrained soil condition:

$$FS = \frac{tan\,16.0°}{tan\,18.4°} + \left[\frac{1}{(120)(2)}\right]\left[\frac{\frac{1}{sin\,18.4°\,cos\,18.4°}}{1 - tan\,18.4°\,tan\,0°}\right]\frac{(400)(2)}{(30)}$$ FS = 0.86 + 0.37 = 1.23

2.ii. Drained soil condition:

$$FS = \frac{tan\,16.0°}{tan\,18.4°} + \left[\frac{\frac{tan\,25°}{2\,sin\,18.4°\,cos^2\,18.4°}}{1 - tan\,18.4°\,tan\,25°}\right]\frac{(2)}{(30)} + \left[\frac{1}{(120)(2)}\right]\left[\frac{\frac{1}{sin\,18.4°\,cos\,18.4°}}{1 - tan\,18.4°\,tan\,25°}\right]\frac{(250)(2)}{(30)}$$

FS = 0.86 + 0.06 + 0.27 = 1.20

CONCLUSIONS

For the analyses using peak strengths herein, GeoSyntec selected target minimum calculated factors of safety of 1.25 for the liner system and 1.5 for the final cover system. A specified minimum peak secant interface friction angle of 21.1º for the liner system was selected to achieve the target minimum calculated factor of safety (at a normal stress of 500 psf) for the tallest liner slope at the facility. For the liner system, the slope stability analysis shows that the calculated maximum incremental cover placement height varies with the minimum secant interface friction angle. With the specified minimum interface friction angle of 21.1º, the calculated maximum protective cover placement height is 106 ft for 3H:1V side slopes, which is equal to the highest side slope for Unit 2. For all cases, the incremental placement height may be adjusted based on the results of the site-specific interface tests and the table presented above. For the final cover system, the calculated factor of safety is approximately 1.51 for a minimum peak secant interface friction angle of 21.3º (at a normal stress of 500 psf) for the tallest final cover side slope at the facility.

Prepared for Applicant:

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

SUPPLEMENTAL HYDROLOGY AND HYDRAULICS EVALUATION

MESQUITE CREEK LANDFILL
NEW BRAUNFELS,
COMAL AND GUADALUPE COUNTIES, TEXAS
MSW PERMIT NO. 66B

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STATE OF TEXAS
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4/19/2021

FOR PERMIT PURPOSES ONLY

Initial Submittal – 24 February 2021
Revised – 19 April 2021

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4/19/2021

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APPENDICES

SUPPLEMENTAL HYDROLOGY AND HYDRAULICS EVALUATION

PURPOSE

This Supplemental Hydrology and Hydraulics Evaluation (Supplemental Report) has been prepared to accompany a permit modification application dated February 2021 to request revisions to the landfill layout, thus necessitating an assessment of the potential effects on the facility drainage plan. More specifically, the permit modification proposes to eliminate Unit 3 (which has never been constructed) from the permit, and to compensate for this loss of airspace, make adjustments to the Unit 2 base and final cover grades. The changes to the Unit 2 final cover grades are minor, and by comparing the previously approved final cover grades to the new proposed grades (e.g., on Part III, Attachment 6 (Storm Water Plan), Drawing 6-1), it is evident that they are "*de minimis*" in terms of drainage patterns on the final cover and overall site surface water management. However, to check and affirm this, this Supplemental Report (i) evaluates the post-development drainage conditions under the proposed minor revisions; and (ii) verifies that no changes are necessary to the existing surface water management system design established in the Storm Water Plan. Specific objectives of this Supplemental Report are to:

- describe how the proposed changes may affect some of the hydrologic elements and drainage features of the currently permitted facility;
- conduct an updated post-development drainage hydrologic analysis;
- compare the updated post-development discharges resulting from this modification to the post-development discharges reflected in the final cover layout of the approved Permit No. 66B design conditions before submittal of this modification, to demonstrate that the proposed minor changes will not adversely impact or otherwise change to any significant degree the discharges from the site; and
- analyze and demonstrate that the hydraulic sizing of affected surface water conveyances established in the Storm Water Plan of the current permit are still met as-designed.

Note that the post-development hydrologic modeling was performed using the latest available "Atlas 14" rainfall data (National Oceanic and Atmospheric Administration (NOAA), Atlas 14, 2018) and agency guidance. To compare "apples-to-apples", both the as-permitted post-development condition and the proposed revised post-development condition from this 2021 modification were re-modeled with the latest Atlas 14 rainfall data.

OVERVIEW OF PROPOSED MODIFICATIONS TO THE SURFACE WATER MANAGEMENT SYSTEM

Unit 3 is proposed to be removed from the permit, and as a result, surface water runoff from the Unit 3 area will continue to route to the same unnamed tributary of Mesquite Creek following drainage patterns consistent with natural conditions.

The Unit 2 area is proposed to be modified by (i) reducing the final cover top-deck slope from 5% to 2% (the peak landfill elevation of 690-ft MSL remains unchanged); and (ii) slightly extending the 3(horizontal):1(vertical) (3H:1V) side slopes to intersect the updated 2% top-deck surface, shifting the alignment of the crest formed by the final cover top-deck and side slopes inward. Side slope benches and downchute channels have been slightly extended to tie in with the adjusted top-deck.

The Unit 2 landfill footprint area is unchanged, and accordingly the total acreage associated with surface water runoff routing off the Unit 2 area is unchanged as well. Surface water will continue to be routed in the same manner as described in the Storm Water Plan.

The configuration of all features in the Unit 2 area that are downstream of the top-deck downchute channels (i.e., perimeter channels, culverts, and storm water detention ponds) are not be affected by the proposed final cover grading revisions.

SUPPLEMENTAL HYDROLOGY MODELING

This supplemental hydrology modeling evaluates the post-development drainage patterns at the site, comparing the results of the Base Case versus the Supplemental Case. The "Base Case" refers to the final cover layout currently reflected in approved Permit No. 66B before submittal of this modification, and as such, is an evaluation of the post-development model presented in the Storm Water Plan. The "Supplemental Case" refers to the revised layout associated with this permit modification, and as such, is an evaluation of a post-development model of the revised layout resulting from this modification. The analyses presented herein both (Base Case and Supplemental Case) incorporate the latest available Atlas 14 rainfall data and agency guidance. This was done to generate results that would be compatible for comparison purposes (i.e., "apples-to-apples").

Updated Hydrologic Parameters

The hydrologic methodology and parameter selection in this Supplemental Report are consistent with those described in the Storm Water Plan, except for the following updates to simplify the model to focus on the areas being changed.

- All nodes in the Unit 1 and Unit 3 areas not discharging to the comparison point of interest referred to herein as "Point A" (i.e., regions of the Unit 1 and Unit 3 area unimpacted by the removal of Unit 3) are removed from the simplified model. Point A is the appropriate point of interest for this area because it is situated at the point where stormwater runoff is received from the Unit 3 area affected by this modification, before it continues to pass downstream. In other words, it is the uppermost node in the hydrology model that captures the removal of Unit 3 and thus is the relevant point of comparison between the Base Case and Supplemental Case to assess whether there are changes in the runoff characteristics.
- At Unit 2, the four low points along the perimeter drainage system (junctions J-1 through J-4) are the appropriate points of interest for these areas because they are situated at points where stormwater runoff is received from Unit 2 areas affected by this modification, before it continues to pass downstream into storm water ponds. In other words, these are the uppermost nodes in the hydrology model that encapsulate proposed modifications associated with Unit 2, and thus are relevant points of comparison between the Base Case and Supplemental Case to assess whether there are changes in the runoff characteristics.
- The 24-hour, 2-year storm and 24-hour, 25-year storm are updated to 4.06 inches 8.90 inches, respectively. Rainfall values are based on region-specific data published by the NOAA (2018), as presented in Appendix 6J-1.
- Time of concentration calculations are performed on all subbasins according to the 24-hour, 2-year rainfall depth of 4.06 inches. Time of concentration calculations for all nodes are calculated with a maximum sheet flow length of 100 feet to reflect the latest Texas Department of Transportation guidance (TXDOT, 2019).
- The latest version of HEC-HMS (Version 4.7, 2020) is utilized. Kinematic Wave Routing is used for all reaches with index flows that are determined iteratively using guidance from the US Army Corps of Engineers (USACE, 2018) by setting the index flow for a given reach equal to half of the peak discharge from the 24-hour, 25-year event routing into the reach.

Hydrologic Parameter Considerations Specific to the Supplemental Case

The Supplemental Case is altered relative to the Base Case to account for the proposed changes, with the following considerations.

- Subbasins associated with Unit 3 (Subbasin-12 through Subbasin-16) were replaced with Subbasin-12-16, which routes directly into Point A and has an equivalent area to Subbasins-12 through Subbasin-16 combined. A curve number of 80 was selected, consistent with the current permit, to represent undeveloped conditions and a time of concentration was calculated according to the natural condition grades established in the Storm Water Plan .
- No reaches, subbasins, discharge points, or junctions were added.
- Acreages and times of concentration were recomputed for the slightly-adjusted subbasin layout associated with the Unit 2 final cover area to reflect the changes to the top-deck slope and crest alignment mentioned in the previous section.
- Combined acreages routing to each downchute are comparable to the Base Case. Slight variations in acreages are attributed to the side slope bench system being adjusted to tie into the modified Unit 2 crest alignment.

Results of the Supplemental Hydrology Analysis

Basin delineations for the Base Case are presented on Drawing 6-3 of the Storm Water Plan (i.e., the post-development plan, as currently permitted). Basin delineations at Unit 2 for the Supplemental Case are shown on a figure contained in Appendix 6J-2 of this document. Also, the combined exterior boundaries formed by Subbasin-12 and Subbasin-15 on Drawing 6-3 incorporates the boundary used to define Subbasin-12-16 for the Unit 3 area of the Supplemental Case. Other basin delineations for the Supplemental Case are shown in Appendix 6J-2.

Time of concentration calculations are included as Appendix 6J-3. Hydrographs for each of the five assessment points comparing the two supplemental cases are included as Appendix 6J-4. HEC-HMS results for the supplemental cases are included as Appendix 6J-5 and summarized in Table 6J-1.

TABLE 6J-1
HEC-HMS RESULTS FOR THE 24-HOUR, 25-YEAR DESIGN EVENT

Assessment Point of Interest	Location	BASE CASE			SUPPLEMENTAL CASE		
		Peak Discharge (CFS)	Time to Peak (Hours)	Runoff Volume (ACRE-FT)	Peak Discharge (CFS)	Time to Peak (Hours)	Runoff Volume (ACRE-FT)
J-1	Low Point at Unit 2 Perimeter Channel	331	12.2	29.5	315	12.2	29.5
J-2	Low Point at Unit 2 Perimeter Channel	140	12.1	11.9	136	12.1	12.1
J-3	Low Point at Unit 2 Perimeter Channel	65	12.1	5.4	65	12.1	5.4

J-4	Low Point at Unit 2 Perimeter Channel	131	12.1	11.2	124	12.1	11.1
A	Low Point at Unit 3	2565	12.6	452.9	2570	12.6	452.4

As discussed, the purpose of the analyses whose results are summarized above in Table 6J-1 is to assess stormwater runoff characteristics at the relevant points of interest under Base Case (initial design layout of approved Permit No. 66B before submittal of this modification) and Supplemental Case (revised layout associated with this permit modification) conditions. Inspection of Table 6J-1 reveals that the calculated peak discharges, times to peak discharge, runoff volumes, and hydrographs at each assessment point of interest are comparable, demonstrating that the proposed revisions do not affect post-development drainage conditions in any material way.

SUPPLEMENTAL HYDRAULIC ANALYSIS AND RESULTS

This supplemental hydraulic analysis evaluates the final cover surface water conveyances affected by the proposed revisions, comparing the results of the Base Case versus the Supplemental Case. The analysis was performed for affected final cover drainage terraces, benches, top-deck channels, and downchute channels (consistent with design methodology of Attachment 6C of the Storm Water Plan). Note that the perimeter channels for the Unit 2 area, designed in Attachment 6E of the Storm Water Plan, have no proposed modifications but were also included in this Supplemental Report because they are connected to features proposed to be revised. The purpose of this evaluation is to demonstrate that the revised features continue to meet the hydraulic design requirements established in the Storm Water Plan, which include:

- conveyance of the 24-hour, 25-year storm with adequate freeboard; and
- selection of channel lining materials with a permissible tractive stress greater than the calculated tractive stress.

Hydraulic Parameter Considerations Specific to the Supplemental Analysis

The Supplemental Case was updated relative to the Base Case with following considerations.

- For final cover drainage features, peak discharges are established in Attachment 6C of the Storm Water Plan using a linear regression plot of HEC-HMS subbasins associated with final cover landfill areas. This relationship was recalculated as 6.64 cfs/acre multiplied by the number of acres draining to a given component using data from the Supplemental Case, as shown in Appendix 6J-6.

- Subbasins developed for the Supplemental Case were further delineated to evaluate individual reaches of each final cover surface water feature and determine the critical cases for design as a function of acreage and flowline slope. The naming convention for these drainage areas was carried over from Attachment 6C of the Storm Water Plan. Drainage areas associated with the critical cases for the modified condition are shown on the figure in Appendix 6J-7.
- For perimeter channels, peak flow rates for subbasins developed for the HEC-HMS model of the Supplemental Case that correspond to the Unit 2 perimeter channel reaches (nodes R201 through R215) were used to evaluate each respective reach.

Results of the Supplemental Hydraulic Analysis

Results of the hydraulic analysis for the final cover drainage features are included as Appendix 6J-8 and summarized in Table 6J-2. Results of the hydraulic analysis for the perimeter channels are included as Appendix 6J-9 and summarized below in Table 6J-3. Calculated flow depths allow for conveyance of the 25-yr peak flow with 0.5 feet of freeboard or more using the currently permitted channel design. Calculated tractive stresses are below the maximum permissible tractive stresses for the channel lining materials selected in current permit. Bracketed values represent the results of this supplemental report and unbracketed values represent results from the current permit.

TABLE 6J-2
FINAL COVER HYDRAULIC ANALYSIS RESULTS

Channel Type	25-Yr Peak Flow Rate (ft^3/s)	25-Yr Peak Flow Depth (ft)	25-Yr Peak Flow Velocity (ft/s)	25-Yr Peak Tractive Stress (lb/ft^2)	Channel Lining Material
Top-deck Terrace, ≤2.0% Slope	23.5 [26.10]	0.80 [0.72]	3.25 [1.88]	1.00 [0.36]	Grass Lining
Top-deck Terrace, >2.0% Slope	17.4 [n/a]	0.69 [n/a]	3.27 [n/a]	1.07 [n/a]	Turf Reinforcement Mat
Side Slope Bench, ≤3.0% Slope	16.9 [18.2]	0.93 [0.95]	3.56 [3.65]	1.16 [1.19]	Turf Reinforcement Mat
Side Slope Bench, >3.0% Slope	15.8 [18.1]	0.76 [0.80]	4.94 [5.08]	2.37 [2.43]	Turf Reinforcement Mat
Top-deck Channel	50.1 [32.3]	0.68 [0.95]	6.30 [5.08]	1.91 [2.49]	Turf Reinforcement Mat
Downchute Channel	96.7 [113.7]	0.57 [0.62]	12.49 [13.17]	10.08 [10.91]	Reno Mattress

TABLE 6J-3
PERIMETER CHANNEL HYDRAULIC ANALYSIS RESULTS

Channel Segment Designation	25-Yr Peak Flow Rate (ft^3/s)	25-Yr Peak Flow Depth (ft)	25-Yr Peak Flow Velocity (ft/s)	25-Yr Peak Tractive Stress (lb/ft^2)	Proposed Channel Lining Material[1]
R201	15.9 [17.8]	0.59 [0.61]	3.66 [3.74]	0.81 [0.85]	Type 1
R202	16 [17.9]	0.46 [0.49]	5.05 [5.20]	1.59 [1.67]	Type 2
R203	8 [8.1]	0.43 [0.42]	2.77 [2.73]	0.48 [0.47]	Type 1
R204	105.2 [128.1]	1.35 [1.48]	7.49 [7.88]	3.13 [3.44]	Type 2
R205	21 [22.4]	1.00 [1.03]	2.33 [2.37]	0.31 [0.32]	Type 1
R206	8.0 [10.2]	0.43 [0.48]	2.78 [2.98]	0.49 [0.55]	Type 1
R207	8.0 [7.8]	0.50 [0.49]	2.27 [2.25]	0.32 [0.31]	Type 1
R208	23.9 [26.3]	0.59 [0.61]	5.51 [5.60]	1.84 [1.90]	Type 2
R209	24.0 [26.4]	0.73 [0.76]	4.18 [4.30]	1.04 [1.09]	Type 2
R210	20.0 [22.4]	0.79 [0.83]	3.09 [3.17]	0.56 [0.59]	Type 1
R211	19.9 [22.4]	0.56 [0.58]	4.94 [5.07]	1.49 [1.56]	Type 2
R212	19.9 [22.4]	0.53 [0.56]	5.21 [5.35]	1.67 [1.75]	Type 2
R213	99.4 [129.2]	1.61 [1.81]	5.41 [5.79]	1.61 [1.81]	Type 2
R214	174.6 [218.3]	1.87 [2.07]	7.5 [7.94]	3.03 [3.35]	Type 2
R215	174.3 [218]	1.61 [1.78]	9.5 [10.07]	4.96 [5.50]	Type 2

(1) Lining Type 1 is native vegetation. Lining Type 2 is Turf Reinforcement Mat and native vegetation having an allowable tractive stress greater than that shown.