

CORRESPONDENCE COVER SHEET WASTE PERMITS DIVISION TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Fa Pe *If I (Pre	ate: April 25, 2019 Acility Name: City of Kingsville Landfill Acrmit or Registration No.: MSW 235-C Response/Revision, please provide previous TCEQ Tracking Acronic TCEQ Tracking No. can be found in the Subject line Acronic Scover sheet should accompany all correspondences	of t	the TCEQ's response letter to your original submittal.)
be a	affixed to the front of your submittal as a cover page.	Ple	ase check the appropriate box for the type of
	respondence being submitted. For questions regardin	ıg t	his form, please contact the Waste Permits Division
at (512) 239-2335.		
	Table 1 - Munici	pa.	l Solid Waste
	APPLICATIONS		REPORTS and RESPONSES
	New Notification		Closure Report
	New Permit (including Subchapter T)		Groundwater Alternate SRC Demonstration
	New Registration (including Subchapter T)		Groundwater Corrective Action
\boxtimes	Major Amendment		Groundwater Monitoring Report
	Minor Amendment		Groundwater Statistical Evaluation
	Limited Scope Major Amendment		Landfill Gas Corrective Action
	Notice Modification		Landfill Gas Monitoring
	Non-Notice Modification		Liner Evaluation Report
	Transfer/Name Change Modification		Soil Boring Plan
	Temporary Authorization		Special Waste Request
	Voluntary Revocation	$\overline{\mathbb{X}}$	
	Subchapter T Workplan		•
	Other:		
	Table 2 - Industrial 8	Q- T	Jazardous Wasto
	APPLICATIONS	ХІ	REPORTS and RESPONSES
	New	一	Annual/Biennial Site Activity Report
H	Renewal		CfPT Plan/Result
H	Post-Closure Order	┢	Closure Certification/Report
H	Major Amendment	H	Construction Certification/Report
H	Minor Amendment	┢	CPT Plan/Result
H	Class 3 Modification	┢	Extension Request
H=	Class 2 Modification	┢	Groundwater Monitoring Report
H	Class 1 ED Modification	╁	Interim Status Change
H	Class 1 Modification	┢	Interim Status Change Interim Status Closure Plan
H	Endorsement	┢	Soil Core Monitoring Report
H	Temporary Authorization	┢	Treatability Study
H	Voluntary Revocation	┢	Trial Burn Plan/Result
H	335.6 Notification	\vdash	Unsaturated Zone Monitoring Report
H	Other:	\vdash	Waste Minimization Report
Щ	JOHIEL.	\vdash	Other:
			Ouici.

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April 25, 2019

Ms. Mihaela Chilarescu Municipal Solid Waste Section Waste Permits Division (MC 124) Texas Commission on Environmental Quality P.O. Box 13087 Austin, TX 78711-3087

Re: City of Kingsville Landfill – Kleberg County

Municipal Solid Waste (MSW) - Permit No. 235C Permit Amendment Application – Notice of Deficiency

Tracking No. 23301130, 23458984, and 24040819; RN102334570/CN600674246

Dear Ms. Chilarescu,

On behalf of the City of Kingsville and in response to the Texas Commission on Environmental Quality's (TCEQ) March 27, 2019 Notice of Deficiency (NOD) letter, we hereby submit the enclosed response regarding the Permit Amendment Application for the above referenced MSW facility.

We have included our responses to the NOD Items in table format using the file you provided by email (NOD2 Table from 235C_MSW Checklist_Current_20190327.xlsx) on March 28, 2019. A hard copy of the NOD Table of Deficiencies is included in each copy of the response and an electronic version can be provided via email or the TCEQ FTPS upon request.

Where items from the original application have been noted as revised, a redline/strikeout version is included and a replacement copy ("clean copy") of the applicable section or attachment has been provided to allow you to substitute the items in the binders for the originally submitted application.

TXDOT responded to the NORI with a memo, dated April 16, 2019, stating that the facility is subject to the Highway Beautification Act requirements (43 TAC Chapter 21, Subchapter H). The April 16, 2019 memo has been incorporated into the Permit Amendment Application in Part II, Attachment 3–B. We are communicating with TXDOT to determine if the facility is subject to the Highway Beautification Act requirements or not. If it is determined that the facility is subject to the Highway Beautification Act requirements (43 TAC Chapter 21, Subchapter H), the facility will provide screening in accordance with those requirements and as approved by the TXDOT District Engineer for Kleberg County. A statement has been included in Part II, Section 9, page 13 regarding this issue.

Per your March 27, 2019 letter, one (1) original and one (1) copy of the NOD response with applicable application revisions are included and one (1) copy of the NOD response with applicable application revisions has been sent to the TCEQ Corpus Christi Region Office, to the attention of the Waste Section Manager. As noted in the Part I form, the NOD response documents will be posted to a publicly accessible internet web site. If, while reviewing this

response, you have any questions or would like additional information, please don't hesitate to contact me.

Sincerely,

HANSON PROFESSIONAL SERVICES INC.

Jon M. Reinhard, P.E. Project Engineer

cc: Bill Donnell, Kingsville Public Works Director (2 copies)

NOD ID	MRI ID	App. Part	Citation	Location	2nd NOD Type	NOD Description	NOD Response
NT1	12	General	330.57(d)	Vol. 1, Part I, Page 9	Incorrect	Provide acurate location of the information in the application.	As per Miki Chilarescu's April 9, 2019 email, by addressing the other comments specifically, this NOD Item will be addressed and no further response is necessary.
T2	123	Part I	305.45(a)(8)(B)(ii)		Omitted		Vol 1, Part I, Sec 1.4, pg- 3-5 has been revised to provide a more detailed explanation/definition for the wastes to be accepted at the Kingsville Landfill (i.e.: the characteristics for each special waste, and the definition of MSW).
Т3	126	Part II	330.61(b)(1)	Vol 1, Sec 2, pg-3-4	Omitted		As per Miki Chilarescu's April 9, 2019 email, after additional clarification the information was located in Vol 1, Part II, Sec 2, pg 3-4 therefore this NOD Item has been addressed and no further response is necessary.
T4	143	Part II	330.61(i)(4)	Vol. 1, Part II, Section 9.2, Page: Part II, pg-13; Part II, Att. 3, Page: Part II, Att. 3A, pg-1-6 & Part II, Att. 3B, pg-1-8	Incomplete	Provide documentation of coordination with Kleberg County for road maintenance.	Documentation of coordination with Kleberg County for road maintenance is provided in as Part II, Attachment 3-C.
NT5	198	Part II	330.61(d)(9)(D)	Vol 1, Part I, Att 2, Fig I.2-1	Comment Only	Information located in Vol 1, Part I, Att. 2, Fig. I.2-5.	As per Miki Chilarescu's April 9, 2019 email, this NOD Item has been addressed and no further response is necessary.
Т6	199	Part II	330.61(d)(9)(E)	Vol 1, Sec 1.2, pg- 1; Vol 5, Part III, Att 7, Fig III.7-1	Incomplete	Revise drawings Fig III.1.4. and III.7.1 in Part III, Att. 1 to clearly indicate the maximum waste and final cover elevations or provide a drawing in Part II with these information.	Vol 1, Part II, Sec 1.2, pg- 1 has been revised to remove reference to Fig III.1.4. indicating the maximum waste and final cover elevations. The maximum waste and final cover elevations are clearly indicated on Vol 5, Part III, Att 7, Fig III.7-1.
Т7	277	Part III	330.63(b)(2)(D)	Vol 1, Sec 3.2.3, pg- 6	Inconsistent	Clarify if a liquid waste solidification facility is being proposed, and revise (also Part II, Sec 2, pg. 3-4, and Part IV, Att.5) Revise Figure III.1-2 to depict the solidification facility.	A liquid waste solidification area is proposed. Part II, Sec 2, pg. 3-4 has been revised. Part IV, Att.5 has been revised to include additional information regarding the design and construction of the liquid waste solidification area including Figure IV.5-1 Liquid Waste Solidification Area Construction Details. The Liquid Waste Solidification Area will be installed within an area that is operationally feasible and will periodically be relocated because of general sequence of filling operations. Due to the liquid waste solidification area being relocated periodically Figure III.1-2 was not revised to depict a permanent location. However Figure IV.5-1 was included in Part IV, Attachment 5 to depict the liquid waste solidification area layout and construction details.
Т8	277	Part III	330.63(b)(2)(D)	Vol 1, Sec 3.2.3, pg- 6	Incomplete	Provide construction details for leachate storage tanks and liquid waste solidification facility.	Vol 1, Part III, Section 3.2.3, pg-6 has been revised to refer to the construction details leachate storage tanks in Part III, Attachment 15, Appendix G, Figure III.15-G-3 and for the liquid waste solidification area in Part IV, Attachment 5, Figure IV.5-1. Part IV, Attachment 5 has been revised to include additional information regarding the design and construction of the liquid waste solidification area including construction details provided as Figure IV.5-1.
NT9	315	Part III	330.63(c)(1)(D)(iv)	Vol 4, Att 6, App 6B.6, 6B.7, 6B.9, 6B.10 & 6B.11; Vol 5, Att 6, App 6B.14, 6B.15 & 6B.18	Comment Only	Information located in Att. 6, Appx. 6B.19 to 6B.22.	As per Miki Chilarescu's April 9, 2019 email, this NOD Item has been addressed and no further response is necessary.
T10	353	Part III	330.63(d)(4)(E)	Vol 1, Att 2, Fig III.2-1 thru III.2-5	Ambiguous	Revise Figure III.2-1 to clearly indicate landfill's maximum waste elevation, maximum final cover elevation, and elevation of the deepest excavation.	Figure III.2-1 has been revised to enlarge the contour labels to make them more legible, and a note has been added to clearly indicate the landfill's maximum waste elevation, maximum final cover elevation, and elevation of the deepest excavation.
T11	356	Part III	330.63(d)(4)(E)	Vol 1, Att 2, Fig III.2-1 thru III.2-5	Ambiguous	Clarify the meaning of each line and revise each section on Figure III.2-2 to Figure III.2-5 to show the top of the waste (existing fill), existing ground, botom of the excavation. Revise the meaning of dotted line for active sectors on Figure III.2-3, Marker 26 Section, and Figure III.2-5, Marker T Section.	Figures III.2-2 to Figure III.2-5 have been revised to clarify the lines representing final grade, top of waste, existing grade, subgrade, and piggyback liner. Revisions to line callouts have been made and additional callouts have been added to provide additional clarification.
T12	356	Part III	330.63(d)(4)(E)	Vol 1, Att 2, Fig III.2-1 thru III.2-5	Incomplete	Provide cross sections showing gas vents or wells, and groundwater monitoring wells.	Figures III.2-2 to Figure III.2-5 have been revised to show gas probes and groundwater monitoring wells.
T13	358	Part III	330.63(d)(4)(F)	Vol 1, Att 2, Fig III.2-1 thru III.2-5	Incomplete	Revise Att. 3 to provide details of liners tie-in for piggyback overliner into existing liner in active sectors (Sector 8 to Sector 1), and into new liner in proposed sectors (Sector 8 to Sector 6).	Figure III.3-5 has been added to Part III, Attachment 3 to show details of the Sector 8 piggyback overliner tie-in to Sector 1 (Detail 15) and the Sector 8 piggyback overliner tie-in to Sectors 6/7 (Detail 16).

NOD ID	MRI ID	App. Part	Citation	Location	2nd NOD Type	NOD Description	NOD Response
T14	359	Part III	330.63(d)(4)(G)	Vol 5, Att 10	Incomplete	Provide tables of the required properties for materials to be used for the liner and final cover systems and subgrades.	Vol 5, Part III, Attachment 10 has been revised to add Tables 10-1 to 10-2 and 10-4 to 10-8. Table C.1 (GCL) has been renamed to Table 10-3.
T15	379	Part III	330.335	Vol 4, Part III, Att. 5	Incomplete	Provide tables summarizing the input and output data from the HELP runs.	Appendix B.21 Table 1-HELP Model Analysis Alternative Liner Summary has been added to Volume 4, Part III, Attachment 5 and the Contents, Part III, Attachment 5, p.gii has been updated to include Appendix B.21.
T16	379	Part III	330.335	Vol. 4, Part III, Att. 5	Incomplete	Provide test data for the final cover over the pre-Subtitle D unit demonstrating that it has the minimum thickness (2 feet) and properties assumed in the alternative overliner design demonstration.	Appendix I, Figure I.1 Pre-Subtitle D Area (Sector 8A and Sector 8B) Final Cover Test Data & Properties has been added to Volume 4, Part III, Attachment 5 and the Contents, Part III, Attachment 5, p.gii has been updated to include Appendix I.
T17	379	Part III	330.335	Vol. 4, Part III, Att. 5	Incomplete	Provide Multimed model runs for interim cases when the landfill is only partially filled, and additional model runs with varied inputs to evaluate model sensitivity, along with discussion and tables summarizing input and output data.	MULTIMED model runs for interim cases when the landfill is only partially filled (various waste fill heights) are located in Part III, Attachment 5, Section 4. POINT OF COMPLIANCE DEMONSTRATION RESULTS for both the nonoverliner and overliner portion of the landfill. Appendix H MULTIMED Model Sensitivity Analysis, Appendix H.1 MULTIMED Model Sensitivity Analysis Tables, Appendix H.2 HELP Model Input and Output Files for Case 10L Base Case & Case 10L Base Case with Liner Defects (4 Defects/Acre), and Appendix H.3 MULTIMED Model Output Files have been added to Volume 4, Part III, Attachment 5. The Contents, Part III, Attachment 5, p.giv has been updated to include Appendices H, H.1, H.2, and H.3.
NT18	379	Part III	330.335	Vol. 4, Part III, Att. 5, Figs III.5- A.5 through A.8	Incorrect	Correct the labels and the distance to POC for the cases that do not include overliner.	The labels and the distance to POC for the cases that do not include overliner have been corrected. This affects Figures III.5-A.1 through A.6. It does not affect overliner Figures III.5-A.7 & A.8.
NT19	379	Part III	330.335	Vol. 4, Part III, Att. 5, Appendix C.4, p. 1	Incorrect	Correct the information for Cases 3OL and 4OL that indicate pre-Subtitle D waste above the overliner.	Vol 4, Part III, Att. 5, Appendix C.4, p.g1 has been corrected to indicate pre- Subtitle D waste is below the overliner.
NT20	379	Part III	330.335	Vol. 4, Part III, Att. 5, Apendices C.6 and C.7	Ambiguous	Revise the tables of Multimed aquifer-specific data to clearly reference the information reproduced from existing permit 235B in Appendices C.7.1 and C.7.2, and remove the note at the bottom regarding Evangeline Aquifer.	The tables of MULTIMED aquifer-specific data in Part III, Att. 5, Appendices C.6 and C.7 have been corrected to clearly reference the information reproduced from existing permit 235B in Appendices C.7.1 and C.7.2. In addition, the note at the bottom regarding Evangeline Acquifer has been deleted.
NT21	379	Part III	330.335	Vol. 4, Part III, Att. 5, Figs III.5- D.1 through D.4	Incorrect	Correct the labels and the distance to POC for the cases that do not include overliner. Correct the DAF values for the non-overliner interim case.	The labels and the distance to POC for the cases that do not include overliner have been corrected. This affects Figures III.5-D.1 and D.2. It does not affect overliner Figures III.5-D.3 and D.4. The DAF values for the non-overliner interim and closed landfill conditions have been corrected as shown in the figures and Section 4 Point of Compliance Demonstration Results in Part III, Attachment 5, p.g7 and Appendix D, p.g1, Calculations of the Dilution Attenuation Factor. The corrections to the distance to POC resulted in slight corrections to the MSW thickness parameters in the HELP Model as shown in corrected Appendices B.3-B.10 used to determine the infiltration rate through the liner for use in MULTIMED as corrected and shown in Part III, Attachment 5, Appendix B.1, p.g1, HELP Model/MULTIMED Model-Summary of Cases 1-8 and Appendix B.2, p.g1, HELP Model Case Summary. However, this correction did not change the infiltration rate used for the various cases in MULTIMED as shown in Appendix C.3, p.g1, MULTIMED Source-Specific Data. These infiltration rates were used to run new MULTIMED models with the corrected lengths to POC as shown in Appendix F.1 MULTIMED Output for Alternative Liner Interim Case 2-Location 2, Appendix F.3 MULTIMED Output for Alternative Liner Interim Case 3-Location 3, Appendix F.5 MULTIMED Output for Alternative Liner Interim Case 3-Location 1, Appendix F.6 MULTIMED Output for Alternative Liner Closed Case 6-Location 2, and Appendix F.7 MULTIMED Output for Alternative Liner Closed Case 6-Location 2, and Appendix F.7 MULTIMED Output for Alternative Liner Closed Case 6-Location 2, and Appendix F.7 MULTIMED Output for Output for Alternative Liner Closed Case 6-Location 2, and Appendix F.7 MULTIMED Output for Alternative Liner Closed Case 6-Location 3. Note, new MULTIMED ondels were not run for Case 4 and Case 8 because the infiltration rate and length to POC did not change.
T22	381	Part III	330.337(b)(1)	Vol 5, Att 10, App E	Incomplete	Provide measurement units for balast thickness calculations in the table on Part III, Att. 10, Appendix E, pg. 6.	Measurement units have been added to the ballast thickness calculations in the table on Part III, Attachment 10, Appendix E, page 6.
T23	381	Part III	330.337(b)(1)	Vol 5, Att 10, App E	Incomplete	Demonstrate that the weight of balast will offset uplift by a facor of safety of 1.2.	A table demonstrating sufficient ballast to offset uplift by the required factor of safety has been added to Part III, Attachment 10, Appendix E on page 7.
T24	382	Part III	330.337(b)(2)	Not Applicable	Incomplete	Demonstrate that the proposed dewatering system will reduce hydrostatic forces by a facor of safety of 1.2.	A demonstration that the proposed dewatering system will reduce hydrostatic forces by a factor of safety of 1.2 has been added to Part III, Attachment 10, Appendix D, Calculation B, page 4.
NT25	412	Part III	330.339(c)(2)	Vol 5, Att 10, Sec 1.1, pg- 1	Comment Only	Information located in Vol. 5, Part III, Att. 10, Sec. 1.6.2, pg 5.	As per Miki Chilarescu's April 9, 2019 email, this NOD Item has been addressed and no further response is necessary.

NOD ID	MRI ID	App. Part	Citation	Location	2nd NOD Type	NOD Description	NOD Response
NT26	476	Part III	330.63(e)&(1)(A)	Att 4, App 1, Fig 4.4 & 4.4a, p. 19-20	Incomplete	Provide hard copies of replacement pages (previewed electronically November 2018) for older reports in which revision-highlighting obscured the content.	Hard copies of replacement pages (previewed electronically November 2018) for the older reports in Part III, Attachment 4, Appendix 1that revision-highlighting obscured the content are provided.
NT27	477	Part III	330.63(e)(1)(B)	Att 4, Table 2-1, p. 6; Att 4, App 1, Fig 4.5, p. 21-23	Incomplete	In Table 2-1, show the stratigraphic position of the site.	A note has been provided below table 2-1 showing the stratigraphic position of the site. The note reads, "The site overlies the South Texas Eolian Plain Deposits. The hydrogeologic units below the site consist of the Chicot Aquifer within the Lissic Formation followed by the Evangeline Aquifer within the Goliad Sand (Principal Aquifer of the site)."
NT28	488	Part III	330.63(e)(3)(J)	Att 4, App 1: Sec 4.4, p. 37; Fig 4.15, p. 46; App J, p. 584-629	Incomplete	Provide a figure showing the locations of the water wells listed in Att. 6 to Att. 4.	Figure III.4-6-1 has been provided within Part III, Attachment 4, Attachment 6 showing the locations of the water wells.
T29	490	Part III	330.63(e)(4)(A)	Att 4, App 1, Sec 5.0, p. 48-55; and App 3, Sec 2, p. 4	Incomplete	Acknowledge in Sec. 1.4 that the drilled locations of borings B-32, 33, 34, 35, and 38 deviated from locations specified in the soil boring plan (March 29, 2016), explain why and how much they deviated, and how the investigator compensated.	"Locations of borings B-32, B-33, B-34, B-35, B-38 and B-40 deviated from locations specified in the soil boring plan due to boring locations being unknowingly moved from original locations during installation. These deviations were identified when the boring locations were surveyed. The distance of boring location deviation varied from approximately 90 feet in B-35 to approximately 440 feet in B-33. With the information obtained during previous subsurface investigations, these discrepancies did not affect the ability to obtain the needed information identified in 30 TAC \$\ \text{S330.63}(e)(4)(A)." This statement has been added to Sec. 1.4 of Part III, Attachment 4. on page 4.
Т30	491	Part III	330.63(e)(4)(B)	Att 4, App 1, Sec 5.0, p. 48-55; Att 4, App 3, Sec 2, p. 4		Acknowledge in Sec. 1.4 that two borings (B-34 and 40) were not drilled to the depth specified in the soil boring plan, explain why and how short they were from the target elevation, and how the investigator compensated.	"Borings B-34 and B-40 were not drilled to 5 foot below EDE due to the boring locations being unknowingly moved from the original locations during installation. Boring B-34 was 0.64 feet short of 5 foot below EDE and B-40 was 1.31 feet short of 5 foot below EDE. Although these borings were not drilled to the target depth, the information obtained from these borings is useful in characterizing the subsurface conditions at the facility and was used for that purpose. Other borings installed at the site in conjunction with the current subsurface investigation are adequate in meeting the requirements identified in 30 TAC §330.63(e)(4)(B)." This statement has been added to Sec. 1.4 of Part III, Attachment 4, on page 4.
T31	491	Part III	330.63(e)(4)(B)	Att 4, App 1, Sec 5.0, p. 48-55; Att 4, App 3, Sec 2, p. 4	Inconsistent	Revise logs and cross sections to include the unit identifiers (Body I, II, III, etc.) used in the narrative.	Logs and cross sections have been revised to include unit identifiers used in the narrative.
NT32	493	Part III	330.63(e)(4)(D)	Att 4, App 1, Att K, p. 631-643; Att 4, App 1, Att M, p. 665-700	Format	Provide legible well reports, and annotate the reports to indicate which wells or borings logs they represent.	More legible well reports have been provided. Reports have been annotated to indicate which wells or boring logs they represent. The majority of the existing monitor wells will be plugged and abandoned, when new monitor wells are installed well reports shall be provided.
Т33	496	Part III	330.63(e)(4)(G)	Att 4, App 1, Sec 6.2.2, p. 64-79	Incomplete	Revise the Hanson cross sections in Exhibit IV of App. 3 to indicate the correlations to the units described in Section 3.3 of the geology report narrative, to distinguish between fill material and the in situ geologic strata, and to show the existing and proposed monitor wells.	Hanson cross sections in Exhibit IV of App. 3 have been revised to indicate the correlations to the units described in section 3.3 of the geology report narrative and to distinguish between fill material and the in situ geologic strata. Existing and proposed monitor wells have not been shown because they are located beyond the limits of cross sections. None of the borings used in the cross sections were converted to monitor wells.

NOD ID	MRI ID	App. Part	Citation	Location	2nd NOD Type	NOD Description	NOD Response
T34	496	Part III	330.63(e)(4)(G)	Att 4, App 1, Sec 6.2.2, p. 64-79	Incomplete	Label all units on cross section B-B' in the FEE geology report.	All units on cross section B-B' in the FEE geology report have been labelled.
T35	500	Part III	330.63(e)(5)(B)	Att 4, App 1, App G, p. 288-400; Att 4, App 3, Ex II, App B, p. 31- 59	Incomplete	Provide a table and discussion detailing which earlier samples and test results are being used as proxies for the borings drilled under the March 2016 SBP.	Tables 4.1 and 4.2 have been provided in Part III, Attachment 4, Appendix 1 beginning on page 92 showing geotechnical testing results by boring. Discussion of the geotechnical laboratory testing has been provided in Part III, Attachment 4, Appendix 1 beginning on page 87. Additional test results have been included in Part III, Attachment 4, Appendix G beginning on page 288. Additional test results are also included in Part III, Attachment 4, Appendix B of Appendix 2 and 3 beginning on pages 22 and 31 in each respective appendix.
T36	511	Part III	330.63(f)(1)	Att 11, App A, Item 1	Ambiguous	Provide a distinct line for the point of compliance line on Figures III.11-A-1A and 1B.	A distinct line for the point of compliance line on Figures III.11-A-1A and 1B has been provided.
T37	558	Part III	330.403(a)	Att 11, App A, Item 1	Incomplete	Revise Figure III.11-A-1B to include the date of the groundwater measurements, and the measured groundwater elevation at each well.	Figure III.11-A-1B has been revised to include the date of the groundwater measurements, and the measured groundwater elevation at each existing well.
T38	559	Part III	330.403(a)(1)	Att 11, Sec 3.1, p. 2; Sec. 1.2, p. 1	Ambiguous	Provide a table detailing which wells "shall be considered upgradient wells until further development of waste sectors occur" and at what stage of landfill development they will become point of compliance wells.	A table detailing which wells "shall be considered upgradient wells until further development of waste sectors occur" and at what stage of landfill development they will become point of compliance wells has been included as Part III, Attachment 11, Appendix A, Table 3, pg-1.
NT39	576	Part III	330.405(b)	Att 11, Sec 5.2 and 5.6	Incomplete	Indicate that the results of the well headspace screening for methane specified by the sampling plan will be recorded and retained in the operating record.	"Results of the well headspace screening for methane will be recorded and retained in the facility operating record," has been added to Part III, Attachment 11, in section 5.2 on page 3.
T40	653	Part III	330.421(e)	Att 11, Sec 1.2, p. 2	Incomplete	Provide monitor well installation and construction details on Form TCEQ-10308.	"Monitor well installation and construction details will be provided on form TCEQ-10308, or current appropriate TCEQ reporting form, upon completion," has been added to Part III, Attachment 11, in section 1.2 on page 2.
T41	684	Part III	330.453(d)(1)	Att 5	Inconsistent	Revise Sec. 9, pg. 14; Att. 3, Fig. III.3-1; Att. 5 Appx. G, pg.1; and Att. 12, Form 20720, pg. 3 for consistency regarding the thickness of subgrade and erosion/protective layers.	Revisions have been made to appropriate sections to ensure consistency regarding the thickness of subgrade and erosion/protective layers. Part III, Site Development Plan, Section 9, page 15 has been revised to include the text "a prepared soil subgrade," in the fourth sentence. Part III, Attachment 3, Figure III.3-1, final cover details have been revised to show the topsoil layer and indicate its thickness as well as identify the prepared subgrade. Part III, Attachment 5, Appendix G, p.g1, Section 1.1 Alternative Composite Liner System has been revised to read 25-inch thick erosion layer. Part III, Attachment 12, Form 20720, page 3 has been revised to clarify the prepared soil subgrade.
T42	684	Part III	330.453(d)(1)	Att 5	Inconsistent	Revise Att. 3, Fig. III.3-1 to show the topsoil layer and indicate its thickness.	Att. 3, Fig. III.3-1 has been revised to show the topsoil layer and indicate its thickness.
T43	694	Part III	330.457(d)(1)	Att 5	Incomplete	Provide Section 2.5 in Part III, Att. 5, pg 4, as mentioned in NOD1 response, and revise the Contents of Part III, Att. 5 accordingly.	Section 2.5 Alternate Composite Final Cover Design Demonstration as mentioned in NOD1 response has been included in Part III, Attachment 5, p.g. 4. The Contents, Part III, Attachment 5, p.g. i, Section 2 Alternate Liner Demonstration Methods has been revised accordingly.
T44	695	Part III	330.457(d)(2)	Att 5	Incomplete	See NOD comment T46 above.	Section 2.5 Alternate Composite Final Cover Design Demonstration as mentioned in NOD1 response has been included in Part III, Attachment 5, p.g4. The Contents, Part III, Attachment 5, p.g.i, Section 2 Alternate Liner Demonstration Methods has been revised accordingly.
T45	810	Part IV	330.133(a)	Vol 6, Sec 4.6, pg 31-33	Incomplete	Remove any reference to acceptance of wastes containing free liquids from Part II, Sec. 2, Part IV Sec. 4.2.2 and address inconsistencies regarding acceptance or processing of those wastes throughout the application. (MRI ID 919)	Kingsville Landfill will accept wastes containing free liquids for processing in the Liquid Waste Solidification Area therefore reference to accepting wastes containing free liquids was not removed from Part II, Sec. 2. Part II, Sec. 2 was revised to elaborate on the acceptance of listed wastes for storage, processing and/or disposal. Part IV Sec. 4.2.2 is regarding the wastes prohibited from disposal, wastes containing free liquids will not be disposed of in the Kingsville Landfill. Wastes containing free liquids will be accepted for processing in the Liquid Waste Solidification Area, once the waste if solidified and passes the Paint Filter Test (EPA Method 9095) the waste will be accepted for disposal and placed in the active working face of the landfill.
T46	833	Part IV	330.141(a)	Vol 6, Sec 4.10, pg 35	Incomplete	Show the location of the utility easement referenced in Sec. 4.10.1.	The overhead powerline easement referenced in Sec. 4.10.1 is shown on Vol 1, Part I, Att 2, Figure I.2-5 & Vol 1, Part III, Att 1, Figure III.1-2.
T47	851	Part IV	330.143(b)(8)	Vol 6, Sec 4.11.7, pg 37	Ambiguous	Revise to show benchmark coordinates depicted in NAD 83 datum (NAD 83 datum: N 27; 26'; 43.08", W 97; 48'; 56.88 ") for consistency with Parts I and II.	Vol 6, Part IV, Sec 4.11.7, pg 39 has been revised to include the benchmark coordinates in NAD 83 datum: N 27; 26'; 43.08", W 97; 48'; 56.88".
NT48	911	Part IV	330.171(a)	Vol 6, Sec 4.24, pg 47; Att 3	Comment Only	Information located in Sec 4.14.3, pg 39, and Att. 3, pg 2	As per Miki Chilarescu's April 9, 2019 email, this NOD Item has been addressed and no further response is necessary.
NT49	919	Part IV	330.171(b)(3)		Comment Only	The operating plan for the liquid waste solidification area is located in Part IV, Att. 5.	As per Miki Chilarescu's April 9, 2019 email, this NOD Item has been addressed and no further response is necessary.

THE CITY OF KINGSVILLE LANDFILL TCEQ PERMIT MSW 235C PERMIT AMENDMENT APPLICATION TECH NOD #2 RESPONSE - APRIL 2019 Volume 1 of 2 CLEAN COPY



CITY OF KINGSVILLE, KLEBERG COUNTY, TEXAS

For Permitting Purposes Uniy

JON M. REINHARD

64541

CENSED 04/25/19

TBPE Firm No. F-417

Prepared by



TBPE F-417

THE CITY OF KINGSVILLE LANDFILL TCEQ PERMIT MSW 235C

PERMIT AMENDMENT APPLICATION Volume 1 of 6



CITY OF KINGSVILLE, KLEBERG COUNTY, TEXAS

September 2018

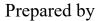
Revision 1 – November 2018

Revision 2 – February 2019

Revision 3 – April 2019

JON M. REINHARI 64541

TBPE Firm No. F-417





TBPE F-417

THE CITY OF KINGSVILLE LANDFILL TCEQ PERMIT MSW 235C

PERMIT AMENDMENT APPLICATION



CITY OF KINGSVILLE, KLEBERG COUNTY, TEXAS

September 2018
Revision 1 – November 2018
Revision 2 - February 2019
Revision 3 - April 2019

Prepared by





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THE CITY OF KINGSVILLE LANDFILL TCEQ PERMIT MSW 235C

PERMIT AMENDMENT APPLICATION Part I



CITY OF KINGSVILLE, KLEBERG COUNTY, TEXAS

September 2018 Revision 1 – November 2018

Revision 2 - February 2019

64541 Revision 3 - April 2019

For Permitting Purposes Only

JON M. REINHARD

TBPE Firm No. F-417

Prepared by



Engineering | Planning | Allied Services

TBPE F-417

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For Permitting Purposes Only

JON M. REINHARD

64541

04/25/19

TBPE Firm No. F-417

Facility Name: City of Kingsville Landfill

Permittee/Registrant Name: City of Kingsville

MSW Authorization #:235C

Initial Submittal Date: September/2018

Revision Date: April/2019



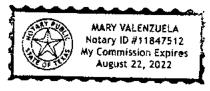
Texas Commission on Environmental Quality Part I Form for New Permit/Registration and Amendment Applications for an MSW Facility

1.	Reason for Submittal			
	☐ Initial Submittal	\boxtimes	Notice of Deficien	cy (NOD) Response
2.	Authorization Type			
	□ Permit		Registration	
3.	Application Type			
	☐ New	\boxtimes	Major Amendmen	t
			Major Amendmen	t (Limited Scope)
4.	Application Fees			
	☐ Pay by Check	\boxtimes	Online Payment	
	If paid online, e-Pay Confirmat Voucher Number: 385823, N			•
_				
5.	Application URL			
	Is the application submitted fo	r Ty	pe I Arid Exempt (AE) and/or Type IV AE facility?
	☐ Yes ☐ No			
	where the application and all re	evisi	ons to that applica	ublicly accessible internet web site tion will be posted. public-works/landfill/landfill-
6.	Application Publishing			
	Party Responsible for Publishin	g No	otice:	
	Applicant Ag	gent	in Service	
	Contact Name: Scot Collins,	P.G	-	Title: Project Manager

Facility Name: City of Kingsville Landfill Initial Submittal Date: September/2018 MSW Authorization #: 235C Revision Date: April/2019

Signature Page

I. Jesus A. (x	· 17 o.	City Ma	nonce	
(Site Operator (Permit	tee/Registrant)'s Autho	rized Signatory) $\frac{(i\hbar \gamma M_{\alpha})}{(i\hbar \gamma M_{\alpha})}$	(Title
certify under penalty of my direction or supervious personnel properly gathe person or persons gathering the information belief, true, accurate,	of law that this document vision in accordance with ther and evaluate the in who manage the syster tion, the information sul and complete. I am aw	nt and all attachments we in a system designed to as formation submitted. Bas in, or those persons direct printited is, to the best of it are there are significant passibility of fine and impris	re prepared undersure that qualificated on my inquirally responsible for my knowledge are penalties for	ed ry of or nd
Signature:)		Date: 4/2	19
Signature:				
TO BE COMPLETED BY REPRESENTATIVE FOR		APPLICATION IS SIGNED	BY AN AUTHOR	IZED
I, <u>Jesus A. Gasza</u> (Print or Type Operato	, hereby designate _ r Name) (William Donnell Print or Type Representati	 tive Name)	
submit additional informe at any hearing or l with this request for a further understand that statements given by n	mation as may be reque before the Texas Commi Texas Water Code or Te at I am responsible for to ay authorized representa	id representative to sign a ested by the Commission; ission on Environmental Q exas Solid Waste Disposal he contents of this applica ative in support of the app ny permit which might be	and/or appear fluality in conjunct in Act permit. I ation, for oral plication, and for	ction
Tesus A. Garra Printed or Typed Name	of Operator or Principa	al Executive Officer		
Signature	•			
SUBSCRIBED AND SW	ORN to before me by th	e said Sesús A.Gor	تص_	
On this <u> </u>	April , 2019			
My commission expire	s on the <u>aa</u> day of	August 2019		
Mous Vounzue Notary Public in and fo	ir Da	9		
Klabera (Note: Application Mu	_ County, Texas st Bear Signature & Sea	il of Notary Public)		



CITY OF KINGSVILLE LANDFILL PART I ATTACHMENT 1 SUPPLEMENTARY TECHNICAL REPORT

THE CITY OF KINGSVILLE LANDFILL TCEQ PERMIT MSW 235C

PERMIT AMENDMENT APPLICATION

Part I

Attachment 1 Supplementary Technical Report



CITY OF KINGSVILLE, KLEBERG COUNTY, TEXAS

September 2018 Revision 1 – November 2018 Revision 2 - February 2019

Revision 3 - April 2019
Prepared by



TBPE Firm No. F-417



TBPE F-417

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1.4 Nature of Business and Solid Waste Data

The existing City of Kingsville Landfill serves residences and businesses in Kleberg County and portions of several surrounding counties, including Nueces, Jim Wells, Brooks and Kenedy. This service area is based on current economic conditions. As economic and available landfill disposal capacity change, the landfill may accept waste from areas other than those noted above.

Kingsville Landfill (current MSW Permit No. 235-B) receives approximately 100.46 tons of waste per day for disposal, six days a week (313 days), or 31,444 tons of waste per year for disposal. Types of waste accepted (currently) for disposal include residential and commercial municipal solid waste, including household wastes, brush, construction/demolition waste and special wastes as authorized by the TCEQ. Wastes currently not accepted at the landfill include hazardous wastes, prohibited wastes, radioactive wastes, industrial wastes, some special wastes including batteries and friable asbestos.

Kingsville Landfill (under the new permit amendment) will accept wastes from residential, municipal, commercial and industrial sources. Kingsville Landfill will accept the following types of waste for processing and/or disposal at the landfill:

• Residential and commercial wastes typical of waste generated by residential and commercial businesses in the area (Municipal Solid Waste):

Municipal Solid Waste (MSW) is defined as: Any solid waste resulting from or incidental to municipal, community, commercial, institutional, and recreational activities, including garbage, rubbish, ashes, street cleanings, dead animals, abandoned automobiles, and all other solid waste other than industrial solid waste;

Construction and demolition waste:

The waste resulting from construction or demolition projects; includes all materials that are directly or indirectly the by-products of construction work or that result from demolition of buildings and other structures, including, but not limited to, paper, cartons, gypsum board, wood, excelsior, rubber, and plastics;

Whole and scrap tires for processing:

Whole and scrap tires are defined as any tire that can no longer be used for its original intended purpose;

Commercial grease and grit trap waste:

Grease and grit trap waste is defined as: material collected from a grease interceptor in the sanitary sewer service line of a commercial, institutional, or industrial food service or processing establishment, including the solids resulting from dewatering processes; and grit trap wastes from interceptors placed in the drains prior to entering the sewer system at maintenance and repair shops, automobile service stations, and washes, laundries, and other similar establishments;

• Liquid wastes for solidification:

The liquid wastes accepted for solidification are characterized as/by untreated liquid wastes which typically do not pass the paint filter test including nonhazardous industrial waste and sludges, food and beverage byproducts and other nonhazardous liquids originated from food and beverage processing plants, and other commercial and industrial facilities;

Industrial non-hazardous waste:

Solid waste resulting from or incidental to any process of industry or manufacturing, mining or agricultural operations, classified as follows:

- Class 2 Industrial Solid Waste any individual solid waste or combination of industrial solid wastes that cannot be described as Class 1 or Class 3, as defined in 30 TAC §335.506 (relating to Class 2 waste determination);
- O Class 3 Industrial Solid Waste any inert and essentially insoluble industrial solid waste, including materials such as rock, brick, glass, dirt, and certain plastics and rubber, etc., that are not readily decomposable as defined in 30 TAC §335.507 (relating to Class 3 waste determination);

and;

Other special wastes:

Special waste is any solid waste or combination of solid wastes that because of its quantity, concentration, physical or chemical characteristics, or biological properties requires special handling and disposal to protect human health or the environment. Special wastes as defined in 30 TAC §330.3, 30 TAC §330.171, and 30 TAC §330.173 include the following:

- Municipal hazardous waste from conditionally exempt small-quantity generators that may be exempt from full controls under Chapter 335, Subchapter N (relating to Household Materials Which Could Be Classified as Hazardous Wastes);
- Class 1 industrial nonhazardous waste;
- Untreated medical waste;
- Municipal wastewater treatment plant sludges, other types of domestic sewage treatment plant sludges, and water-supply treatment plant sludges;
- o Septic tank pumpings;
- o Grease and grit trap wastes;
- Wastes from commercial or industrial wastewater treatment plants; air pollution control facilities; and tanks, drums, or containers used for shipping or storing any material that has been listed as a hazardous constituent in 40 Code of Federal Regulations (CFR) Part 261, Appendix VIII but has not been listed as a commercial chemical product in 40 CFR §261.33(e) or (f);
- Slaughterhouse wastes;

- o Dead animals;
- Drugs, contaminated foods, or contaminated beverages, other than those contained in normal household waste;
- o Pesticide (insecticide, herbicide, fungicide, or rodenticide) containers;
- Discarded materials containing asbestos;
- o Incinerator ash;
- Soil contaminated by petroleum products, crude oils, or chemicals in concentrations of greater than 1,500 milligrams per kilogram total petroleum hydrocarbons; or contaminated by constituents of concern that exceed the concentrations listed in Table 1 of §335.521(a)(1);
- o Used oil;
- Waste from oil, gas, and geothermal activities subject to regulation by the Railroad Commission of Texas when those wastes are to be processed, treated, or disposed of at a solid waste management facility;
- Waste generated outside the boundaries of Texas that contains:
 - any industrial waste;
 - any waste associated with oil, gas, and geothermal exploration, production, or development activities; or
 - any item listed as a special waste in this paragraph;
- Lead acid storage batteries;
- o Used-oil filters from internal combustion engines;
- o Regulated asbestos-containing material (RACM) as defined in 40 CFR Part 61;
- o Nonregulated asbestos-containing material (non-RACM).

Industrial (non-hazardous) and special wastes are accepted and handled in accordance with Part IV – Site Operating Plan.

See Part II, Section 2 for a more detailed breakdown of the quantities, types and characteristics of wastes accepted at the facility.

The life expectancy of the existing permitted sectors is approximately 43 years. The expected rate of solid waste deposition is anticipated to increase at approximately one (1) percent per year (corresponding to the anticipated growth in population) according to information provided by the Texas State Data Center. Based on the anticipated annual growth rate, the expanded facility will last approximately 98 years. See Part II, Section 2.2 and Part III, Section 5.3 for a detailed analysis of the projected life of the expanded site.

The following table provides a summary of the current permitted conditions and proposed permit conditions.

TABLE 2: PERMIT CONDITION SUMMARY

	CURRENT CONDITIONS	PROPOSED CONDITIONS
Permitted Area	120 acres	176.33 acres
	Type I - 4,993,000 cy	
	<u>Type IV - 820,000 cy</u>	
Total Permitted Capacity	5,813,000 cy	17,994,286 cy
	1,258,576 tons	6,295,538 tons
Total Remaining Capacity	3,043,714 cy	15,225,000 cy
Remaining Projected Site Life	43	98
Maximum Elevation of Final Cover		
(msl)	125	200
Elevation of Deepest Excavation		
(msl)	42.5	22.5

2 FACILITY LOCATION §330.59(b)

2.1 Location Description

The City of Kingsville Landfill is located southeast of the City of Kingsville at the northeast corner of the intersection of Farm to Market Road 2619 and East County Road 2130. Kingsville Landfill is outside the City of Kingsville city limits which are approximately 1.45 miles from the northeast corner of the landfill boundary. It however falls within the City of Kingsville's extraterritorial jurisdiction.

2.1 Facility Name, Address and Telephone

Name: City of Kingsville Municipal Solid Waste Landfill

MSW Permit No: 235-C

Physical Address: 348 East C.R. 2130

Kingsville, TX 78363

Mailing Address: P.O Box 1458

Kingsville, TX 78364

Telephone: (361) 595-0092

2.2 Access Routes

The main local public roadways providing access to the facility are East County Road 2130 (E CR 2130), Farm to Market Road 2619 (FM 2619) and Farm to Market Road 1717 (FM 1717). The entrance to the City of Kingsville Landfill is via an existing 24-foot-wide roadway. Refer to Part II, Section 9 - Transportation for more detailed transportation information. Refer to Part I, Attachment 2, Figure I.2-2 - General Highway Map - Kleberg County for the location of the facility in relation to the surrounding roads.

2.3 Geographic Coordinates

The latitudinal and longitudinal geographic coordinates of the permanent site benchmark are:

Latitude: N 27° 26' 41.95" Longitude: W 97° 48' 55.89" Elevation (above msl): 52.60 feet

3 MAPS §330.59(c)

3.1 General Location Map §330.59(c)(1)-(2)

The following maps collectively as a group, comply with the rule requirements of §330.59(c)(1)-(2) and §305.45. These general location maps are included in Part I, Attachment 2 - General Location Maps.

Figure I.2-1 – General Location Map

Figure I.2-2 – General Highway Map - Kleberg County (Texas Department of Transportation, General Highway Map for Kleberg County, Texas)

Figure I.2-4 – Aerial Photograph

Figure I.2-5 – Facility Layout

3.2 Topographic Map

Figure I.2-3 – General Topographic Map (USGS General Topographic Map for the Ricardo, Texas Quadrant)

3.3 Land ownership and Mineral Interests Map

A Land Ownership Map and Land Owners List are included in Part I, Attachment 3. The map and list reflect current property ownership within one-quarter (1/4) mile of the permit boundary and all mineral interest ownership under the facility, as derived from the real property appraisal records as listed on the date that this application was filed. Refer to Figure I.3-1 for location of the properties and Figure I.3-2 for property ownership list. The map and list meet the requirements of 30 TAC §330.59(c)(3), and §281.5. The property ownership list in electronic form is provided in Part I, Attachment 3, Appendix 1, per the requirements of 30 TAC §330.59(c)(3)(B).

Figure I.3-1 – Adjacent Land Ownership Map

Figure I.3-2 – Land Owners List

4 CHARACTER OF THE ADJACENT LAND §305.45(a)(6)

The following sections provide an overview of the various land use conditions of the surrounding area.

- 1) <u>Wind Direction</u>. The nearest reporting station is Corpus Christi, located to the northeast of the landfill site. A wind rose is included as part of Part I, Attachment 2, Figure I.2-1. The wind is predominantly from the southeast.
- 2) Water Wells. A well search was performed using the Texas Department of Licensing and Regulation's (TDLR) State of Texas Well Report Submission and Retrieval System, developed by the Texas Water Development Board in cooperation with the TDLR and the Texas Water Information Network. Based on this search, one well (Tracking Number 178262) is identified within 500 feet of the City of Kingsville Landfill site. During a site reconnaissance visit, this well was not confirmed to be located at the identified location (near the intersection of CR 2130 and CR 2619) and is believed to be plotted incorrectly based on available data, shown on Part II, Attachment 1, Figure II.1-4.
- 3) Existing Structures. The number of structures located within 500 feet of the landfill were determined through a visual reconnaissance and review of aerial photography. Approximately four (4) non-habitable structures are located within the 500-foot boundary of the City of Kingsville Landfill. These structures are associated with agricultural activities within the surrounding areas. Within the permitted boundary of the site, there is a scale house, an office building, and a maintenance shop, (see Part I, Attachment 2, Figure I.2-5and Part III, Attachment 1, Figures III.1-2and III.1-14).
- 4) Special Use areas. A visual reconnaissance and available records search revealed that other than the City of Kingsville Landfill, there are no active disposal facilities located within one mile of the landfill. Surrounding land uses include agriculture (crop land and pasture) with a few remote residences interspaced within the agricultural areas. There are no known licensed day care facilities, hospitals, cemeteries, ponds, or lakes within one mile of the permitted boundary of the landfill.
- 5) Area Streams. The nearest stream to the City of Kingsville Landfill is the Santa Gertrudis Creek. Santa Gertrudis Creek is located about 3,000 feet to the northeast of the northeast corner of the current site and about 2,000 feet to the northeast of the northeast corner of the proposed easterly expansion. No perennial or intermittent streams are located within 500 feet of the location of the proposed expansion.

- 6) Airports. The nearest airfield is the non-public-use Kingsville Naval Air Station (NAS-Kingsville) located northeast of the landfill. The north landfill boundary line is approximately 2.73 miles to the end of the nearest runway and falls within the 6 miles jurisdictional limit of the regulatory airport restrictions. NAS-Kingsville personnel have been notified of the proposed development and how it may impact their activities. The Kingsville Naval Air Station has provided notice that the airfield operations will not be adversely affected by the development. A detailed discussion on airports within the proximity of the landfill site can be found in Part II, Section 9.5. as well as correspondence with NAS-Kingsville and the FAA can be found in Part II, Section 9.5.
- 7) <u>Easements</u>. There is one (1) known aerial electrical line easement within the permitted boundary of the City of Kingsville Landfill.
- 8) <u>Historic Sites</u>. A review of the Texas Historical Commission's database for a one-mile radius and visual observations indicated that no historic sites are present. A detailed discussion on historic sites within one-mile of the landfill site can be found in Part II, Section 15 as well as applicable correspondence with the Texas Historical Commission can be found in See Part II, Attachment 7.

5 PROPERTY OWNER INFORMATION §330.59(d)

5.1 Legal Description

The legal description for the City of Kingsville Landfill property boundary and the Kleberg County Clerk's file number are included in Part I, Attachment 4, Appendix 1. The drawing of the property boundary metes and bounds is included in Part I, Attachment 4, Appendix 1.

The legal description for the City of Kingsville Landfill permit boundary and the Kleberg County Clerk's file number are included in Part I, Attachment 4, Appendix 2. The drawing of the permit boundary metes and bounds is included in Part I, Attachment 4, Appendix 2.

5.2 Ownership

Kingsville Landfill is owned and operated by the City of Kingsville (City). The facility services residences and businesses within Kleberg County and portions of several surrounding counties, including Nueces, Jim Wells, Brooks and Kenedy.

5.3 Property Owner Affidavit

The property owner affidavit for this permit amendment application found in Part I, Attachment 6 meets the requirements of §330.59(d)(2).

6 LEGAL AUTHORITY §330.59(e)

The legal authority and status of the applicant has been verified as required by §330.59(e) and §281.5 and is included in Part I, Attachment 5 – Verification of Legal Status. The City of Kingsville owns and operates the City of Kingsville Landfill. No other person or entity owns more than 20 percent of the facility.

7 EVIDENCE OF COMPETENCY §330.59(f)

Kingsville Landfill is owned and operated by the City of Kingsville (City). The landfill serves residences and businesses within Kleberg County and portions of surrounding Texas counties. The City has been providing waste disposal since the 1970's and has successfully operated the municipal landfill operation. The City owns and operates the City of Kingsville Citizens Collection Station MSW Registration # 120081, since June 2012. The City does not own and has not operated any other solid waste sites in the last 10 years, in Texas or any other state. It has, to this date, complied with all regulations and requirements set forth by the regulatory agency and most currently, Texas Commission on Environmental Quality (TCEQ). Evidence of Competency for the City of Kingsville Landfill is provided in Part I, Attachment 7.

8 APPOINTMENTS §330.59(g)

Part I, Attachment 9 provides documentation that the person signing the application meets the requirements of §305.44 of this title (relating to Signatories to Applications). Article V, Section 31 of the City of Kingsville Charter, establishes that the City Manager is the chief administrative and executive officer of the City. As the City's executive officer, the City Manager has the authority to sign this application and to delegate signatory responsibility related to the permit amendment application.

9 OTHER PERMITS AND AUTHORIZATIONS §305.45(a)(7)

Section 11 of the TCEQ Part I Form for New Permit/Registration and Amendment Applications for an MSW Facility (TCEQ-0650) contains the required information relating to additional permits or approvals. The City of Kingsville currently has Standard Air Operating Permit (#3337), Air New Source Registration (#91376), Air New Source Registration (#54070L001) and General Permit to Discharge Under The Texas Pollutant Discharge Elimination System (TPDES) under provisions of Section 402 of the Clean Water Act and Chapter 26 of the Texas Water Code (#TXR05L074).

10 APPLICATION FEES §330.59(h)

In accordance with §330.59(h), The City of Kingsville has made payment of \$150.00. This fee was paid to TCEQ online via the TCEQ ePay online payment system, the receipt is provided in Part I, Attachment 10.

THE CITY OF KINGSVILLE LANDFILL TCEQ PERMIT MSW 235C

PERMIT AMENDMENT APPLICATION PART II



CITY OF KINGSVILLE, KLEBERG COUNTY, TEXAS

September 2018
Revision 1 – November 2018
Revision 2 - February 2019
Revision 3 - April 2019

JON M. REINHAR

64541

Prepared by



HANSON PROJECT NO. 16L0438-0003

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Submittal Date: September 2018 Revision 3 - April 2019

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ATTACHMENT 5 – WETLANDS CORRESPONDENCE

ATTACHMENT 6 – ENDANGERED OR THREATENED SPECIES CORRESPONDENCE

ATTACHMENT 7 – CULTURAL RESOURCES CORRESPONDENCE

ATTACHMENT 8 – COUNCIL OF GOVERNMENTS CORRESPONDENCE

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Submittal Date: September 2018 Revision 3 - April 2019

1 EXISTING CONDITIONS SUMMARY §330.61(a)

The City of Kingsville currently operates the City of Kingsville Landfill, which is a Type I and Type IV municipal solid waste facility operating under TCEQ Permit No. 235-B. The landfill is scheduled to cease operation in 2061. The City intends to increase the site life and better utilize the available space at the landfill through the proposed expansion and design modifications.

1.1 General Facility Description

The City of Kingsville Landfill (Kingsville Landfill) is located in Kleberg County, Texas, at the northeast corner of the intersection of Farm to Market Road 2619 and County Road 2130. The northern boundary of the property is approximately 2,811 feet from FM 1717, while the eastern boundary is approximately 1,300 feet from N. County Road 1070 (See Part I, Attachment 2, Figure I.2-1 – General Location Map).

The Kingsville Landfill has been in existence since February 1977 and is intended to provide waste disposal for residences and businesses in Kleberg County and surrounding Texas counties. The nearest community is the City of Kingsville, whose city limits are approximately 1.45 miles from the northeast corner of the landfill boundary. The facility has undergone two permit amendments to date allowing it to extend its initial permit boundaries, and increase the permitted maximum elevation (Refer to Part I, Attachment 1, Section 1.2 – Permit History).

The existing Kingsville Landfill includes a scale house, an office building, and a maintenance shop, all enclosed within a perimeter fence. These facilities will continue to be operational for the life of the landfill. No new building or infrastructure improvements will be constructed as part of the proposed permit amendment.

The overall property consists of gently undulating grasslands with limited forest cover. The property generally slopes to the northeast with no major topographic features. The nearest 100-year floodplain is located to the northeast of the site along Santa Gertrudis Creek. There is one (1) known aerial electrical line easement within the permitted facility boundary. Surrounding land use is predominantly agricultural.

1.2 Purpose of the Permit Amendment Application

The City of Kingsville proposes to redesign the current City of Kingsville Landfill Permit 235-B, a Type I and Type IV Municipal Solid Waste Facility, in accordance with the Texas Administrative Code Chapter 330: Municipal Solid Waste Regulations. The redesign includes both a vertical and lateral expansion to increase the currently permitted disposal facility from 120-acres to 176.33-acres (121.3 acre waste disposal footprint), and the permitted maximum (final cover) elevation for the facility from 125-feet to 200-feet above MSL (the maximum waste elevation for the facility will be 196.92 feet-msl) as indicated in Part III, Attachment 1, Figure III.7-1. The elevation of the deepest excavation will also be increased 20-feet to an elevation of 22.5 feet-msl

2 WASTE ACCEPTANCE PLAN §330.61(b)

2.1 Sources and Characteristics of Waste

The operational procedures and redesign described in the Permit Amendment Application, once approved, will allow the facility to accept, store, process and/or dispose of municipal solid waste, construction and/or demolition waste, whole and scrap tires, grease and grit trap waste, liquid waste, industrial waste non-hazardous Class 2 and Class 3 and some special wastes as defined by 30 TAC §330.3, 30 TAC §330.171, and 30 TAC §330.173.

The facility will accept for disposal the following special waste allowable under 30 TAC §330.171: special wastes from health care related facilities, dead animals and/or slaughterhouse waste, non-regulated asbestos-containing materials (non-RACM), empty containers which have been used for pesticides, herbicides, fungicides, or rodenticides, Municipal hazardous waste from a conditionally exempt small quantity generator (CESQG), sludge, grease trap waste, grit trap waste, soil contaminated by petroleum products, crude oils, or chemicals and liquid waste from oilfield activities. Procedures for accepting and processing all special waste are detailed in the Site Operating Plan (Part IV). In the event that the City of Kingsville Landfill elects to accept other special wastes in the future, TCEQ authorization will be sought and procedures for acceptance and processing will be provided. Other materials that will be received for processing and potentially beneficial reuse include scrap tires and unsorted mixed recyclables.

Consistent with 30 TAC §330.15, the City of Kingsville Landfill will not accept for disposal lead acid storage batteries, used motor vehicle oil, used oil filters, refrigerators, freezers, air conditioners or other items containing chlorinated fluorocarbons (CFC), regulated hazardous waste, polychlorinated biphenyls (PCB) waste, radioactive materials, or other wastes prohibited by TCEQ. Friable asbestos-containing materials, and empty containers, as well as industrial hazardous waste, and Non-hazardous Class 1 industrial waste will not be accepted for disposal.

The Site Operating Plan in Part IV of the application contains a detailed description of the restrictions pertaining to waste acceptance procedures. The Applicant (City of Kingsville) reserves the right to reject any waste material, including those mentioned above, that contributes a constituent or characteristic that may impact or influence the design or operation of the facility.

2.2 Volume and Rate of Disposal

Kingsville Landfill received approximately 31,444 tons of incoming solid waste in 2017. The maximum annual waste acceptance rate is anticipated to increase at approximately one (1) percent per year which corresponds to the anticipated yearly population growth rate for Kleberg County (based on population projections from the Texas State Data Center).

9 TRANSPORTATION §330.61(i)

9.1 Selected Routes

Vehicles entering the City of Kingsville Landfill include semi-trailers, dump trucks and trailers, and light duty trucks. E County Road 2130 (CR E 2130), Farm to Market Road 1717 (FM 1717), and Farm to Market Road 2169 (FM 2169) will provide access to the site. These routes are asphalt paved and are the same routes currently in use for the City of Kingsville Landfill. The transportation network used to access the landfill is presented as Part II, Attachment 1. Figure II.1-1.

9.2 Adequacy of Roads

The privately owned site entrance road is currently a two-lane, 24-foot wide road maintained by the City of Kingsville to ensure access to the facility. The Texas Department of Transportation is responsible for maintaining FM 2169 and FM 1717 while E CR 2130 is maintained by Kleberg County. All roads are adequate for use by vehicles up to the legal maximum of 58,420 pounds, including solid waste collection vehicles entering and exiting the facility. Periodic maintenance of the roads is routinely undertaken by the City and TXDOT as necessary to maintain availability of these routes to the landfill and to ensure that residents and businesses along the routes have continued access. Correspondence with TXDOT regarding the adequacy of roads used to access the facility is included in Part II, Attachment 3. TXDOT responded to the NORI with a memo, dated April 16, 2019, stating that the facility is subject to the Highway Beautification Act requirements (43 TAC Chapter 21, Subchapter H). The April 16, 2019 memo is included with Part II, Attachment 3-B. Further communication with TXDOT is required to determine if the facility is subject to the Highway Beautification Act requirements or not. If it is determined that the facility is subject to the Highway Beautification Act requirements (43 TAC Chapter 21, Subchapter H), the facility will provide screening in accordance with those requirements and as approved by the TXDOT District Engineer for Kleberg County.

9.3 Existing Traffic Volumes

All landfill traffic access the facility via the single site entrance road from E County Road 2130 (E CR 2130) and Farm to Market Road 2619 (FM 2619) which is in-turn accessed via Farm to Market Road 1717 (FM 1717). TXDOT records show the Annual Average Daily Traffic (2016 AADT) is approximately 731 on FM 2619 at the nearest traffic count northwest of the landfill and 1,218 on FM 1717 at the traffic count northwest of the landfill (Refer to Part II, Attachment 1. Figure II.1-1. There are no available traffic counts for E CR 2130. Approximately 46 City, commercial, and citizen waste hauling vehicles per day use the City of Kingsville Landfill.

9.4 Projected Volume of Vehicular Traffic

The proposed vertical and lateral expansion will not have an impact on vehicular traffic in the area as the rate at which municipal solid waste is received by the facility will not be affected. The traffic volume projection is calculated at the expected annual population growth rate of approximately one (1) percent. Traffic volumes and calculations are presented in the Table 3.

CITY OF KINGSVILLE LANDFILL PART II

ATTACHMENT 3-B

RESPONSES FROM
TEXAS DEPARTMENT OF TRANSPORTATION (TxDOT)



MEMO

April 16, 2019

To: Gulay Aki, Team Leader

Municipal Solid Waste Permits Section

Waste Permits Division

From: Alanna Bettis, P.E., Section Director

Contracts & MMS Support Section

Maintenance Division

Docusigned by:

Clauma Buttis

652B54A269034EB...

Subject: City of Kingsville Landfill – Kleberg County

Municipal Solid Waste - Permit Amendment Application No. 235C

Application Summary for Agency Review

Tracking No. 23301130 and 23458984; RN102334570/CN600674246

After review by TxDOT, it was determined that the City of Kingsville Landfill falls within 1,000 feet of FM 2619. Thus, it is subject to regulations of the Highway Beautification Act and Texas Administrative Code, 43 TAC Chapter 21, Subchapter H. The critical elements for review are as follows:

- (1) Before any screening is commenced, the plans and specifications therefor shall first be submitted by the owner of the junkyard to, and approved by, the district engineer of the department who serves the county in which such screening is to be placed.
- (2) Such screening shall be located outside the highway right-of-way in such manner as not to interfere in any way with traffic along any highway or roadway.
- (3) Such screening may be accomplished by means of earthen berms, plantings, fences, walls, or other durable materials provided they are effective in blocking the view of such junkyard or automobile graveyard from the motoring public traveling in a standard size automobile along the main traveled way of the controlled highway. The height and density of such screening shall be such as to effectively block such view at all times.
- (4) Such screening shall be so designed and landscaped as to cause the junkyard or automobile graveyard area to be inconspicuous and pleasing to the motoring public in accordance with the purposes of the Highway Beautification Act.

For further assistance please contact Harsh Doshy at 512-416-3185 or at harsh.doshy@txdot.gov.

OUR GOALS

MAINTAIN A SAFE SYSTEM • ADDRESS CONGESTION • CONNECT TEXAS COMMUNITIES • BEST IN CLASS STATE AGENCY

An Equal Opportunity Employer

CITY OF KINGSVILLE LANDFILL PART II ATTACHMENT 3-C SUBMITTAL TO KLEBERG COUNTY (COUNTY)





Hanson Professional Services Inc. 4501 Gollihar Road Corpus Christi, TX 78411 (361) 814-9900 Fax: (361) 814-4401 www.hanson-inc.com

April 8, 2019

Mr. Roy Cantu Precinct 3 County Commissioner Kleberg County 433 E. County Road 2310 Riviera, Texas 78379

Re: Coordination Letter for Road Maintenance City of Kingsville Landfill – Kleberg County Municipal Solid Waste (MSW) - Permit No. 235C Permit Amendment for Vertical and Lateral Expansion

Dear Mr. Cantu,

On behalf of the City of Kingsville (City), Hanson Professional Services Inc. has prepared a permit amendment application for a vertical and lateral expansion of the City of Kingsville Municipal Solid Waste Landfill (Kingsville Landfill). The Kingsville Landfill is located southeast of the City of Kingsville, Kleberg County, Texas. The entrance to the landfill is located at 348 East County Road 2130. Other roads used to access the site include Farm to Market Road (FM) 1717 and Farm to Market Road (FM) 2619. The enclosed maps show the access routes and location of the landfill.

This letter is being submitted to document coordination with Kleberg County (County), the agency exercising maintenance responsibility of the public roadway involved (consistent with the requirements of Texas Commission on Environmental Quality (TCEQ) municipal solid waste (MSW). Rule 30 TAC §330.61(i)(4)). We are requesting a written response from the County to acknowledge receipt of this letter and to provide information regarding any traffic or related location restrictions, and any proposed roadway improvements being planned in the vicinity of the site.

BACKGROUND INFORMATION

- The landfill is an existing facility, currently in operation. The location is shown on attached Figure 1. The landfill entrance/exit is located on East County Road (E CR) 2130. No changes to the existing landfill entrance/exit are planned at this time.
- On a typical day the existing facility generates approximately 65 vehicle trips entering and exiting the landfill via the driveway on E CR 2130. These vehicle counts are based on the facility's scale records, waste receipts, and the typical number of employees and visitors accessing the site on a given day.
- To clarify terminology, please note that the term "expansion" refers to a waste disposal
 capacity increase of the landfill. Thus, it will allow an extension in site life of the landfill. In
 terms of expected traffic, the expansion is not expected to trigger any new sources of traffic
 or sudden increase in traffic rather, gradual steady growth of existing landfill traffic over time
 is anticipated.
- Based on existing landfill customer traffic patterns, the main area roads used by waste hauling vehicles coming to and from the landfill are E CR 2130, FM 1717 and FM 2619, shown on the enclosed maps.

· The current site life of the landfill is approximately 46 years. At this time, we estimate that the post-expansion remaining site life of the landfill to be about 100+ years.

We would appreciate your timely review of this information and thank you in advance for your response that provides the above-requested information. If you have any questions or require additional information, you may contact me or Kelly Mayfield at (361) 814-9900.

Sincerely,

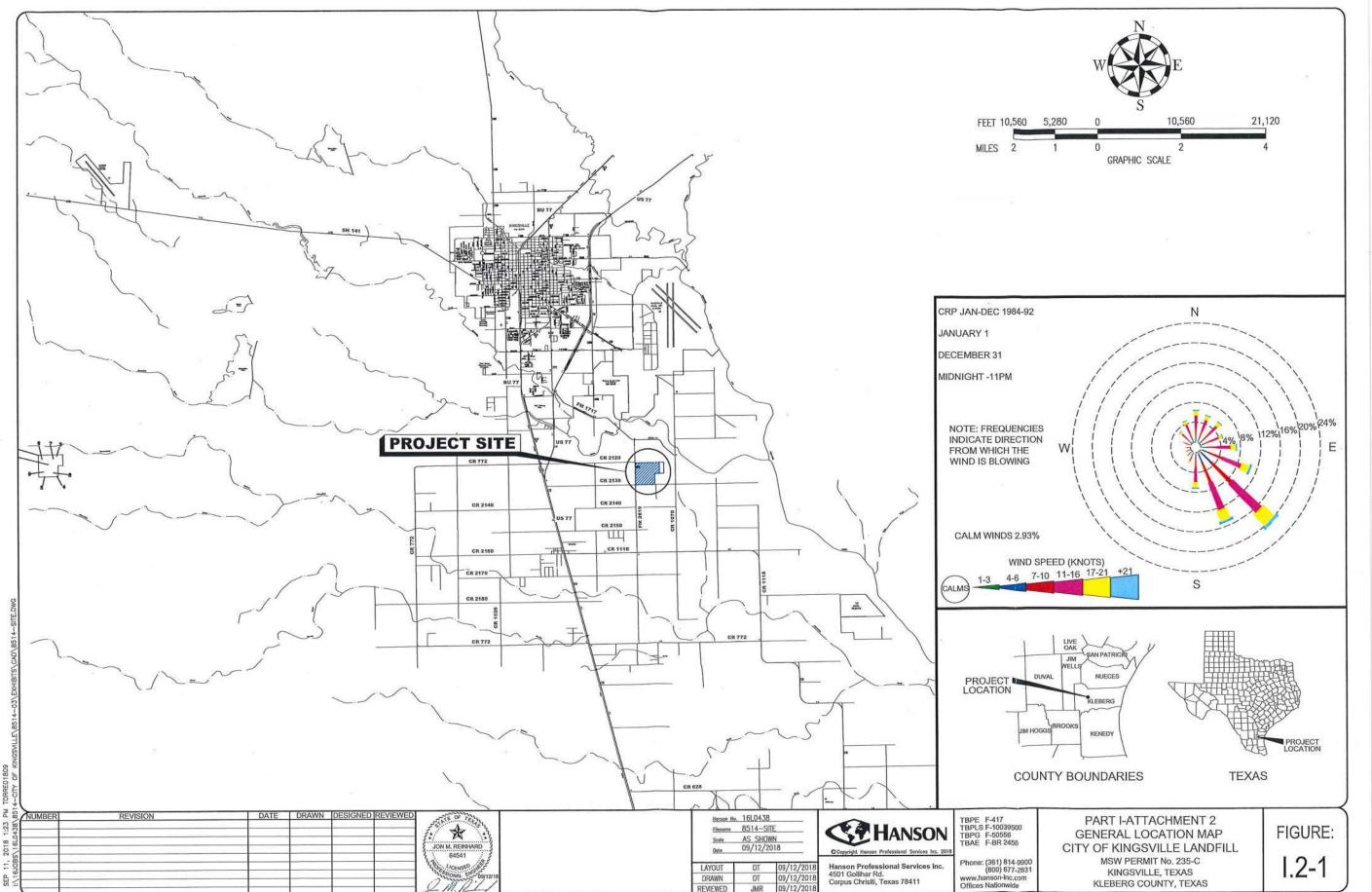
HANSON PROFESSIONAL SERVICES INC.

Jon M. Reinhard, P.E. Project Engineer

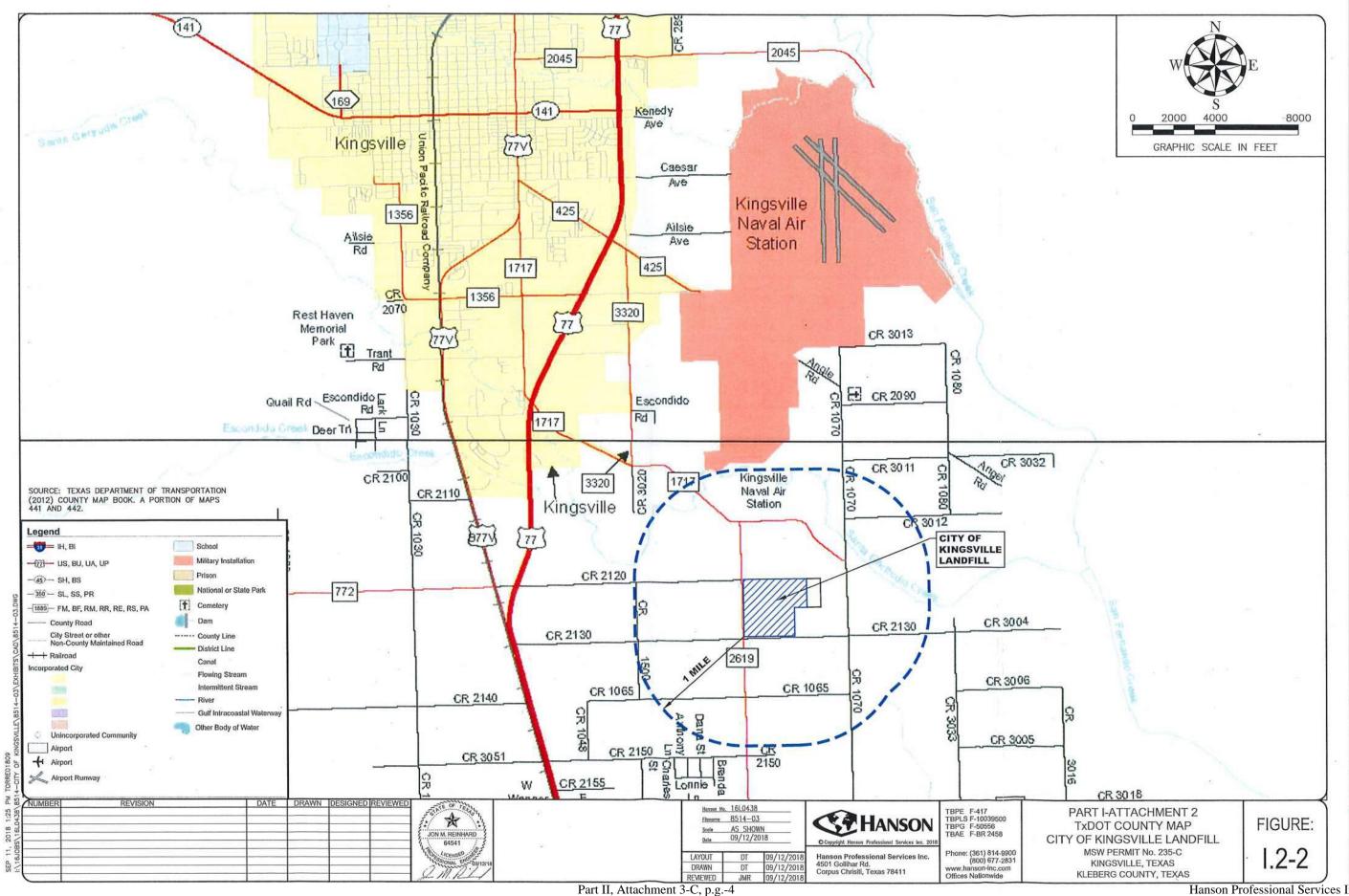
Enclosures: General Location Map **TXDOT County Map** 2013 Corpus Christi District Traffic Map

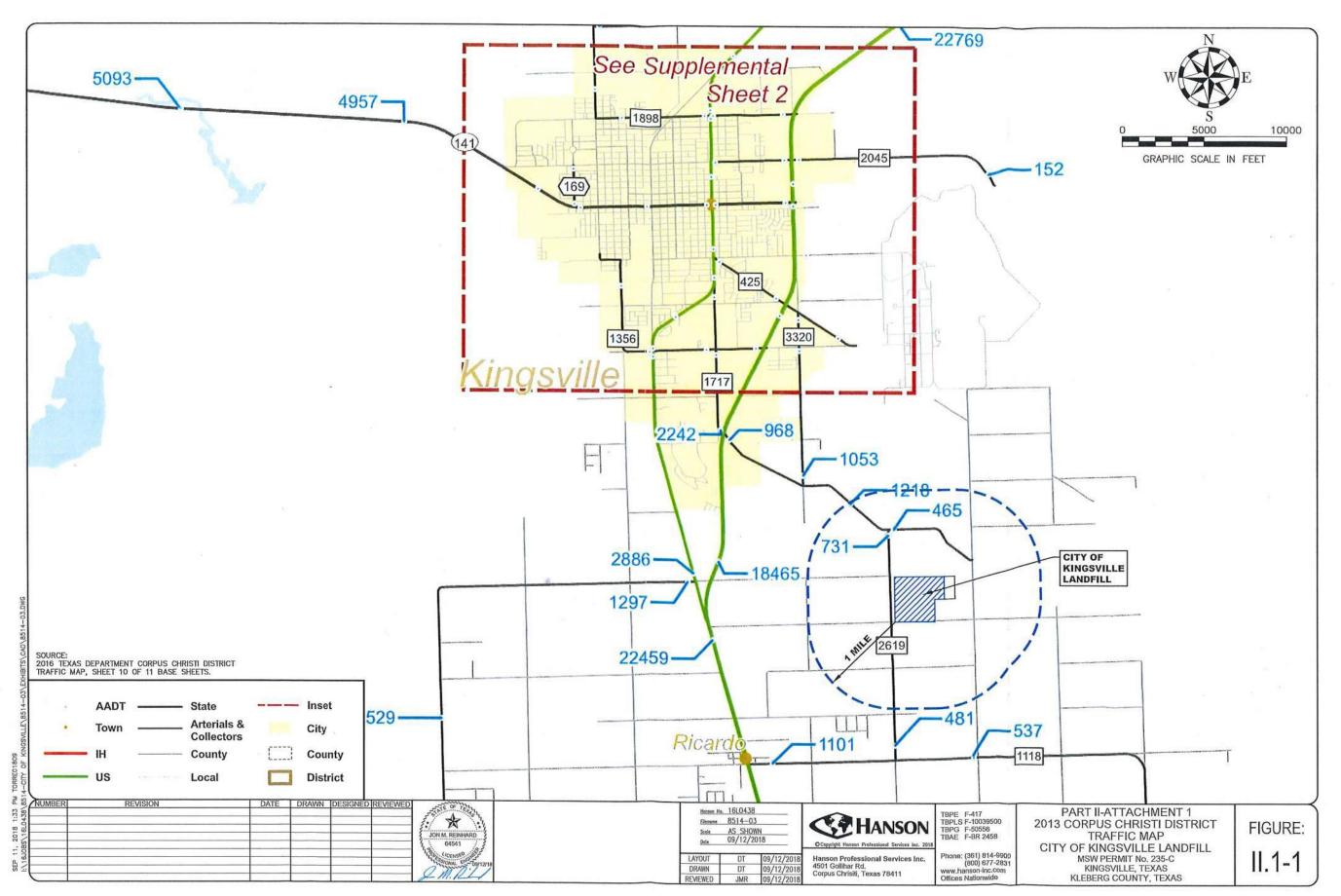
cc: Bill Donnell, City of Kingsville Public Works Director Gary Fuselier, City of Kingsville Landfill Manager

Revision: 3 - April 2019



Part II, Attachment 3-C, p.g.-3





THE CITY OF KINGSVILLE LANDFILL TCEQ PERMIT MSW 235C

PERMIT AMENDMENT APPLICATION PART III SITE DEVELOPMENT PLAN



CITY OF KINGSVILLE, KLEBERG COUNTY, TEXAS

September 2018 Revision 1 – November 2018 Revision 2 - February 2019 Revision 3 - April 2019

Prepared by



TBPE Firm No. F-417



HANSON PROJECT NO. 16L0438-000

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ATTACHMENT 9	-	FINANCIAL ASSURANCE
ATTACHMENT 10	-	LINER QUALITY CONTROL PLAN
ATTACHMENT 11	-	GROUNDWATER SAMPLING AND ANALYSIS PLAN
ATTACHMENT 12	-	FINAL CLOSURE PLAN
ATTACHMENT 13	-	POST-CLOSURE CARE PLAN
ATTACHMENT 14	-	LANDFILL GAS MANAGEMENT PLAN
ATTACHMENT 15	-	LEACHATE AND CONTAMINATED WATER MANAGEMENT
		PLAN
ATTACHMENT 16	-	SECTOR 4C LINER CONSTRUCTION CORRESPONDENCE
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Submittal Date: September 2018 Revision 3 - April 2019

3.2.2 Ventilation and Odor Control Measures

Potential odor sources associated with a landfill can vary considerably and may include the wastes being delivered to the landfill, waste in the open working face, landfill gas, the leachate collection system, or ponded water. Some wastes such as sludge and dead animals are a source of odor upon receipt, while other wastes have the potential for becoming a source of odor by their biodegradable nature. Leachate, liquid that has passed through or emerged from solid waste, may also be a source of odor if not properly handled in a timely manner.

Landfill operation at the site will occur in open areas within the permitted waste disposal footprint, therefore adequate ventilation will be provided. Landfill operators will ensure that odors are kept to a minimum by keeping the size of the working face area to a minimum, identifying any waste streams that require special attention to control odor, proper handling and disposal of leachate in a timely manner, and preventing ponded water. These and other odor control measures are discussed in detail in Part IV – Site Operating Plan.

The site will comply with all the applicable air quality rules and regulations. Accidental fires will be controlled, and open burning of waste will not be permitted.

3.2.3 Generalized Construction

Generalized construction details for the landfill are included in Part III, Attachments 1 through 3. Storage and Processing Area Plans, Figure III.1-16 in Part III, Attachment 1, provides details for the White Goods and Metal Recyclables Storage Area and the Tire Storage and Processing Area. Design and operation requirements for the Liquid Waste Solidification Area are included in Part IV- SOP, Attachment 5. Construction details for the liquid waste solidification area are shown on Figure IV.5-1. Details of the leachate management system are included in Part III, Attachment 15. Construction details for the leachate storage tanks are shown on Part III, Attachment 15, Appendix G, Figure III.15-G-3.

3.3 Sanitation and Water Pollution Control §330.63(b)(3) – (4)

The white goods and metal recyclables storage area and the tire storage and processing area contains waste handling and storage operations but there is no process wastewater produced at these areas or other operations of the landfill. The areas will be built up with an all-weather surface that is graded and bermed to prevent surface water from running into the storage area. In addition to preventing surface water runon into the areas, the berms enclosing the areas will also serve to contain runoff. The areas will be graded to a stormwater collection sump that wil collect and hold runoff from within the area. If runoff is determined to be contaminated it will be collected and transported to the contaminated water evaporation pond or the contaminated water management area.

3.4 Endangered Species Protection §330.63(b)(5)

A literature review of threatened or endangered species in Kleberg County was conducted as discussed in Part II, Section 14. The review included both US Fish and Wildlife (USFWS) and Texas Parks and Wildlife Department documentation and their requirements for endangered species assessment and compliance. No potential habitat for federally listed threatened or endangered species or designated critical habitat occurs within the permit area, or the property. And no federally listed threatened or endangered species have been observed on the property. Neither the facility nor its operations will result in the destruction or adverse modification of the critical habitat of threatened or endangered species. If endangered species are encountered during site operations, USFWS and TPWD will be notified.

Revision 3 - April 2019

9 **CLOSURE PLAN §330.63(h)**

Part III, Attachment 12 - Final Closure Plan contains the details of the final cover design, which has been developed to comply with Subchapter K, §330.501 through 330.505 of the TCEQ regulations. A composite cover will be constructed over the entire landfill. The composite cover will overlay a 12-inch thick intermediate cover layer immediately above the top of waste. The composite cover will consist of, from bottom to top, a prepared soil subgrade, a geosynthetic clay liner (GCL), a 40-mil flexible membrane cover, a drainage geocomposite, and a 25-inch thick protective soil erosion layer. The Alternative Liner and Overliner Point of Compliance Demonstrations found in Part III, Attachment 5 includes a demonstration that the GCL material proposed in the final cover design is acceptable.

The initial and primary vegetative cover for the site will include appropriate native grasses. Typical types of grasses include Coastal Bermuda, Buffalo Grass, Texas Grama, Bluestem and Johnson Grass. Winter Rye and Fescue may be used in the cool seasons. The Kleberg County Extension Agent may also be consulted on the use of appropriate grasses and the appropriate planting seasons as cover projects are initiated. The maintenance of grass cover over completed areas is an essential component of erosion control in post closure care.

A demonstration that this specified final cover design will provide effective long term erosional stability is included in Part III, Attachment 6 - FSWDR.

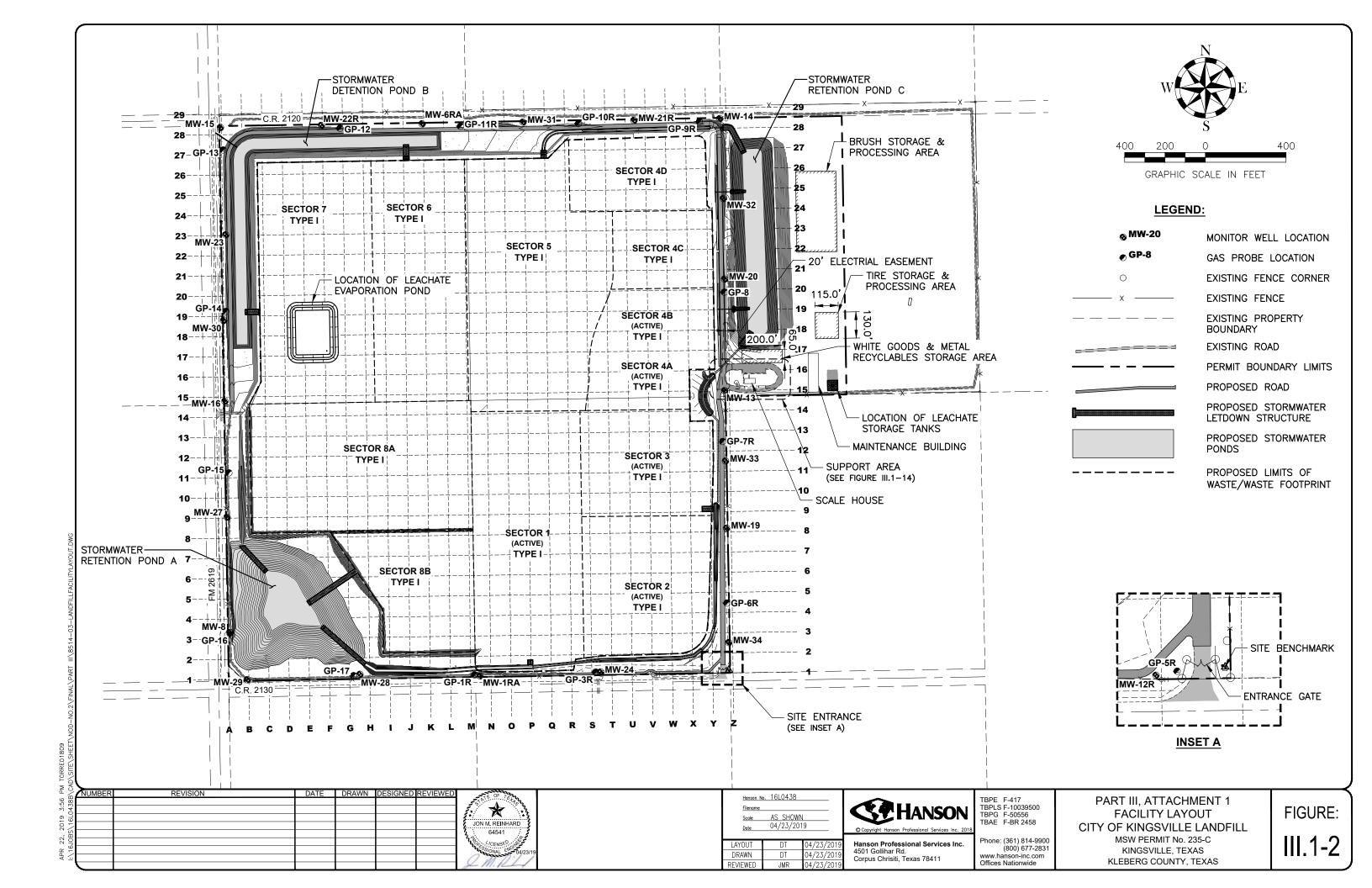
CITY OF KINGSVILLE LANDFILL PART III ATTACHMENT 1 SITE LAYOUT PLANS

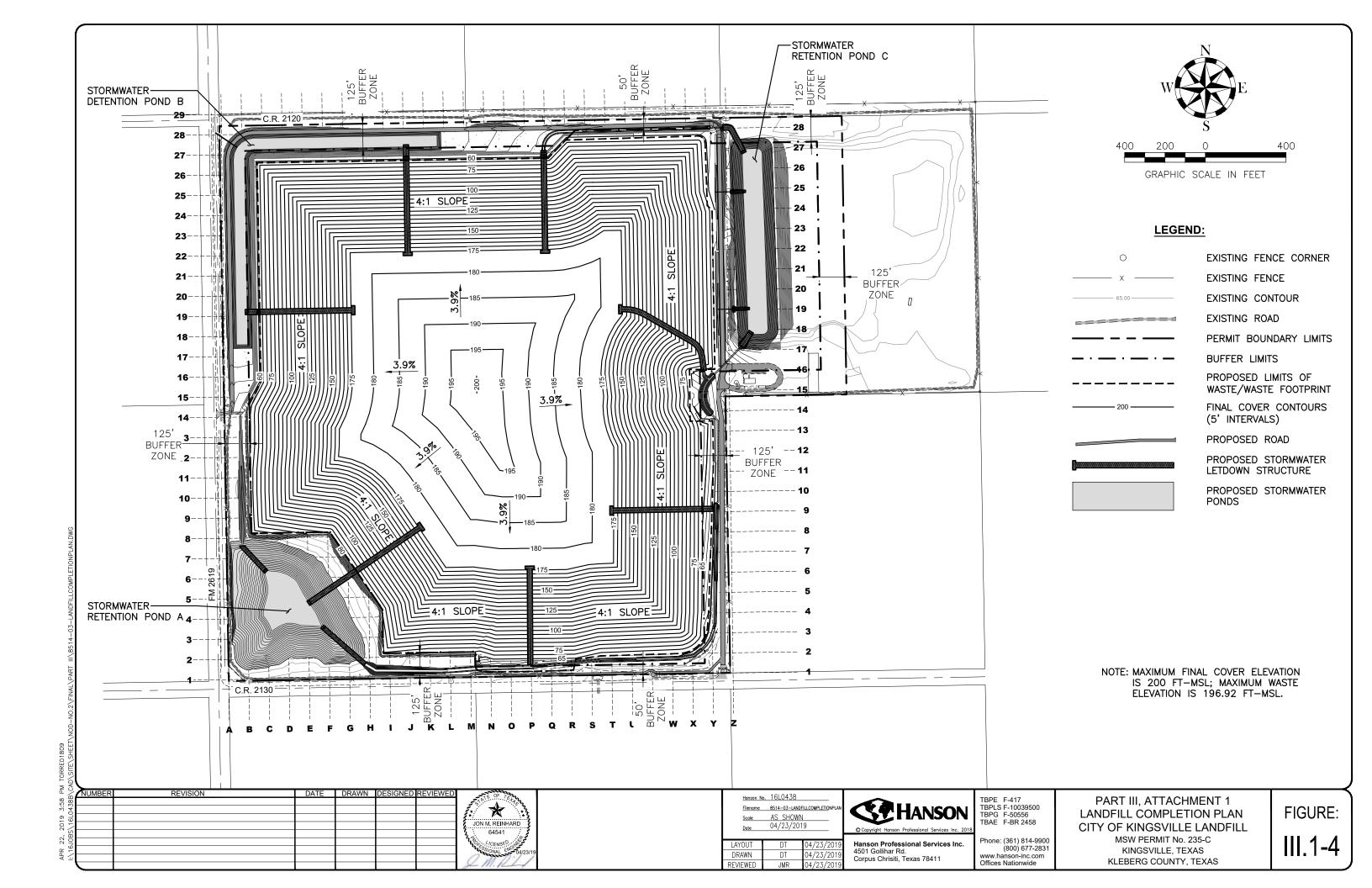
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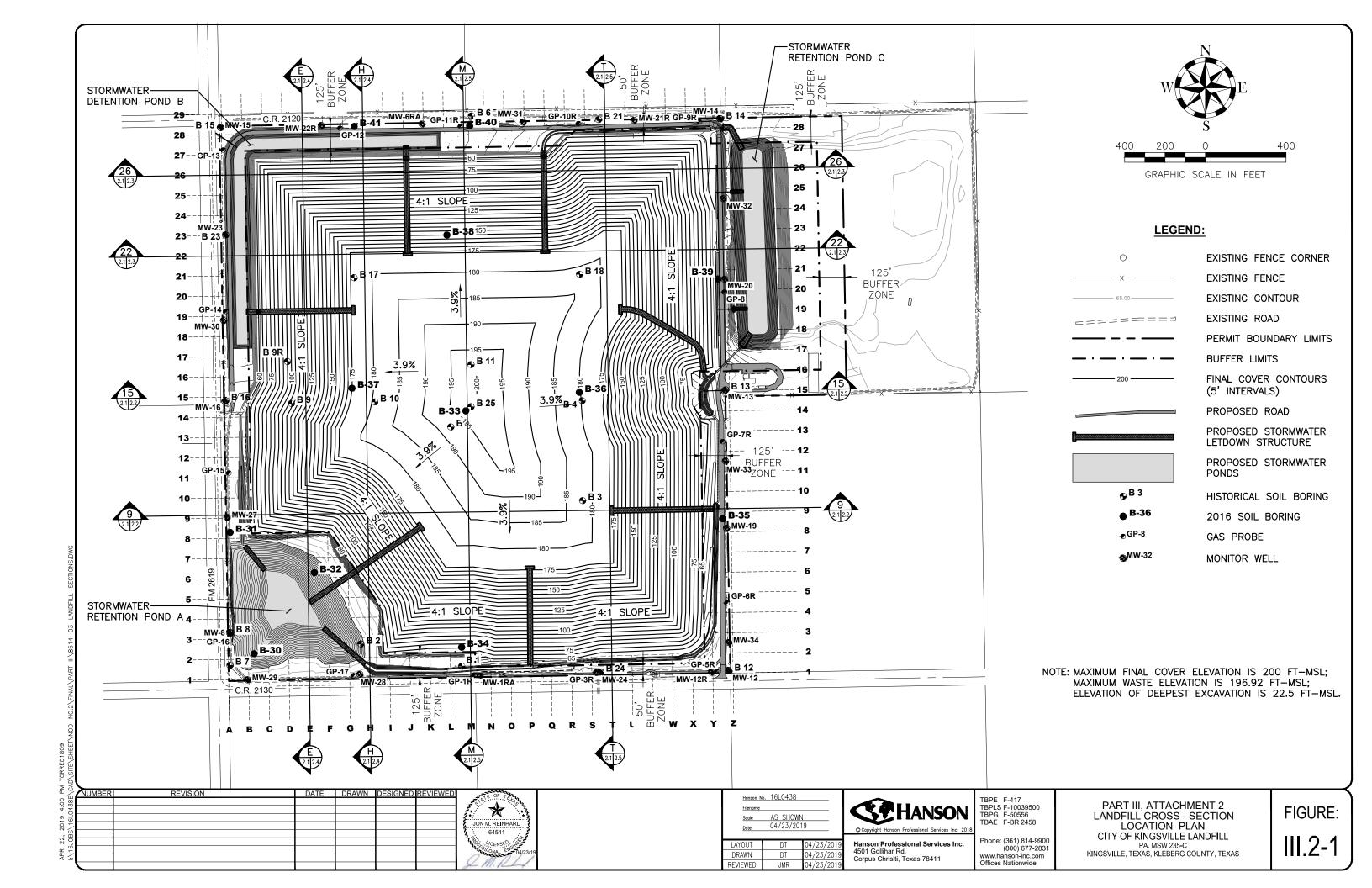
CITY OF KINGSVILLE LANDFILL PART III ATTACHMENT 2 CROSS-SECTIONS

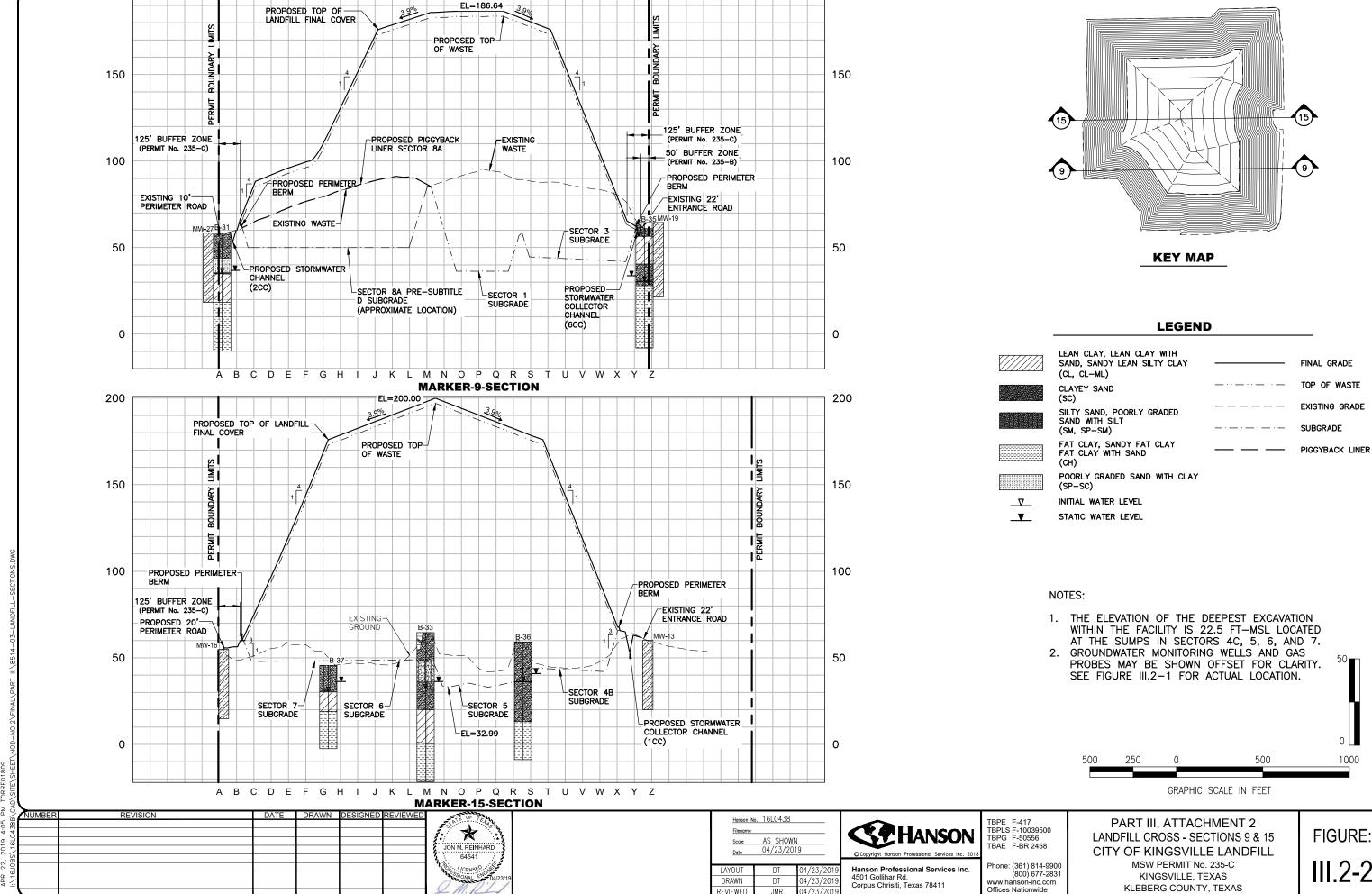
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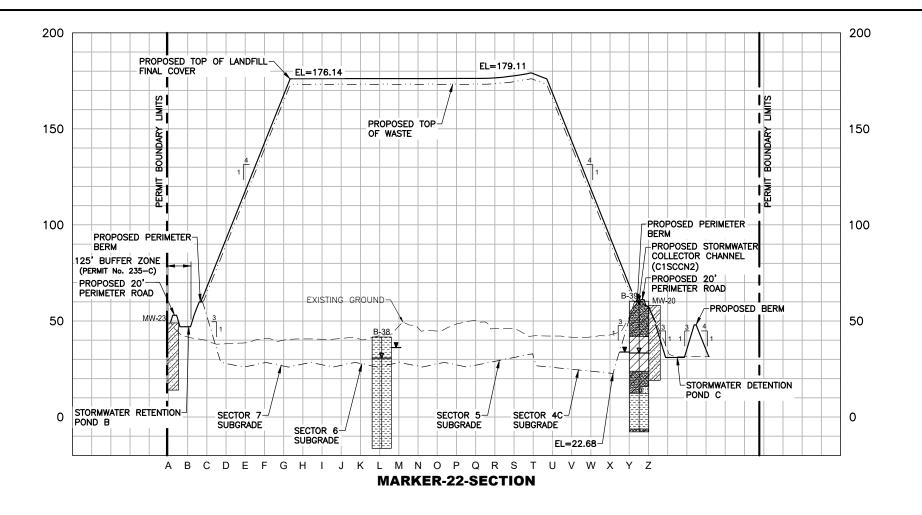
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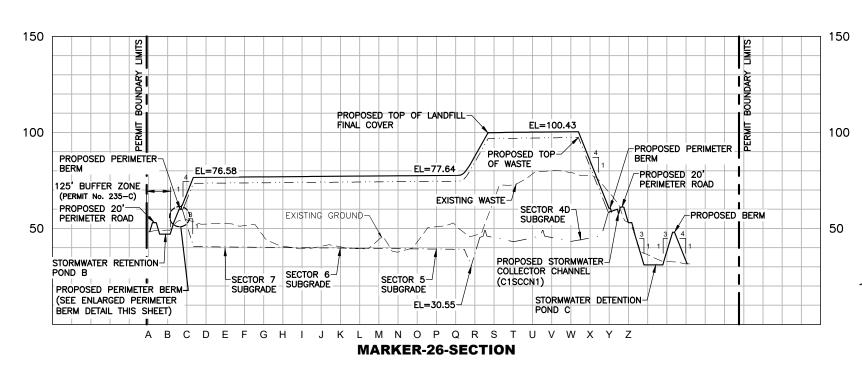
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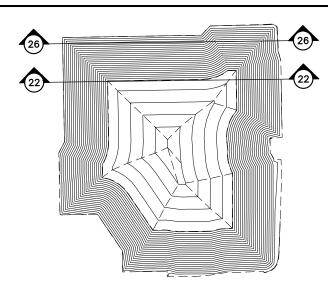




KLEBERG COUNTY, TEXAS







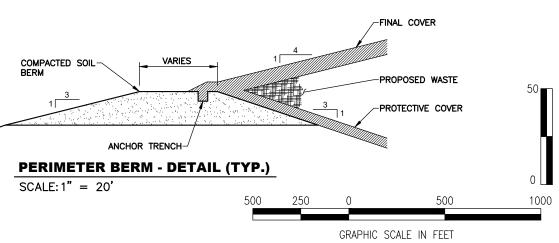
KEY MAP

LEGEND

LEAN CLAY, LEAN CLAY WITH SAND, SANDY LEAN SILTY CLAY FINAL GRADE (CL, CL-ML) TOP OF WASTE CLAYEY SAND (SC) EXISTING GRADE SILTY SAND, POORLY GRADED SAND WITH SILT (SM, SP-SM) SUBGRADE FAT CLAY, SANDY FAT CLAY FAT CLAY WITH SAND PIGGYBACK LINER (CH) POORLY GRADED SAND WITH CLAY (SP-SC) INITIAL WATER LEVEL STATIC WATER LEVEL

NOTES:

- 1. THE ELEVATION OF THE DEEPEST EXCAVATION WITHIN THE FACILITY IS 22.5 FT-MSL LOCATED AT THE SUMPS IN SECTORS 4C, 5, 6, AND 7.
- 2. GROUNDWATER MONITORING WELLS AND GAS PROBES MAY BE SHOWN OFFSET FOR CLARITY. SEE FIGURE III.2—1 FOR ACTUAL LOCATION.



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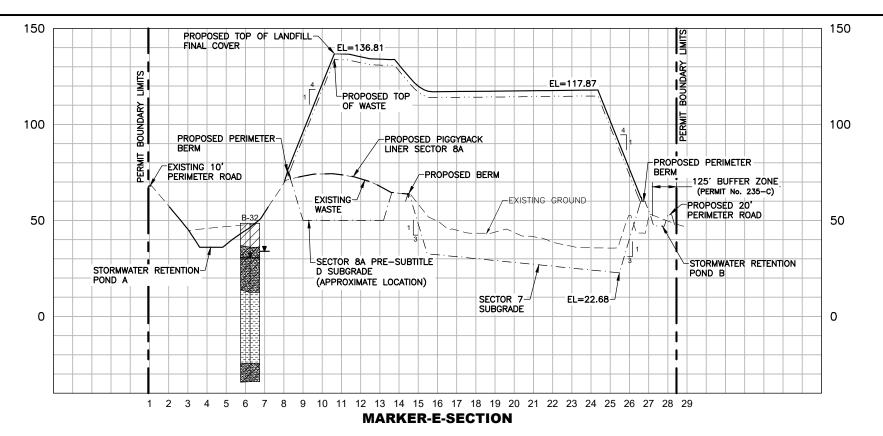
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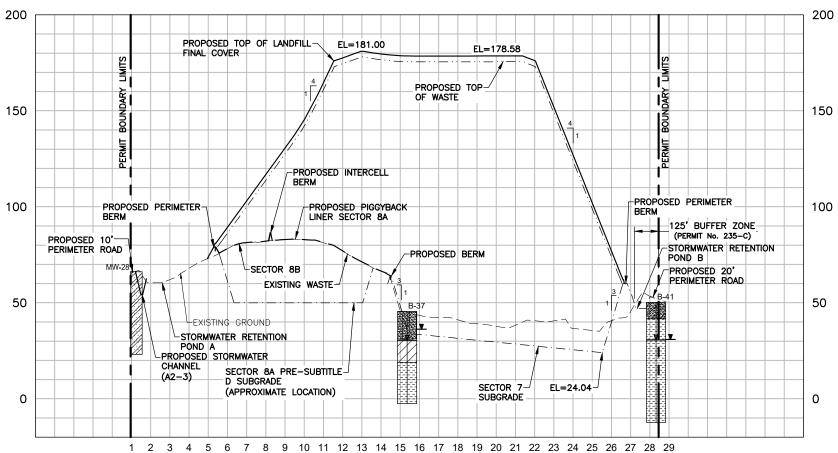
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PART III, ATTACHMENT 2 LANDFILL CROSS - SECTIONS 22 & 26 CITY OF KINGSVILLE LANDFILL MSW PERMIT No. 235-C KINGSVILLE, TEXAS

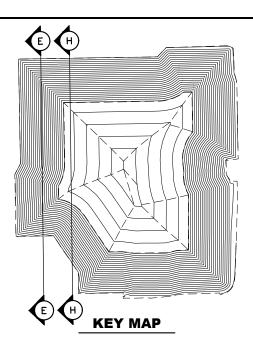
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MARKER-H-SECTION



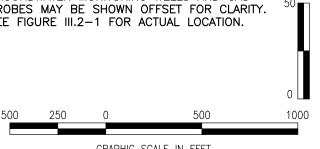
LEGEND

	LEAN CLAY, LEAN CLAY WITH SAND, SANDY LEAN SILTY CLAY (CL, CL-ML)	 FINAL GRADE
	CLAYEY SAND (SC)	 TOP OF WASTE
	SILTY SAND, POORLY GRADED	 EXISTING GRADE
	SAND WITH SILT (SM, SP-SM)	 SUBGRADE
	FAT CLAY, SANDY FAT CLAY FAT CLAY WITH SAND (CH)	 PIGGYBACK LINER
	POORLY GRADED SAND WITH CLAY (SP-SC)	
∇	INITIAL WATER LEVEL	
	STATIC WATER LEVEL	

NOTES:

1. THE ELEVATION OF THE DEEPEST EXCAVATION WITHIN THE FACILITY IS 22.5 FT-MSL LOCATED AT THE SUMPS IN SECTORS 4C, 5, 6, AND 7.

2. GROUNDWATER MONITORING WELLS AND GAS PROBES MAY BE SHOWN OFFSET FOR CLARITY. SEE FIGURE III.2-1 FOR ACTUAL LOCATION.



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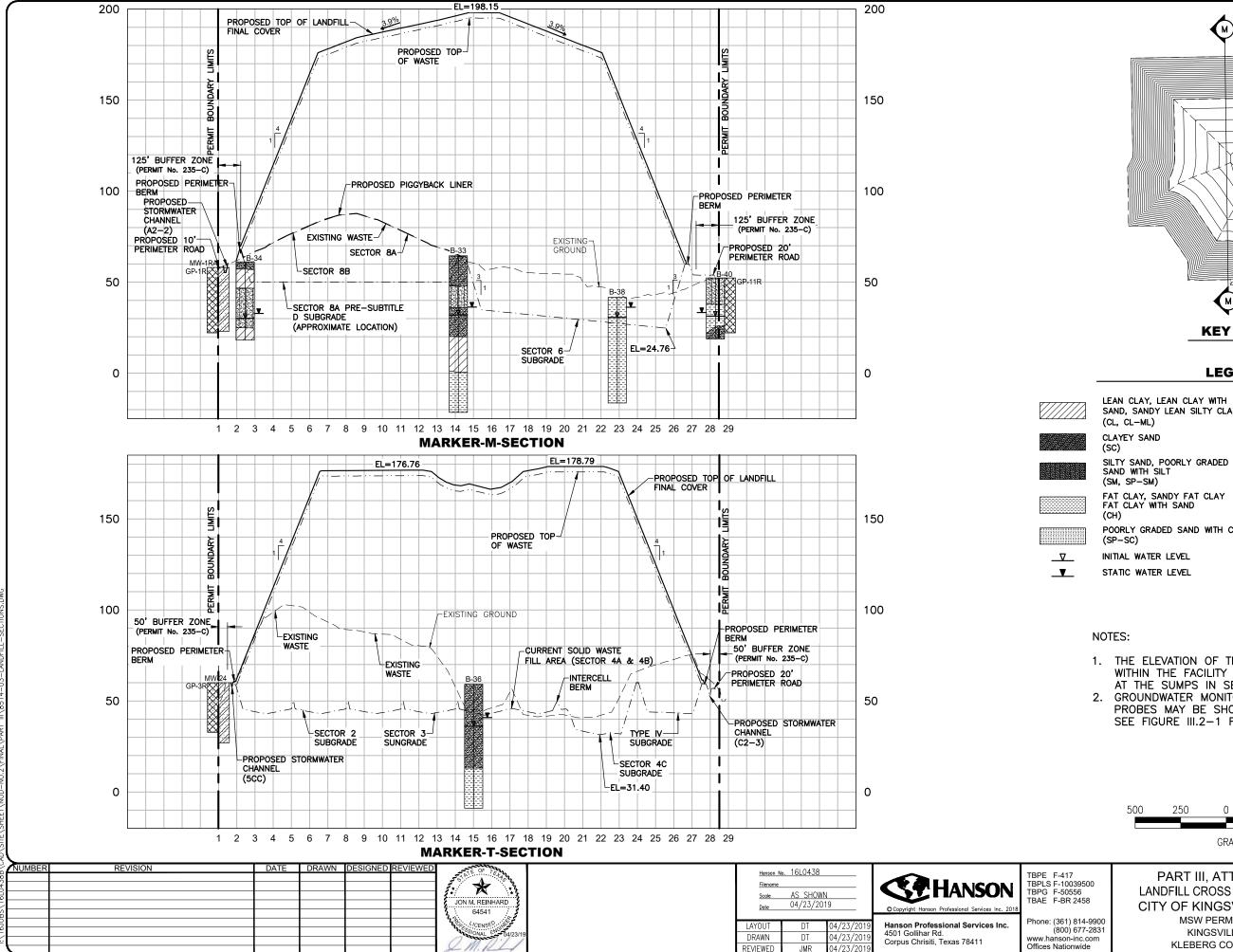
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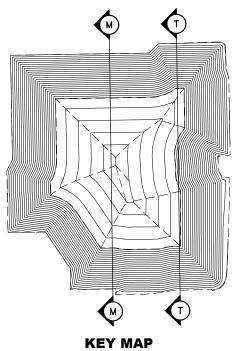
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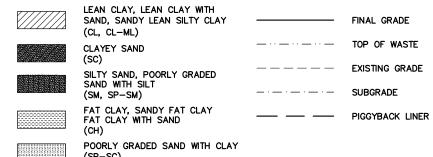
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FIGURE:

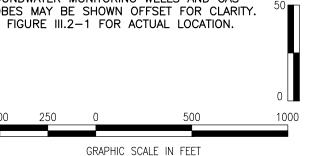




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- 1. THE ELEVATION OF THE DEEPEST EXCAVATION WITHIN THE FACILITY IS 22.5 FT-MSL LOCATED AT THE SUMPS IN SECTORS 4C, 5, 6, AND 7.
- 2. GROUNDWATER MONITORING WELLS AND GAS PROBES MAY BE SHOWN OFFSET FOR CLARITY. SEE FIGURE III.2-1 FOR ACTUAL LOCATION.



PART III, ATTACHMENT 2 LANDFILL CROSS - SECTIONS M & T

CITY OF KINGSVILLE LANDFILL MSW PERMIT No. 235-C KINGSVILLE, TEXAS

KLEBERG COUNTY, TEXAS

FIGURE: **III.2-5**

CITY OF KINGSVILLE LANDFILL PART III ATTACHMENT 3

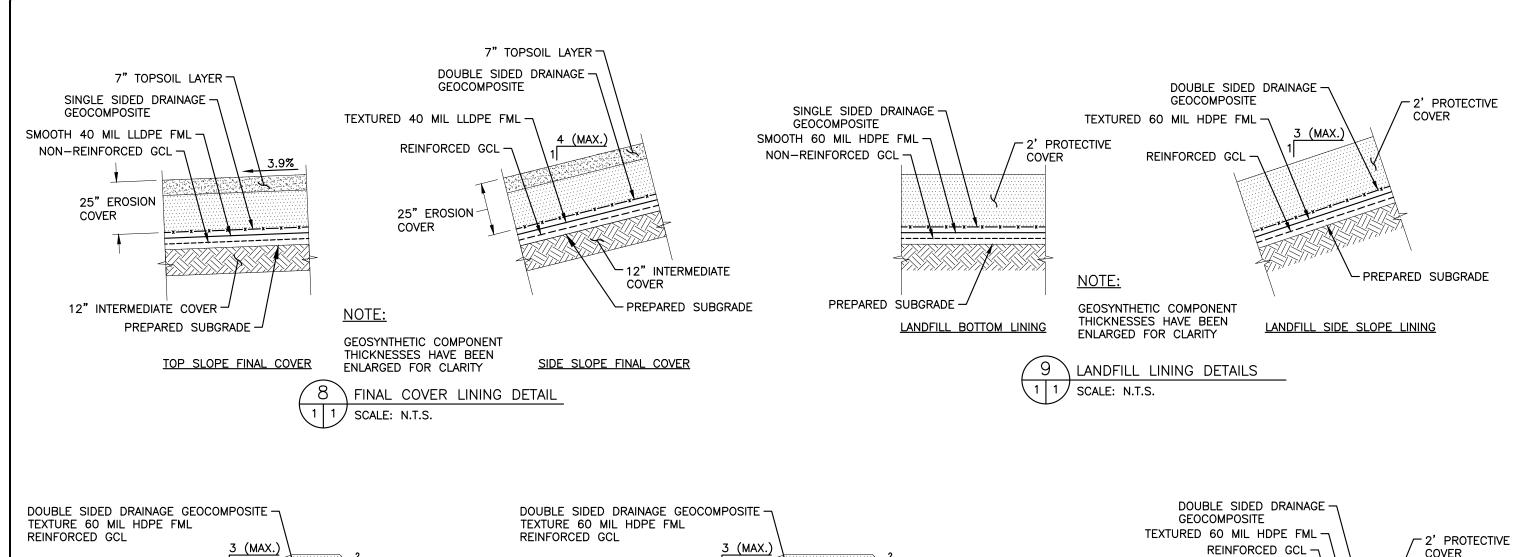
WASTE MANAGEMENT UNIT DESIGN DRAWINGS

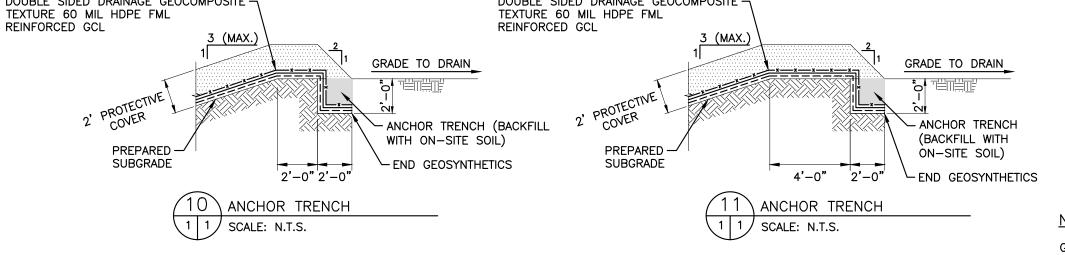
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DOUBLE SIDED DRAINAGE
GEOCOMPOSITE
TEXTURED 60 MIL HDPE FML
REINFORCED GCL
DOUBLE LAYER GEOGRID

6" PREPARED SUBGRADE
EXISTING 2' SOIL COVER
EXISTING WASTE MATERIAL

NOTE:

GEOSYNTHETIC COMPONENT
THICKNESSES HAVE BEEN
ENLARGED FOR CLARITY

DOUBLE SIDED DRAINAGE
2' PROTECTIVE
COVER

PIGGY BACK LINER DETAIL
1 SCALE: N.T.S.

NOTE:

1. ALL LINER SYSTEMS DEPICTED ARE ALTERNATIVE LINER SYSTEMS. ALTERNATIVE LINER DEMONSTRATIONS CAN BE FOUND IN PART III, ATTACHMENT 5.

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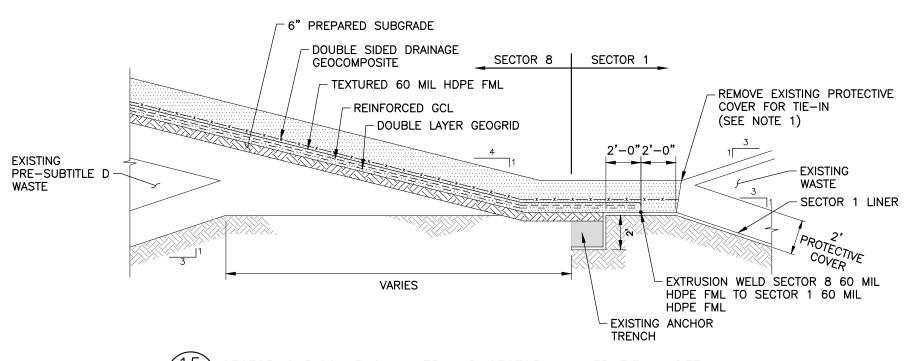
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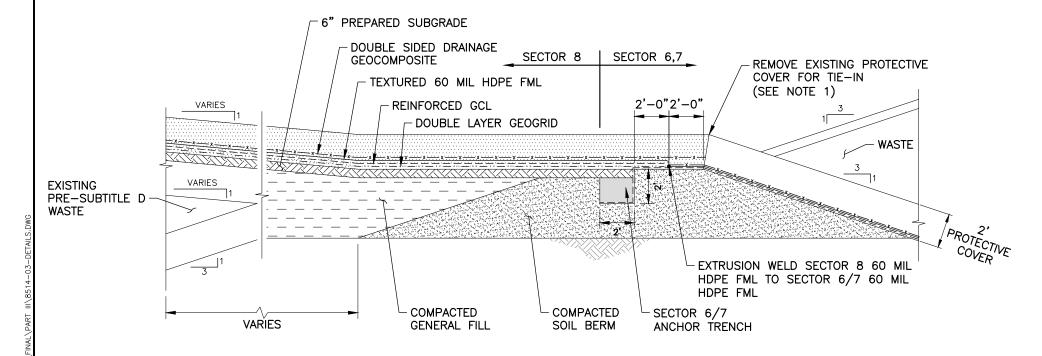
PART III, ATTACHMENT 3 LINER DETAILS CITY OF KINGSVILLE LANDFILL MSW PERMIT No. 235-C KINGSVILLE, TEXAS

FIGURE:

III.3-′



SECTOR 8 PIGGY BACK LINER AND SECTOR 1 LINER TIE-IN DETAIL 1 1 SCALE: N.T.S.



SECTOR 8 PIGGY BACK LINER AND SECTOR 6 & 7 LINER TIE-IN DETAIL 1 1 SCALE: N.T.S.

NOTE:

- REQUIRE LAST 6" OF PROTECTIVE COVER OVER LINER TIE-IN LOCATION TO BE REMOVED BY HAND W/SHOVELS AND/OR BROOMS.
- 2. ALL LINER SYSTÉMS DEPICTED ARE ALTERNATIVE LINER SYSTEMS. ALTERNATIVE LINER DEMONSTRATIONS CAN BE FOUND IN PART III, ATTACHMENT 5.

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PART III, ATTACHMENT 3
PIGGY BACK LINER CONNECTION DETAILS
CITY OF KINGSVILLE LANDFILL
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KINGSVILLE, TEXAS

KLEBERG COUNTY, TEXAS

III.3-5

FIGURE:

THE CITY OF KINGSVILLE LANDFILL TCEQ PERMIT MSW 235C

PERMIT AMENDMENT APPLICATION Volume 2 of 6



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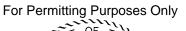
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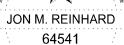
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Revision 2 – February 2019

Revision 3 – April 2019

Prepared by





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HANSON PROJECT NO. 16L0438-0003

PART III ATTACHMENT 4 GEOLOGY REPORT

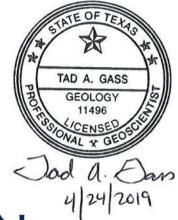
THE CITY OF KINGSVILLE LANDFILL TCEQ PERMIT MSW 235C

PERMIT AMENDMENT APPLICATION PART III, ATTACHMENT 4 GEOLOGY REPORT



CITY OF KINGSVILLE, KLEBERG COUNTY, TEXAS

September 2018 Revision 1 – November 2018 Revision 2 – February 2019 Revision 3 – April 2019





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Submittal Date: September 2018 Revision: 3-April 2019

1.0 INTRODUCTION

1.1 Project Information

The City of Kingsville Landfill is located approximately 1.45 miles southeast of the City of Kingsville city limits, at the northeast corner of the intersection of Farm to Market Road 2619 and East County Road 2130 as shown on Attachment 1- Location Map (Figure III.4-1-1). The initial facility was permitted by the State of Texas in 1977 (Permit No. 235), and initial filling operations began in February 1977. The original 40 acre landfill is currently closed and is not Subtitle D compliant. The City of Kingsville was authorized a permit amendment for a 40-acre lateral landfill expansion of the site in 1986 (Permit No. 235-A). The approved Permit No. 235-A was developed and Sector 1 received its first load of waste material in March 1992. The City of Kingsville was again authorized a permit amendment in 1999 (Permit No. 235-B). This amendment increased the permitted acreage from 80 acres to approximately 120 acres and a maximum height of final cover of 125 feet-msl. The Kingsville Landfill is currently operating under Permit No. 235-B and subsequent permit modifications and/or authorizations.

The City of Kingsville Landfill is currently comprised of 120 acres. The City of Kingsville wishes to increase the capacity of the landfill site via a vertical and horizontal expansion through a permit amendment. The proposed permit amendment will increase the total permitted area to 176.33 acres. This will be accomplished by incorporating additional acreage to the northeast and southwest of the current permitted boundary. The existing active 108-acre waste disposal area will be expanded to a total of 121.3-acres. Other parts of this permit amendment are to; convert the current Type IV waste sector to accept Type I waste, request approval to process and dispose of liquid wastes and used tires, and to revise the floor contour and final contour plans to incorporate the vertical and horizontal expansion previously discussed.

1.2 Scope of Investigation

The purpose of this study is to provide geological and geotechnical data for the design of the city of Kingsville Landfill. The scope of services included reviewing previous subsurface studies, summarizing the engineering properties of the subsurface materials and determining certain geotechnical design criteria such as estimated settlement and future slope stability.

1.3 Previous Subsurface Investigations

Previous subsurface investigations were conducted for the City of Kingsville Landfill to characterize subsurface conditions and assist with the development of landfill disposal cell designs. The previous testing and soils exploration work was performed by:

- Finch Energy and Environmental Services, Inc. (FEE)
- and Professional Service Industries, Inc. (PSI).

These reports are included in Appendix 1. A total of 23 soil borings were installed at this site at varying depths and testing intervals during these previous investigations. Finch Energy and Environmental Services, Inc. conducted an investigation of subsurface materials at the Landfill location. Twelve (12) soil borings were installed and sampled. Laboratory tests were performed to determine the engineering properties of the subsurface materials. The report discussed the soils, sediments, and geologic and groundwater conditions encountered by FEE, Inc. during the hydrogeological/geotechnical investigations at the City of Kingsville Landfill. The report also discussed the characteristics of the soil samples collected and tested during the investigation.

As requested by the Texas Natural Resource Conservation Commission (TNRCC) in an NOD letter, Professional Service Industries, Inc. also conducted a subsurface investigation for FEE, Inc. and the City of Kingsville to evaluate the soil and groundwater conditions present at the site and to better define the aquiclude below the landfill site. A total of eleven (11) soil test borings were drilled and laboratory tests were performed to determine the engineering properties of the subsurface materials. This additional study discussed the types of subsurface materials encountered in the test borings and the results of the field and other laboratory tests performed for this site.

1.4 Current Subsurface Investigation

As previously identified, the proposed permit boundary for this facility will incorporate 176 acres of land with 128 acres being utilized for waste disposal. In accordance with 30 TAC 330.63 (e)(4)(B), a facility of this size requires 23-26 borings with 13-15 of these borings being installed at least 30 feet below the elevation of deepest excavation (EDE) and the remainder of the borings being installed at least 5 feet below the EDE. Before this subsurface investigation, there were fifteen (15) borings that were installed at least 5 feet below the EDE and four (4) of those borings were installed at least 30 feet below the EDE.

For this investigation, nine (9) soil borings were advanced to a minimum depth of 30 feet below the elevation of the deepest excavation of 22.5 ft and one (1) additional soil boring was advanced to 5 feet below the elevation of the deepest excavation to supplement the existing facility data. The borings were drilled in the locations identified on Attachment 2- Soil Boring Location Map (Figure III.4-2-1). Attachment 2 also identifies the locations of the previously installed soil borings. Attachment 3- Groundwater Contour Map (Figure III.4-3-1) identifies groundwater elevations in addition to the current groundwater monitoring system.

The soil borings for the current subsurface investigation were installed by Tolunay-Wong Engineers, Inc. Representative samples were collected with split-barrel sampling procedures in general accordance with the procedures for "Penetration Test and Split-Barrel Sampling of Soils" (ASTM Designation D-1586) and Standard Practice for Thin-Walled Tube Sampling of Soils for Geotechnical Purposes (ASTM Designation D-1587). Borings were dry-augered using hollow stem augers to advance the boreholes until groundwater was encountered or until the boreholes became unstable and/or collapsed. Wash rotary drilling techniques were used as necessary in order to continue advancing the borings to their required completion depths. No borings collapsed during this investigation. Samples were identified according to boring number and depth, protected against moisture loss, and transported to the laboratory for analysis. After obtaining all required soil samples and groundwater level readings, the soil borings were properly plugged and abandoned in accordance with 16 TAC Chapter 76, Texas Department of Licensing and Regulation (TDLR)-Water Well Drillers and Pump Installers rules. Table 1-1 below identifies specific details for both existing and newly installed soil borings. For this investigation, borings B30 through B41 were installed. These borings were advanced to depths ranging from 33.5 to 86 feet beneath the existing ground surface. Tolunay-Wong Engineers, Inc. prepared a Geotechnical Engineering Study Report that is provided in Appendix 2. Hanson Professional Services also prepared a soil boring report that has been included as Appendix 3.

Table 1-1 Soil Borings

Identification Elev (ft. A Finch En B-1 B-2 B-3	59.25 52.64 56.1 58.01 60.54	Boring Depth (ft. bgs) ad Environmenta 42 27 37 39	17.25 25.64	≥5 Feet Below E.D.E? ∴ Borings YES NO	≥30 Feet Below E.D.E?
(ft. A Finch En B-1 B-2 B-3	MSL) 1ergy an 159.25 152.64 158.01 160.54	ad Environmenta 42 27 37	(ft. AMSL) al Services, Inc 17.25 25.64	E.D.E? c. Borings YES	E.D.E?
Finch En B-1 B-2 B-3	59.25 52.64 56.1 58.01 60.54	42 27 37	17.25 25.64	e. Borings YES	NO
B-1 B-2 B-3	59.25 52.64 56.1 58.01 60.54	42 27 37	17.25 25.64	YES	
B-2 B-3	52.64 56.1 58.01 60.54	27 37	25.64		
B-3	56.1 58.01 60.54	37		NO	NO
	58.01 60.54		10.1		NO
	60.54	39	19.1	NO	NO
B-4		37	19.01	NO	NO
B-5		48	12.54	YES	NO
B-6	55.46	38	17.46	YES	NO
B-7	61.05	36	25.05	NO	NO
B-8	59.79	43	16.79	YES	NO
B-9	62.51	44	18.51	NO	NO
B-9R	41.41	17	24.41	NO	NO
B-10	49.78	29	20.78	NO	NO
B-11	60.2	33	27.2	NO	NO
Pro	fession	al Service Indus	tries, Inc. Bor	ings	
B-12	52.38	48	4.38	YES	NO
B-13	59.13	50	9.13	YES	NO
B-14	49.94	42	7.94	YES	NO
B-15	48.39	37	11.39	YES	NO
B-16	55.96	47	8.96	YES	NO
B-17	41.35	33	8.35	YES	NO
B-18	50.04	42	8.04	YES	NO
B-21	52.41	84	-31.59	YES	YES
B-23	49.5	86	-36.5	YES	YES
B-24	47.38	72	-24.62	YES	YES
B-25	61.12	88	-26.88	YES	YES
Tolunay-Wong Engineers, Inc. Borings					
B-30	45.99	82.5	-36.51	YES	YES
B-31	58.37	68	-9.63	YES	YES
B-32	48.46	82.5	-34.04	YES	YES
B-33	64.51	86	-21.49	YES	YES
B-34	61.14	43	18.14	NO	NO
B-35	64.5	72.5	-8	YES	YES
B-36	59.13	68	-8.87	YES	YES
B-37	45.52	48	-2.48	YES	NO

Boring	Surface	Boring Depth	Bottom	≥5 Feet	≥30 Feet
Identification	Elevation	(ft. bgs)	Elevation	Below	Below
	(ft. AMSL)		(ft. AMSL)	E.D.E?	E.D.E?
B-38	41.64	58	-16.36	YES	YES
B-39	60.26	68	-7.74	YES	YES
B-40	52.31	33.5	18.81	NO	NO
B-41	50.2	62.5	-12.3	YES	YES

E.D.E.-Elevation of Deepest Excavation (22.5' Above Mean Sea Level (AMSL))

Locations of borings B-32, B-33, B-34, B-35, B-38 and B-40 deviated from locations specified in the soil boring plan due to boring locations being unknowingly moved from original locations during installation. These deviations were identified when the boring locations were surveyed. The distance of boring location deviation varied from approximately 90 feet in B-35 to approximately 440 feet in B-33. With the information obtained during previous subsurface investigations, these discrepancies did not affect the ability to obtain the needed information identified in 30 TAC §330.63(e)(4)(A).

Borings B-34 and B-40 were not drilled to 5 foot below EDE due to the boring locations being unknowingly moved from the original locations during installation. Boring B-34 was 0.64 feet short of 5 foot below EDE and B-40 was 1.31 feet short of 5 foot below EDE. Although these borings were not drilled to the target depth, the information obtained from these borings is useful in characterizing the subsurface conditions at the facility and was used for that purpose. Other borings installed at the site in conjunction with the current subsurface investigation are adequate in meeting the requirements identified in 30 TAC §330.63(e)(4)(B).

2.0 REGIONAL INFORMATION

2.1 Regional Physiography

As discussed in Finch Energy and Environmental Services' Report (Appendix 1, Section 2.0, Page 11-12), the site of the landfill is located in the part of the Gulf Coastal Plain that has been defined as the Coastal Bend of Texas. The coastal plain is gently, but irregularly, inclined gulfward at about 5 feet or less per mile. In many areas, coastal plain slopes range from 1 to 3 feet per mile, and on the lagoonal wind-tidal flats, slopes are usually less than 1 foot per mile. Elevations within the county range from 0 feet (Gulf of Mexico) to 125 feet above Mean Seal Level (MSL) in the extreme northwestern part. It is characterized as an arid, desert like region where wind (Eolian) erosion and wind transported sediment have determined much of the area's character and distinctiveness. The surface features of the county are broad, dune covered mainland prairies and extensive coastal wind-tidal flats.

Eolian transport of silts and sands has produced the South Texas Eolian System (Sand Sheet). Extensive, hummocky prairies within the South Texas sand sheet are underlain by relic sand dunes and wind-deflated depressions which extend inland from broad wind-tidal flats along the landward margin of Laguna Madre and parts of Baffin Bay.

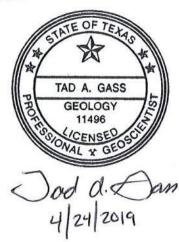
2.2 Regional Stratigraphy

Table 2-1 presents the geologic formations that characterize the regional stratigraphy of Kleberg County.

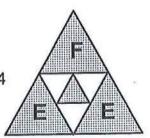
ATTACHMENT 4

Geology Report

For Permitting Purposes Only. Applies to pages of Attachment 4 — Finch Energy & Environmental Services, Inc. Geology Report, sealed by Ray N. Finch, P.E. on 6-26-98 and 9-30-98 altered to provide a clean and legible copy and includes pages: 3, 3.0 Cover Page, 8, 9, 15 - 17,22 - 25, 29 — 30, 33 - 35, 39 - 46, 48 — 60, 60a, 62 - 98, 100 - 101, 104, 108 — 109, D-32 - D-46 and K-1 — K-12. No information or data was altered or changed from the original 6-26-98 and 9-30-98 Geology Report other than text scale corrections on pages 48-60. Bar scales were also added to pages 48-60.



Finch Energy & Environmental Services, Inc. P.O. Box 73/1204 W. King, Kingsville, TX 78364 Phone: (512) 592-9810 Fax: (512) 592-5552



2.0 REGIONAL PHYSIOGRAPHY AND TOPOGRAPHY

The Kingsville MSWLF is located within the part of the Gulf Coastal Plain that has been defined as the Coastal Bend of Texas. (See Figure 4.2) The coastal plain is gently, but irregularly, inclined gulfward at about 5 feet or less per mile. In many areas, coastal plain slopes range from 1 to 3 feet per mile, and on the lagoonal wind-tidal flats, slopes are usually less than 1 foot per mile. Elevations within the county range from 0 feet (Gulf of Mexico) to 125 feet above Mean Seal Level (MSL) in the extreme northwestern part. It is characterized as an arid, desert like region where wind (Eolian) erosion and wind-transported sediment have determined much of the area's character and distinctiveness. The surface features of the county are broad, dune covered mainland prairies and extensive coastal wind-tidal flats. The climate is one of low rainfall, high evaporation, and persistent onshore winds.

Eolian transport of silts and sands has produced the South Texas Eolian system (sand sheet). Extensive, hummocky prairies within the South Texas sand sheet are underlain by relic sand dunes and wind-deflated depressions which extend inland from broad wind-tidal flats along the landward margin of Laguna Madre and parts of Baffin Bay.

Live-oak mottes, stands of brushland, and active sand dunes break the widespread sandy prairies of the Kingsville area into many local, discontinuous patches of rangeland. A few small ephemeral streams, that extend coastward across the northern and northwestern parts of the area, discharge into Baffin Bay.

In a broad area southwest of Santa Gertrudis Creek and Cayo del Grullo, mud and sand substrates are veneered by relatively thin airborne silt (loess) deposits that have settled out downwind from the large dune fields southeast of Sarita. The silt, or loess, sheet overlies muddy sediments between U.S. Highway 77 and Cayo del Grullo and sandy and silty deposits west of U.S. Highway 77. (Brown, 1977)

The Santa Gertrudis Creek, located 0.7 miles to the north, trends to the east-southeast 3.25 miles to it's confluence with the San Fernando Creek which then flows southeast to the Cayo del Grullo of Baffin Bay. Jaboncillos Creek, Ebanito Creek and several small unnamed ephemeral streams, are located several miles south of the site. (See Figure 4.3)

Standing water several feet deep is present on the floor of the abandoned caliche mines to the west and southwest. These mines were excavated to a depth of approximately forty feet. This would place the mine floor in proximity to ground water level. The standing water has continued to be present throughout the extended drought period of the past 2-3 years. The USGS topographic map of the area indicates that these pits are considered permanent water bodies. A more complete discussion of the impacts of these local depressions on groundwater is given in Section 6.2.3.

3.0 REGIONAL GEOLOGY AND HYDROLOGY

During Pleistocene time, large streams eroded large amounts of sand, gravel, clay, and silt from the upland areas. These clastic sediments were deposited by streams meandering across the nearly featureless coastal plain. Sand beds are lenticular grading rapidly both horizontally and vertically into clay or silt within short distances. These deposits slope to the east at about 25 feet per mile. The thickness of the unit ranges from 100 feet in parts of Jim Wells County where the base of the unit is nearest land surface to approximately 1,400 feet in far eastern Kleberg and Kenedy Counties. The formations consist mostly of very calcareous, slightly carbonaceous, blue and yellow clay, and a few lenticular beds of sand. Many of the sand beds, especially those near the surface, are fine to very fine grained. Calcareous nodules and disseminated caliche are common in the shallow part of the section. The group yields small quantities of slightly to moderately saline water to a few shallow wells used mostly for stock needs in eastern Kleberg and Kenedy Counties. (Shafer, 1973)

The South Texas Eolian system is of Modern, Holocene, and Pleistocene age according to the Environmental Geologic Atlas of the Texas Coastal Zone - Kingsville Area. The landfill site is situated within the Riviera loess sheet to the east of U.S. Highway 77 and southeast of Kingsville. The Riviera loess sheet is characterized as a thin, discontinuous loess sheet composed of airborne silt derived from upwind areas of wind deflation. East of U.S. Highway 77, the loess overlies flat Pleistocene delta-plain deposits composed principally of mud with localized elongate sand and silt bodies (Beaumont Clay). The Riviera loess sheet varies in thickness from a few inches to several feet; locally the loess is absent and Pleistocene deposits are exposed at the surface. The loess and underlying Pleistocene deposits, especially the sands, are extensively calichified. This formation is of minor importance in the site area (Brown, 1977). (See Figure 4.7)

3.2.1 Regional Soils

The Environmental Geologic Atlas - Kingsville Area indicates that the soils in the area of the landfill site are of two types: Type II and Type IX. (See Figure 4.7) The predominant soil group is Group IX which is described as clay -sand dunes and dune complexes, active and inactive, sparsely and heavily vegetated respectively. Older vegetated dune complexes have a higher sand and caliche content. Currently active dunes are high in clay content. Type II soil group is defined as dominantly sand, high to very high permeability and drainage, moderate water-holding capacity, low to moderate compressibility and shrink-swell potential. The Atlas also points out in Table 6 that these types of soils may have problems as solid waste disposal areas. However, the use of geosynthetic clay liner as replacement for higher permeability soils addresses this problem.

The Texas Coastal Basins Cooperative River Basin Survey Plate 4-5 indicates that the

soils at the landfill site are type 3-V described as Victoria-Orelia-Clareville group. These are described as cracking clay soils; soils with loamy surface layers underlain by cracking clayey layers and soils loamy throughout, some of which are compact beneath the surface layer.

The soil in the area of the landfill site is defined the be Czar-Delfina-Orelia according to the General Soil Map of Kleberg County, Texas prepared by the Soil Conservation Service. This soil group is described as "somewhat poorly to well drained loamy fine sands, fine sandy loams and sandy clay loams that have moderately to very slowly permeable lower layers with low and moderate shrink-swell potentials. This unit consists of about 35 percent Czar soils, 30 percent Delfina soils, 20 percent Orelia soils, and 15 percent other soils. The detailed description of these soils is given in Appendix O. This same source states that the Czar soils have slight limitations for area type sanitary landfills but are so minor they are easily overcome. The Czar soil is good for daily landfill cover. The Delfina soil has the same rating (slight) for area type sanitary landfills as Czar soils. The use of Delfina soil for landfill cover varies from good to fair. The Orelia soil has a moderate rating for area type landfills which means that limitations can be overcome or modified. The Orelia soil has fair use as landfill cover.

Consultation with the local USDA Soil Conversation Office produced a specific aerial photograph soils map of the area. This map defines the caliche pits as just that. The soils surrounding the remainder of the site are of four types: Hidlago fine sandy loam, Racombes sandy clay loam, Runge fine sandy loam, and Willacy fine sandy loam. The description of these soils from the National Soils database at lowa State University are attached in Appendix O.

The geologic description of the site surface and subsurface described in sections 6 and 8 confirm that the site has a major caliche bearing channel, a discontinuous sand filled channel, and two clay dunes. Thus, the soils description from the Environmental Geologic Atlas, the Kleberg County Soils Map and the local SCS describe the site soils best.

3.3 Active Geologic Processes

3.3.1 Faults and Faulting

The site is located on the west flank, southwest quadrant, of the Kingsville Dome, an Area of post Late Miocene (<8 m.y.b.p.) uplift which is the largest isolated, positive structure in Kleberg County. The uplift influences an area of approximately 50 square miles. Although origin of the uplift is unknown it is attributed to deep seated diapiric shale or salt movement. The overall paucity of oil and gas production on the Dome is due to late uplift and resulting late trap formation. Possible destruction of any pre Miocene hydrocarbon traps could have also occurred. Past and current oil and gas production has been obtained from sands within the Oligocene age Frio and Miocene age Oakville formations. Productive reservoirs are highly compartmentalized by faulting. Two primary fault zones divide the Dome into quadrants.

- a.) Northeast striking regional Frio, down to the coast, growth fault buried below the Oakville formation, and
- b.) West-Northwest striking post Miocene Santa Gertrudis Fault zone, down to the South-Southwest with associated, up to the north northeast, relief faults.

An updip projection of the regional Frio growth fault passes below the landfill site at approximate depths of 6,000 to 7,000 feet, but the fault is buried below the Miocene age Oakville formation and therefore does not influence shallower beds. Updip projections of the Santa Gertrudis fault system are located north of and not in the vicinity of the landfill site. Beds as recent as the Goliad sand are influenced by uplift but it is unknown as to whether Santa Gertrudis faulting penetrates this high in the section. It is believed that the Late Miocene uplift and associated Santa Gertrudis faults predate deposition of the Pleistocene Beaumont and Lissie formations. The Pleistocene beds exhibit northeast dip in the landfill site vicinity (Structure Map, Top LT. Olive Green Clay) whereas deeper Miocene and Oligocene beds exhibit west to southwest dips due to uplift.

An evaluation of potential faults or fault zones does not indicate the presence of active faults. Topographic Maps, literature searches, aerial photographs, Petroleum Industry maps and a field survey were used in this evaluation. The field survey combined with topographic maps did not reveal structural damage to buildings, ground scarps, or unusual surface depressions. Changes in drainage or vegetation patterns which are also associated with faulting were not present.

A surface lineament passing through the site was noted on the Physical Properties map in the Kingsville Volume of Environmental Geologic Atlas of the Texas coastal Zone. (See Figure 4.7, Lineament Labeled A) No surface expression of faulting as related to this lineament is noted. Improved copies of Figures 4.8 & 4.9 could not be located.

Electric logs the oil and gas wells drilled in the immediate area are not recorded to

Ground surface. Electronic logs of two uranium wells were located and obtained from URI, Inc.'s Kingsville office. The location of these wells are noted on the Cross section map and subsurface maps submitted with this revised report.

Subsidence and Unstable Areas 3.3.2

Site specific soil conditions which might result in differential compaction are not evident. A 2' to 2.5' topsoil and loess cover is present in the current agricultural area and the unmined areas. Below, the topsoil, is a firm to very hard clay. This clay is described as silty, calcified, with caliche, and is uniform in character throughout the site.

A field investigation did not reveal any geologic or geomorphologic features which might affect the soil stability. On site are an office and scale house, and maintenance facilities. Off site (within a one (1) mile radius) are 41 residences and agricultural buildings. All buildings are one-story in design.

An off-site field investigation of the petroleum producing areas did not reveal any major storage, processing or secondary recover facilities which could affect site stability at the surface or at depth.

Subsidence at the site does not appear to be a problem. The settlement analysis in Appendix H indicates a maximum settling of 3.0 inches at the center of the landfill and 1.5 inches at the edges. The maximum stress when the landfill is completely filled is between 1.25 to 1.50 tons per square foot. Unconfined compressive strength is typically 3.0 to 5.0 tons per square foot. Typical strain of less than 1% is encountered when compressive stress is 1.5 tons per square foot. Therefore, subsidence does not appear to be a problem. Some localized sand channels will have to be replaced during construction.

3.3.3 Erosion

Based on soil types and character, and topography, erosion does not appear to be a significant factor under "normal conditions" or if design criteria are met and maintained. The soils data found in the references given in Section 3.2.1 above say very little about erosion potential. However, it is obvious that sandy soils will tend to become airborne with sufficient velocity. It is therefore important that the cap for the landfill be immediately covered, compacted and vegetated. The length of the rainfall run-off on slopes has been addressed by breaking up the long runs on the cap with diversionary berms. Thus, active cap cover and maintenance will minimize erosion from the site. However, in a situation of torrential rains associated with tropical storms or hurricanes erosion may be significant in local areas and for a limited time frame.

Although cultivated agricultural lands may tend to undergo some erosion with sandy types

of soils, pasture lands or other vegetated soils greatly reduce the potential to erode. The land fill soils for capping will be compacted and/or vegetated of both to minimize erosion. The final cover for the landfill will be well capped and diversionary berms for water flow control on long slopes will be used.

3.3.4 Seismic Impact Zones

Data presented by Algermissen, et al, 1990 suggests a low probability of major seismic activity in the vicinity of the site. (See Figure 4.9)

3.4 Wetlands

A representative from the U.S. Army Corps of Engineers has visited the site. The U.S. Army Corps of Engineers has concluded that there are no wetlands on the COK MSWLF site. (See Figure 4.10)

4.0 Regional Aquifers

The Evangeline Aquifer is the principal aquifer in the region and is considered one of the most prolific aquifers in the Texas Coastal Plain. The aquifer is composed of at least the Goliad Sand and includes sections of sand in the Fleming Formation. Only in South Texas the base of the Evangeline coincides with the base of the Goliad. The upper boundary of the Evangeline probably follows closely the top of the Goliad Sand where present, but this relationship is somewhat speculative (Muller, 1979). (See Figure 4.11) Ground water flow direction in the Evangeline is in a Northerly direction based on a water level map of the Goliad sand. There are two very significant cones of depression in the Evangeline (Goliad) aquifer located to the northwest of the City of Kingsville MSWLF site. These depressions are primarily due to large groundwater production rates by the City of Kingsville and the Exxon King Ranch Gas Plant. The extent of salt water intrusion from the Gulf of Mexico into the Evangeline (Goliad) aquifer is shown on Figure 4.16.

The Goliad consists of fine to coarse, mostly gray calcareous sand interbedded with sandstone and varicolored clay. Recharge within the site area occurs along the outcrop which is located in western Hidalgo, central-eastern Starr, central Jim Hogg, Duval, southeastern Webb, northeastern Brooks, northern Jim Wells, and extreme northeast Zapata counties, as well as other counties to the north. The maximum width of the outcrop is west of Falfurrias where the Goliad Sand extends for nearly 50 miles at the surface and completely overlaps the underlying Lagarto Clay and Oakville Sandstone and nearly overlaps the Catahoula Tuff (Shafer, 1973). (See Figure 4.12)

The water of the Goliad is under artesian pressure and is yielded to flowing and nonflowing wells. The average coefficient of transmissibility determined during drawdown of the fresh to slightly saline water section of the Goliad Sand in southwestern Kleberg County measured in well no. RR-83-41-803, was about 34,400 gpd per foot. The specific capacity of the well was 17.8 gpm per foot. This was derived from a screened interval of 126 feet near the north boundary of Kenedy and south boundary of Kleberg Counties.

Fresh water of domestic use quality in the Evangeline is found in well developed sands at depths of 500 feet and greater in the MSWLF area. From surface to the fresh water sands in the Evangeline the lithology is predominately a clay described as silty, calcareous, firm to hard with occasionally silty sands.

The regional Chicot aquifer lies approximately 220 feet below ground surface in the vicinity of the MSWLF according to two deep well logs obtained from a local mineral company. (see Section 4.2) The Light Olive Green Clay layer serves as aquiclude between the uppermost aquifer below the landfill site and the Chicot aquifer. The Kleberg County, and specifically the MSWLF, the waters from the Chicot aquifer are generally slightly-saline to saline and yield only marginal quantities of water.

The local unconfined water table aquifer tends to flow in all directions away from the landfill site. The only exception is that for a period of time after excessive rainfall events, groundwater in this local uppermost aquifer tends to flow toward the site from the northwest. This determination is based on water levels recorded in wells completed for use in the current expansion phase. However, the largest gradients for ground water flow are in the northeast and southwest directions. The flow toward the southwest is along a caliche channel which slopes to the southwest toward some lower elevation caliche pits. The flow toward the northeast is toward the Santa Gertrudis creek. However, the ground water tends to flow through some fairly tight clay in that direction. The high point of ground water at the MSWLF site is at least partially a following of the surface topography and influenced by direct recharge from any ponding which is not promptly removed. Attachment 5, Appendix E gives a more thorough analysis of ground water direction and rate of ground water flow.

The initial interpretation, based on available data and monitor well density and location, indicated a predominate flow to the north or west. Completion of monitor and observation wells in the current expansion program indicate a northeast flow direction. Later analysis shows that ground water flows slowly away from MSWLF in all directions. This is based on measurements of the top of the saturated zone as evidence by water levels in wells. The initial flow direction determined by REI when the landfill was started was toward the northeast.

4.1 Water Quality

The water quality of the Goliad is highly variable. Chloride contents in the wells sampled ranged from 94 to 9,100 mg/l, exceeding 250 mg/l in 60% of the samples. Sulfate content ranged from 26 to 4,630 mg/l. In Kleberg County, 33% of the samples exceeded 250 mg/l sulfate. Dissolved-solids content ranged from 601 to 49,900 mg/l. Over 75% exceeded 1,000 mg/l dissolved-solids. In summary, ground water that meets most of the quality standards of the U.S. Public Health Service is available from wells less than 1,000 feet deep in the Goliad Sand, Principally in southern Jim Wells County, the western one-half of Kleberg County, and in a few other relatively small areas throughout the report area. Shallow, moderately saline to very saline water overlies the fresh to slightly saline water at most places (Shafer, 1973). (See Figure 4.13)

The Beaumont Clay and Lissie Formation, undifferentiated, (Chicot Aquifer) yields small quantities of slightly to moderately saline water to a few shallow wells used mostly for stock needs in eastern Kleberg and Kenedy Counties. Test wells drilled near Riviera, 15 miles south of Kingsville, in southern Kleberg County show that in this area the shallow sands of the Beaumont and Lissie (Chicot) usually contain very saline water. This group is not considered a supply of useable water because of the highly mineralized water associated with formations in most places. The casings of many wells are cemented through these

formations. (Shafer, 1973)

Water held in the Beaumont Clay and Lissie Formation, undifferentiated, (Chicot) is under water-table (unconfined) conditions. There were no recoverable aquifer tests from reference material on this formation as it occurs in the area of the site. This formation is not recognized as a useable source of ground water.

Historical ground water monitoring from in-place monitor wells indicates that the sulfates range approximately from 45 to 500 mg/l, chlorides from approximately 50 to 500 mg/l, and dissolved-solids from approximately 500 to 6.000 mg/l. Values of pH have consistently ranged between 7.00 and 8.00. More detailed analytical data from the ground water monitor wells at the site is given in Table 5.1 in Attachment 5.

4.2 Hydraulic Connection

No hydraulic connection was found between the uppermost fluvial-deltaic beds which will host the MSWLF and the deeper Chicot and Evangeline (Goliad) aquifers.

Deep elevations prepared from water well data located in the vicinity show that the Chicot aquifer is located approximately 200 feet below ground surface in the MSWLF vicinity. The data is confirmed by electric logs from two (2) deep uranium tests located on the southeast side and adjacent to the MSWLF acreage block (URI, Inc. well nos. 2001 & 2016). These wells exhibit the top of the main Chicot sand body at depths of 220 & 225' of measured depth, respectively. The top of the deeper Evangeline (Goliad) sands are found at approximately 500' MD. A confining clay, at the base of the fluvial-deltaic section which will host the MSWLF, is indicated in both URI wells to depths of 120' and 130' respectively. In addition, four deep borings (wells 21, 23, 24, 25) at the MSWLF confirm that the "light olive green clay" is ubiquitous under the site with a minimum proven thickness of 38'.

TABLE 4.2.1

WELL#	ELEVATION (feet)	TOTAL DEPTH (feet)	TOP LT OLIVE GRN CLAY (ft.,+M.S.L.)	FOOTAGE OF CLAY
21	52.4	84	+6.4	38
23	49.5	86	+13.5	38
24	47.4	72	+15.4	40
25	61.1	88	+11.1	38

The "light olive green clay" is the aquiclude for the MSWLF facility.

4.3 Recharge

Recharge within a 5 mile radius is from downward percolation of surface water, infiltration from streams. impoundments and water retained in abandoned caliche pits. (Figure 4.14) Flow Through the soils is very slow.

4.4 Water Use

A survey of, and for, water wells within a 1 mile radius of the MSWLF site was prepared by Agency Information Consultants (AIC). All known water wells within the survey area produce water for domestic use from the Evangeline Aquifer (Goliad Sand). Thirty one wells were identified in the survey area. (See Figure 4.15) Depth to the top of the perforated or screened interval varies from 524 feet to 726 feet, with an average depth of 621 feet. (See Figure 4.12 & 4.13) There are no known water wells completed in the Chicot aquifer for potable water. There are a few stock wells. The water from the Chicot is mostly very saline. This salinity causes casing corrosion problems with the good fresh water wells in the Goliad aquifer unless they are cemented properly through the Chicot.

seeps, ponds). No seeps were noted on-site.

5.3 Drilling and Soil Sampling

F.E.E geologists provided technical oversight of all drilling and sampling activities. This section describes subsurface exploration procedures performed during the hydrogeological/geotechnical investigation activities.

5.3.1 Soil Borings

The field portion of this hydrogeological/geotechnical investigation consisted of the drilling and sampling of seven (7) geotechnical borings to assess subsurface hydrogeological and geotechnical conditions of the underlying materials. All soil borings were completed in accordance with the Soil Boring Plan approved by TNRCC in a letter dated June 4, 1997, (see Appendix A).

An original program of 12 borings was proposed and approved, with a stipulation that seven borings be completed initially. Upon completion of the initial seven borings the homogeneity of the sediments was demonstrated. This data was submitted to TNRCC, (see Appendix A), in the form of geological cross sections. Consequently, the remaining five borings were not being required at that time (see Appendix A). Five of these wells were subsequently completed as Monitor Wells. All borings were completed to a depth approximately 10 feet above MSL. Nine other previous soil borings were available to assist in the subsurface investigation. The completions will be discussed in the Ground Water Characterization Section. The location of these borings (as well as previous borings drilled at the site) are presented on Figure 4.17. In April, 1998 four (4) deeper soil borings were completed to better define the aquiclude below the landfill site per TNRCC's NOD letter. These deeper borings were drilled to varying depths between 72 feet and 88 feet below ground surface (BGS), Core samples were taken from these deep borings at two (2) foot intervals.

Professional Services, Inc (PSI), a F.E.E. drilling subcontractor, drilled the borings utilizing 4.25" I.D. hollow-stem auger during July, 1997. The subcontractor advanced the borings until target depths, or specific lithologic zone, were encountered. Borings were completed using a CME-75 Hollow System Auger rig. The CME-75 system uses a 5 foot long core barrel which recovers 3 inch diameter cores from a 10 inch boring.

In one well (completed as MW 16) zone of highly calcified sandy clay was encountered. Drilling time with auger methods was very slow and the interval was drilled using the split spoon. No commercial additives were used in the boring operation.

Water for mixing grout was obtained on site and supplied by the City of Kingsville from

a South Texas Water Authority connection. Installation and plugging of the borings were in accordance with current rules and prudent operational procedures. Documentation of this work has been submitted.

Subsurface soil and sediment core samples were collected from each soil boring on a continuous basis to a depth of approximately 30 beet below expected base grades (or approximately 50 feet below ground surface) and on 5-foot centers, thereafter, for lithologic classification and selection of geotechnical laboratory samples for potential analyses. Depths of the borings vary from +4.83 MSL to +11.38 feet MSL with on average of +8.37 feet MSL. The proposed depth of excavation is +40.00 feet MSL. This meets the stipulation of all borings being 5 feet deeper than the deepest excavation and also the 30 feet depth requirement. Core samples were collected using either a split spoon for unconsolidated samples or a 3-inch outside diameter (O.D.) Shelby tube for undisturbed samples of cohesive material. Upon sample retrieval, each core was classified as described in Section 5.3.2 below. Each sample was labeled (at a minimum) with the following information: project name; boring number; and sample depth range.

The geologist or geotechnical engineer sealed the soil core samples with plastic wrap, and plastic bags, then placed them in protective crates for transport to the laboratory. The geologist or geotechnical engineer also sealed the samples of cohesionless materials in plastic bags, and packaged them in protective crates for transport to the laboratory. (Hand drawn field logs will be supplied separately.)

5.3.2 Classification and Logging of Soils

The F.E.E., Inc. geologist or geotechnical engineer visually classified the samples in the field in accordance with ASTM D2487 and D2488 (Standard Practice for Description and Identification of Soils, Visual-Manual Procedure) and used field soil borehole forms to record soil classification at each boring location. The borehole forms included additional information such as ground surface elevation, north and east coordinates, surface conditions, ground water elevation, driller's name, and the make of the drilling rig. The geologist or geotechnical engineer later checked the accuracy, consistency, and format. The soil borehole logs prepared as part of this investigation are included within Appendix B.

5.4 Piezometer Installation and Development

A total of 7 piezometers (B-12 through B-18) were constructed during the July, 1997 phase of this investigation to evaluate the water-bearing strata underlying the site. All but B-17 and B-18 were converted to groundwater monitoring wells. During the April, 1998 phase of this investigation four more borings (B-21, 23, 24, and 25) were completed. These borings well all grouted upon completion, except 24 which was made

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into a monitor well. Appendix C includes detailed Piezometer Construction Summaries. The following sections describe piezometer installation and development protocols utilized during the investigation. Texas Water Well Driller's Reports for Borings B-12 through B-18, B-21, B-23, B-24, and B-25 are shown in Appendix K.

5.4.1 Piezometer Installation

All piezometers were constructed using new, 2" I.D. (B-17 and B-18) or 4" I.D., Schedule 40, flush-threaded polyvinyl chloride (PVC) well risers, 5 or 10-foot screens, bottom plugs, and fittings. Five piezometers. B-12 through B-16, were converted to groundwater monitoring wells. Later, in April, 1998 soil boring 24 was made into a monitor well. Each piezometer was fitted with a vented top-end cap and all the joints were screwed together with O-rings (no glue was used). centralizers were also installed that were made of inert material compatible with the casing on piezometers. Riser lengths ranged between 2.5 and 3.0 feet above ground surface. The geologist or geotechnical engineer measured each piezometer's screen and riser lengths to the nearest 0.01 foot and recorded all the information pertaining the construction of each piezometer on a Piezometer Construction Summary form prior to installation.

The sand filter pack consisted of washed and pre-graded 20/40 sand (95% minimum silica and visibly free of dust, mica, and organic matter), and extended from the bottom of the borehole to approximately two feet above the screened interval. A one-foot fine sand filter pack seal ("sugar sand", 100% passing the No. 30 sieve and less than 2% passing the No. 200 sieve, and visibly free of clay, mica, and organic matter) followed the 20/40 filter pack to help prevent any intrusion of high pH water associated with the bentonite seal.

A minimum three-foot bentonite seal, utilizing bentonite pellets, immediately followed placement of the sugar sand. Where more than twenty feet of water was present in the borehole, a high solids bentonite slurry was pumped or carefully tremied into place. A one-foot layer of sugar sand was immediately tremied to provide weight during hydration of the bentonite seal and help enhance the expansion of the pellets sideways. Approximately five gallons of clean, potable water was then added and a minimum two-hour hydration time was allowed for the bentonite to hydrate before proceeding further.

A bentonite powder grout consisting of Benseal bentonite, bentonite catalyst, and clean potable water was then mixed by recirculation with a grout pump and tremied via a side-discharge tremie pipe into the annular space from the top of the sugar sand to a depth of five feet below the ground surface upon hydration of the bentonite seal. The bottom tremie pipe had side-discharge exits to avoid washing of the sugar sand and consequent erosion of the bentonite seal. The grout was allowed to settle a minimum of twelve hours. More grout was added, when necessary, to bring the top of the grout to five feet

6.0 SITE-SPECIFIC STRATIGRAPHIC CONDITIONS AND SUBSURFACE GEOLOGIC INTERPRETATIONS

This section describes the soils, sediments, geologic and groundwater conditions encountered by F.E.E., Inc. during the Hydrogeological/Geotechnical Investigations at the City of Kingsville, (COK), Municipal Solid Waste Landfill (MSWLF) site as required in 30 TAC § 330.56(d). The section also describes the characteristics of the soil samples collected and tested during the investigation. The locations of all subsurface boring explorations performed for the design of engineered cells, and for the Geological/Geotechnical investigation are shown on Figure 4.17. Subsurface geologic correlations showing stratigraphy and structure beneath the site are presented on the following exhibits included herein;

Cross Section Location Map

Cross Sections A-A' through I-I' (9 total) [Note Maximum ground water levels.]

Structure Map – Top "Light Olive Green Clay"

Isopach Map Sand Units I & II

Isopach Map Sand Units III & IV

Information from sample borings at the COK-MSWLF site and electrical logs of uranium test wells which immediately offset the site to the southeast were used in the construction of the geologic maps and cross sections as part of this investigation.

The primary geologic formations exposed at the surface of the site are recent Holocene South Texas Eolian Plain Deposits. The topsoil (approx 0 feet - 20 feet) consists of a clay which is black, silty and contains humic material. This soil is overlain in the extreme northeast corner with a veneer of loess. Sediments encountered in borings at the site are Holocene to Pleistocene in age and consist of clays, silts, sands, and caliches deposited in two (2) separate and distinct environments of deposition. Cross section A-A' serves to illustrate these environments of deposition. The cross section traverses the MSWLF site using four (4) deep borings all deep enough to penetrate a minimum thickness of 38' of a massive, low permeability, light olive green clay ("Light Olive Green Clay") believed to have been deposited in a marine (estuarian) environment. The interpretation of a marine environment of deposition for this unit is based upon the presence of sand filled burrows in the top surface of the massively bedded clay. The clay also contains sparse pelecypod molds scattered throughout and a single, correlative, thin bedded, pebble conglomerate (rip up clasts) believed to represent a storm deposit.

As noted in Section 4.2 the "Light Olive Green Clay" is the aquiclude for the MSWLF facility. In turn, the "Light Olive Green Clay" is capped by a sheet sand ("Orange sand") possibly 2 to 10' thick across the site of the MSWLF. The "Orange sand" is believed to have been deposited in a near shore or beach environment based on sample descriptions. The sand is extremely well sorted and clean, grains are well rounded and composed of approximately 90% fine quartz grains and 10 % fine multicolored shell fragments giving the overall sand color an orange cast.

Stratigraphy above the "Orange sand", the environment of deposition changes to fluvial-deltaic for the remaining 40 to 50' of section, measured back to surface. These beds are comprised of sands, silts, caliches and clays deposited as superimposed channel sands and clayey dunes or bars. A detailed cross section net was constructed using all sample borings at the MSWLF and four significant sand bodies are believed to be present within the fluvial-deltaic sequence. Locations of these sand bodies are shown on isopach maps included herewith. Bodies I & II, are superimposed, caliche or sand filled channels with Body I having the larger areal extent. Bodies III & IV are interpreted as dunes or bars of limited extent and are comprised of clayey sand. All of the above sand bodies are incised into, or embedded within, a tan, silty clay containing abundant mottles of organic matter.

Taken together, the marine clay section ("Light Olive Green Clay") overlain by fluvial-deltaics section represents a single regressive cycle, with respect to sea level, at the top of the Pleistocene Beaumont formation. The sea level regression was probably caused by an onset of a period of Wisconsan (Stage unknown) glacial ice formation. Bone fragments of large vertebrates and mammoth teeth recovered from the fluvial-deltaic section in nearby areas, i.e. Taylor Ranch, date from approximately 8,000 to 10,000 years B.P. It is believed that the entire fluvial-deltaic section is comprised of Holocene sediments with the Holocene-Pleistocene boundary represented by the top of the "Light Olive Green Clay" or "Orange sand".

The shallow subsurface geological structure at the Kingsville MSWLF site is shown by the Structure Map- Top "Light Olive Green Clay" to be monoclinal dip to the northeast at approximately 20 feet per mile. The horizon was chosen as most representative of structure affecting and underlying the MSWLF site. Any structural mapping on beds above the "Light Olive Green Clay" are less correlative and would reflect local scouring of channel sands causing structural inconsistencies due to stratigraphic variation within the fluvial-deltaic section. Correlations are excellent on the top of the "Light Olive Green Clay" and the surface is most likely to be planar in nature. Some scouring of this surface probably occurs at the extreme southwest corner of the MSWLF site due to the incisement of the overlying Body I, caliche bearing channel.

Deposition of the above sediments postdates uplift of the Kingsville Dome. Pre-lift formations are Miocene and older and exhibit west dip at depth in the vicinity of the MSWLF site. There is no evidence of folding or soft sediment deformation in subsurface boring samples. Some fracture and slump deformation does occur on steeply excavated caliche outcrops.

Quantitative descriptions of the physical characteristics of the investigated sediments are presented in Appendix G, Geochemical Laboratory Test Report and Appendix B, Boring Logs. A qualitative description of the shallow beds which can be correlated across the area as exhibited on cross sections A-A' through I-I' is presented below. The descriptions should aid in the confirmation of interpretations made regarding subsurface structure and environments of deposition of the sand bodies and the clays within and upon which the sand bodies were deposited.

6.0.1 Body I- Caliche Bearing Channel

This is the youngest, most extensive, sand containing body that can be correlated across the site. Body I is internally complex and comprised of a mélange of interbeds of caliche, clays and sands which, in themselves, are noncorrelative. The individual beds within this body appear to be of limited extent, and probably represent braided deposits within a single channel approximately ½ mile in width. The base of this channel is placed at the base of the lowest caliche encountered in the borings at the site. When grouped together, it can be shown via cross section and isopach mapping that the body can obtain a maximum thickness of 40' and, as a whole, cuts downward into underlying beds. Body I was deposited as a channel system which trends in a down dip direction, southwest to northeast, across the MSWLF site. Much of the caliche contained within this body has been previously removed from the site by mining operations.

6.0.2 Body II- sand Filled Channel

Body II was deposited as a channel filled with a homogeneous, well sorted, very fine grained to fine grained, clean, unconsolidated sand. Body II differs from Body I in the simplicity of fill sediment. The preserved length and width of this channel sand is less than one half mile due to truncation and incisement by the overlying channel, Body I. Body II is interpreted as being a channel due to downcutting evident on the cross sections. Maximum preserved thickness of this channel sand in 20' as evidenced in Borings Nos. 10 and 17. Deposition of the Body II channel sand was oriented in a dip direction, southwest to northeast across the site.

6.0.3 Body III- Clayey Sand (Clay Dune)

Sand Body III lies under the eastern edge of the MSWLF site and is composed of a

homogeneous, very fine grained, well sorted, clayey sand. Well #13 is the only known penetration of the sand encountering a thickness of 17. At it's base, the sand appears conformable with the underlying "Orange" sand which is interpreted as a near shore or beach sand. Sand Body III is interpreted as a clay dune based on clay content, sorting and stratgrapghic position within an overall regressive section. Sand Body III could possibly be present in the two URI deep wells but poor sample descriptions of the rotary drilled wells preclude an interpretation and the E-logs obtained were shut off below this shallow interval.

6.0.4 Body IV- Clayey Sand (Clay Dune)

Sand Body IV is believed to be a time and stratigraphic equivalent of Sand Body III, described above, and underlies a portion of the western edge of the MSWLF site. Boring #'s 16 and 23 penetrated 18' and 12' respectively, immediately above the underlying "Orange" sand. Body IV sand is similar in all respects to the homogeneous, very fine grained, well sorted, clayey sand which comprises Body III above. Cross section G-G' (wells 16 and 23) illustrates the top of Sand Body IV as being concave downward with a flat base, indicating deposition as a "buildup" or Clay Dune. Again, sand Body IV appears conformable with the underlying "Orange" which is interpreted as a near shore or beach sand.

Sand Bodies III and IV above are typical of the type IX soil which is comprised of stabilized clay dunes and dune complexes as indicated by the Environmental Atlas.

6.0.5 Sandy Clay Bed

The Sandy Clay Bed was a deposited penecontemporaneous with Bodies I through IV and is comprised of a homogeneous, tan, sandy clay containing abundant decomposed organic material. Thickness of this clay ranges from 40' to 60' under the MSWLF site with the above described Sand Bodies deposited within or adjacent to this clayey interval. The basal contact is abrupt with the underlying "Orange" Sand.

6.0.6 "Orange" Sand

As noted earlier, the "Orange sand" appears to have been deposited in a near shore or beach environment. The sand is extremely well sorted and clean, grains are well rounded and composed of approximately 90% fine quartz grains and 10 % fine multicolored shell fragments giving the overall sand color an orange cast. The thin (< 5'), sheet-like nature of the sand represents a beach environment of short duration developed at the top of the Beaumont clay (Light Olive Green Clay). It is present in all well control of sufficient depth.

6.0.7 "Light Olive Green Clay"

Tops on the "Light Olive Green Clay" are necessary to make the above interpretations of shallower beds in that it is the most definitive, planar marker bed under the MSWLF site. As noted earlier, this massive, low permeability, clay was deposited in a marine environment based upon the presence of sand filled burrows in it's top contact with the overlying "Orange" sand. The clay also contains sparse pelecypod molds scattered throughout and a single, correlative, thin bedded, pebble conglomerate (rip up clasts) believed to represent a storm deposit. This clay is pure and therefore exhibits characteristic low permeabilities with a proven thickness of at least 38'. E-logs from the URI deep uranium wells indicate a much thicker section is present under the site.

6.1 Holocene Stratigraphy as related to Groundwater Migration Pathways

Detailed correlation of borings show that the Holocene sediments which will host the proposed City of Kingsville MSWLF were deposited in a fluvial-deltaic environment. The massive "Light Olive Green Clay" which is believed to be Pleistocene age and deposited in a near shore marine environment underlies the section. As noted previously, the clay serves as the aquiclude between the Holocene sediments hosting the MSWLF and the underlying, saline, "Chicot" sand and the even deeper regional "Evangeline" (Goliad) aquifer.

Although excellent vertical separation exists between the Holocene sediments which will host the MSWLF and underlying Pleistocene beds, lateral migration of groundwater occurs within and through the host beds. From a potentiometric standpoint, it is evident from existing monitor well data that migration of groundwater within the Holocene host sediments is occurring in almost all directions away from the MSWLF site, the exception being to the northwest.

From geologic perspective, it is evident that migration of groundwater should occur primarily away from the MSWLF site to the northeast and southwest. Controlling this trend is the presence of the incised channel containing sands, clays and caliche noted on cross sections and maps as Sand Body I. This body, which hosts the thin to massively bedded caliche deposits in the area, strikes northeast and is approximately ½ mile in width. Body I trends directly through both the existing and proposed landfill sites. Other sand bodies in the host section are noted on the cross sections as II, III and IV. Sand body II is, again an incised, sand filled channel with limited areal extent. Sand Body II is truncated along its strike on the northeast and southwest by the overlying Body I. Sand Bodies III and IV are interpreted as being clay dunes or bars of limited areal extent. It should be noted that the entire Holocene section which contains all of the above sand bodies is permeable and therefore all are in communication. Even so, the

orientation of Sand Body I should exert an influence on preferential ground water migration to the northeast and southwest and away from the City of Kingsville's MSWLF site.

Note that ground water modeling using site specific data was performed using HELP3 and Multi-Media computer models. The results of these studies are given in Attachment 15, Appendices B & C, and in Attachment 10, Appendices C & D. The HELP3 model is used to estimate liner leakage rates for inputs to the Multi-Media model. The maximum rates were of course encountered for cases with minimum solid waste cover over the bottom liner system. The Multi-Media model used site specific data in the form of the average hydraulic conductivity measured in the wells on site and the average gradient over the entire site, i.e. gradient of 5.19 x 10⁻³ ft/ft to the northeast and hydraulic conductivity of 130 m/yr (4.12 X 10⁻⁴ cm/sec).

The primary impact of construction of the lined landfill cells will be the gradual reduction of any groundwater recharge to the uppermost aquifer from surface rainfall. Current recharge from the surface causes some dilution of groundwater and can potentially carry surface contamination to groundwater, as in the case of agricultural or oil and gas materials.

The primary impact of ponds and mined areas within the landfill site is dilution caused by surface recharge. This recharge and associated groundwater dilution will be reduced as onsite ponds and mined areas are eliminated as landfill expansion proceeds.

6.2 Hydrogeologic Conditions

This section describes groundwater conditions encountered during this investigation. The local groundwater flow regime at the site was determined by the collection of physical data (such as the elevation of the potentiometric surface) and the completion of in-situ hydraulic conductivity (bail) testing from on-site groundwater monitoring points. Depth-to-water measurements were obtained from existing on-site monitor wells and piezometers from August 4, 1997 every 2 weeks to February 18, 1998. Previous data collected from monitor wells during the period from March 29, 1991 through June 25, 1997 are also included. Two additional ground water level measurements are also included for May 18 and June 16, 1998. The depth-to-water measurements were subtracted from a surveyed reference datum (top of PVC casing) to establish a potentiometric surface relative to NGVD. The groundwater elevation data and resultant potentiometric contour maps for each relatively permeable stratum are presented in Attachment 5, Appendices A, B, and C. The water level data measured from soil boring and monitoring well measurements (hydrographs) are included within Appendix D.

The potentiometric contours presented within each map were constructed using the program Surfer (Version 6.04) by interpolation between data points. The primary layer potentiometric contour map from the water level measurement event indicated that ground water appears to flow generally outward from the landfill site in all directions. There are rather strong gradients to the northeast and to the southwest. There is some mounding near the center of the site. The hydraulic gradient was calculated for each of the four quadrants of the landfill site and for the entire site for each monitoring data set over a ten month period form August 4. 1997 through June 16, 1998. These calculations are shown in Attachment 15, Appendix G. The average gradient for the four quadrants over that 10 month period are as follows. The average hydraulic gradient toward the northeast is 7.99 x 10⁻³ ft/ft. The average hydraulic gradient toward the southwest is 2.16 x 10⁻³ ft/ft. The average hydraulic gradient toward the southeast is 1.44 x 10⁻³ ft/ft. The average hydraulic gradient toward the northwest is 3.87 x 10⁻³ ft/ft. Note that the gradient in the northwest quadrant actually changed direction over the 10 month period. The average hydraulic gradient and direction over the entire site is 5.19 x 10-3 ft/ft toward the northeast. This flow gradient and direction is generally consistent with the 9/29/97 and 9/15/97 measuring events and appears to be influenced by Santa Gertrudis Creek located to the northnortheast.

F. E. E., Inc. prepared a hydrograph of existing monitor wells on site using data collected from previous ground water sampling events since May 1991, and data collected during this investigation. Based on the seasonal data for the site collected to date, the

potentiometric surface was slightly lower during periods of low precipitation (summer and early fall) and slightly higher during periods of excess precipitation (winter and spring). The hydrograph indicates no significant changes in groundwater elevations since 1991 until the excessive precipitation event of October 8 -12, 1997. (Appendix F).

6.2.1 Surface Water Hydrology

COK MSWLF is located entirely within the Kleberg County Drainage Watershed. All of the soils are characterized by high to very high permeability and drainage which results in significant recharge from surface percolation. The average yearly rainfall total for the Kingsville area is approximately 30 inches, and is more or less evenly distributed throughout the year. However, monthly rainfall totals generally fall below the overall average of four inches per month during the late fall, winter, and spring. Monthly totals for the summer and early fall generally exceed the overall average.

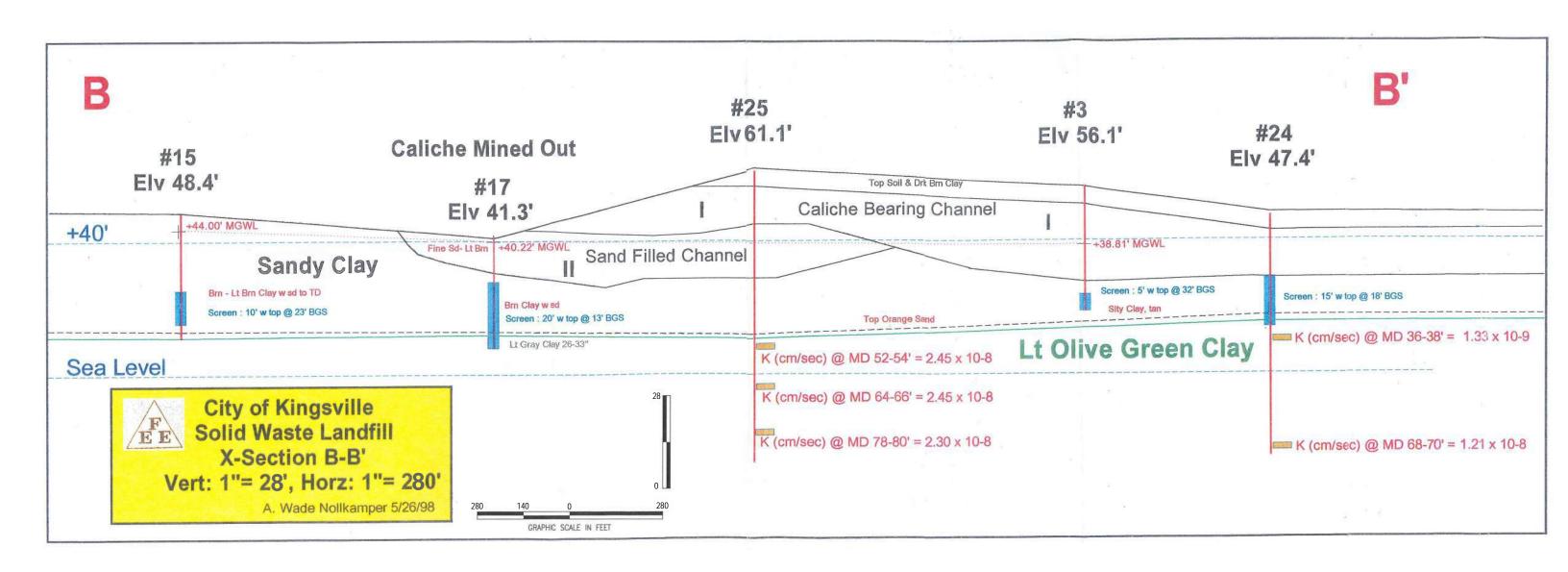
The topography of the watershed is gently sloping. Ground elevations in the Kleberg County Drainage Watershed vary from 125 feet in the extreme northwest to sea level in the East (Gulf of Mexico). Predevelopment ground contours at COK MSWLF varied from approximately 50 to 65 feet NGVD. Ground slope in the area varies from about two feet per mile to 6 feet per mile.

Santa Gertrudis Creek flows from the northwest to the southeast approximately one mile northeast of COK MSWLF before resuming its easterly flow towards Baffin Bay. Surface water runoff from the facility and the vicinity generally follows the easterly down-dip of the surface towards Baffin Bay via Santa Gertrudis Creek east of the site. Uncontaminated surface water from the southern half of the site flows to Santa Gertrudis Creek via drainage ditches to the south of the site, which also crosses the facility's southwest corner. Uncontaminated surface water from the northern half of the site flows to a drainage ditch, which also flows to Santa Gertrudis Creek and ultimately into Baffin Bay.

6.2.2 Groundwater Hydrology

Aquifer (slug) tests were performed in piezometers and monitor wells screened in the uppermost aquifer sand unit utilizing both rising head and falling head methodologies where possible. Results of these tests are shown in Attachment 5 as Appendix E, and are included as Appendix E of this Attachment. Based upon these results, the average (geometric mean) horizontal hydraulic conductivity of the uppermost aquifer is approximately 4.1 x 10-4 cm/sec in the subsurface soils above +10' MSL. These results were obtained using bail, or pump, tests and analyzed using the Horslev graphical method. Note that the Horslev method uses the sand filter pack around the monitor well screen rather than the well screen length in this calculation (Fetter, 1988).

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an equation derived from Darcy's Law,

 $V = Ki/n_e$ where:

V =velocity (length/time)

K =hydraulic conductivity (length/time)

i =hydraulic gradient (length/length)

n_e=effective porosity (decimal)

As calculated from the potentiometric maps of groundwater flow within each stratum (See Attachment 5, Appendix G), the horizontal hydraulic gradient across the site ranges from 1.44 x 10⁻³ ft/ft to 7.99 x 10⁻³ ft/ft. Horizontal hydraulic conductivity values within each stratum, which are stated above, were obtained from in-situ hydraulic conductivity tests (Appendix E). An effective porosity for a silty clay loam (the predominant lithology screened by piezometers in each stratum) is estimated to be 0.43 (Dean, et. al., 1989). Using these parameters, the horizontal velocity of ground water within uppermost aquifer deposits beneath the site is estimated to range from 0.0033 ft/day to 0.0086 ft/day, or 1.2 ft/year to 3.1 ft/year, respectively.

F.E.E. prepared a hydrograph of existing monitor wells on site using data collected from previous ground water sampling events since May 1991, and data collected during this investigation. Based on the seasonal data for the site collected to date, the potentiometric surface was slightly lower during periods of low precipitation (summer and early fall) and slightly higher during periods of excess precipitation (winter and spring). The hydrograph indicates no significant changes in groundwater elevations since 1991 until the excessive precipitation event of October 8 -12, 1997. (Appendix F).

The COK MSWLF site has several excavations which are adjacent to the currently permitted MSWLF and on the same land for which MSWLF expansion is proposed. These excavations were prepared for two reasons: first, to provide cover soil for the existing MSWLF; second, to prepare the excavations for future MSWLF cells. The net result of these excavations was to provide depressions in the earth's surface which collect ponded water from rainfall events. This ponded water provides recharge to the uppermost, unconfined aquifer by percolation through the unsaturated zone to the ground water table. This recharge causes higher than normal water levels (mounding) below and near these ponds. This is the same result as experienced in the 1968-69 TDWB studies of ponded water on the King Ranch.

The King Ranch study showed that water table water levels were influenced by recharge from ponded water as far as 500 feet from the pond. This was confirmed by both water levels and dilution of total dissolved solids (TDS) in the ground water. The COK MSWLF site experienced similar results after the excessive rainfall events of October 8-12,1997. Unfortunately, this rainfall event was right in the middle of a six month study of water levels being made as part of the permitting process for the expansion of the COK MSWLF. This event requires that the design be modified to protect against such events so that groundwater levels will not rise into bottom liners of the expanded landfill. The proposed design change is to provide pumping capacity for non-active excavations such that ponded water is not allowed to accumulate in excavations after rainfall events. The rainfall in expanded active areas will be handled by the leachate collection system.

In April, May and June, 1998, both the topography and groundwater levels on the landfill site and off-site were mapped. The topographic map and the groundwater contour during the May, 1998 period confirm that the ground water flow from the landfill is leaving the landfill in all directions except to the northwest where groundwater is entering the uppermost aquifer under the landfill. This study shows a very steep gradient to the northeast toward monitor well #14 as indicated previously. However, there is also ground water flow to the southwest toward the caliche pit on the southwest corner of the intersection of FM 2619 and CR 2030. There is also ground water toward the Martin Hamilton caliche pit at the southeast corner of FM 2619 and CR 2030. There is also ground water flow toward the landfill from the northwest corner of the landfill, i.e. monitor well #15. By superimposing the current topographic map onto the current ground water contour, it appears that there is no major disruption of ground water flow due to the local depressions. There does seem to be a small impedance to flow under the low point of the old landfill on the northeast corner of the intersection of FM 2619 and CR 2030. This impedance is indicated by a flattening of the ground water contour in the vicinity of the low area at the southwest corner of the 235 closed landfill, i.e. P& A'd Oil Well. There certainly is recharge from the surface ponding as indicated earlier from the study by Baker of King Ranch ponding studies after Hurricane Beulah.

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The May 1998 studies show that there were at that time nine (9) ponds or depressions in the vicinity of the landfill which intersect the ground water table. Eight of these depressions are located in adjacent caliche pits and one is located on site in a former caliche pit which is now inactive. These ponds are shown blue cross hatching on the topographic map in Appendix N. A Surfer ground water contour map using depression water surfaces and ground water monitor well levels was prepared for May 18, 1998. This contour is also shown in Appendix N. The Topographic Map and the Ground Water Contour Map are of the same scale and may be overlain for analysis. The number of ponds or depressions may vary as ground water level varies due to drought or excessive precipitation events. There are also five other ponds or depressions on the landfill site which hold water after rainfall but do not intersect the ground water table. One pond is the excavation where sector 2 is proposed on the southeast corner of the 160 acres. The second pond is about center on the east side of the landfill just north of the service road coming to the current office and weigh station. The third pond (much shallower) is due north of the second pond and also on the east side. The fourth pond is in the same triangular shaped area as the contaminated water evaporation pond but immediately to the north and east. The fifth pond is a long narrow pond immediately south of monitor well #6 at the center of the north side of the landfill. The only pond on site which intersects ground water is in the northwest 40 acre quadrant about the center of the west side and extending about half way across the quadrant. These ponds which do not intersect ground water can be identified on the topographic map in Appendix N by the numbers Pd-1, 2, 3, 4 and 5. These ponds will dry up after pumping or dry conditions.

The uppermost aquifer water table in the vicinity of the landfill site is almost totally supplied by recharge from the surface. This recharge is accelerated by the presence of ponds or depressions as described above which provide a static head through saturated soil. This is explained in the King Ranch ponding study above. The water table in the uppermost aquifer approximately follows the land surface since most of the recharge is from the surface. Since the landfill site is the high point in the area, it also contains the high point in the water table. Ground water tends to flow away from the landfill on all sides except to the northwest during most of the six month test period. However, in the earlier weeks of the test period (August & September, 1997) the ground water gradient was away from the landfill toward the northwest, also. Therefore, the monitor well system will need to monitor the points of compliance on all sides of the landfill site. The steepest ground water gradients are to the northeast and to the southwest. The gradient to the northeast is steep due to stiff clay formation on its way toward Santa Gertrudis creek. The gradient to the southwest is steep due to the caliche channel which rather steeply slopes toward the southwest (relative to the rather flat surrounding terrain).

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7.0 GROUNDWATER CHARACTERIZATION

This section describes the historical groundwater conditions that have existed at the City of Kingsville MSWLF site as required in 30 TAC §330.56(e). A delineation of the waste management area, the property boundary, and the proposed locations of all groundwater monitoring wells are shown on Figure 4.17.

7.1 Background

Currently a total of five groundwater monitoring wells exist to monitor quality in the uppermost aquifer sands along the perimeter of the currently permitted fill area. A series of sampling and analysis events to characterize the background quality of the groundwater occurred in the third and fourth quarters of 1996, and the first, second, and third quarters of 1997.

Beginning in the third quarter of 1996, the groundwater monitoring requirements included the annual sampling of each well for total organic carbon (TOC), iron, manganese, pH, chloride, potassium, total dissolved solids, and a groundwater elevation measurement. Following establishment of background values, the following additional parameters were sampled: calcium, magnesium, sodium, carbonate, phenolphthalein alkalinity as CaCO3, alkalinity as CaCO3, hardness as CaCO3, bicarbonate, sulphate, specific conductance, anion/cation balance, fluoride, and nitrate (as nitrogen). No known plumes of contamination have been identified as entering the groundwater from the facility.

7.2 **Groundwater Quality**

In order to compare with regional groundwater quality data, relevant analytes were selected from groundwater samples collected from groundwater monitor wells screened within the uppermost aquifer sands at the City of Kingsville MSWLF site. These analytes included pH, manganese (dissolved), iron (dissolved), chlorides, and total dissolved solids (TDS). Groundwater samples collected from the uppermost aquifer sand (MW-1 through MW-11) have reported pH values (field) ranging from 7.08 standard units (s.u.) from MW-4 to 7.66 s.u. from MW-11. Dissolved manganese concentration have ranged from Non-Detect from MW-10 to 0.67 µg/l from MW-3. Dissolved iron concentration have ranged from non-detect (MW-4) to 0.68 µg/l (MW-4). Chloride values have ranged from 66 milligrams per liter (mg/l or parts per million - ppm) from MW-11 to 2600 mg/l from MW-4. TDS concentrations ranged from 1580 mg/l (MW-11) to 5,780 mg/l (MW-4). More complete analytical data from the MSWLF ground water monitor wells is available in Table 5.1 of Attachment 5.

As part of the study performed by Shafer (1973), 272 groundwater samples were collected from water wells in the Kleberg, Kennedy, and Southern Jim Wells County

area, ranging in depth from 25 feet below ground surface (ft bgs) to 1,206 ft bgs. Groundwater samples were collected from 1913 to 1969 in order to determine the quality of groundwater supplies in the area. The analyses consisted of dissolved mineral constituents, which determined the fitness of water for industrial, agricultural, and domestic use without reference to the sanitary quality of the sample. A summary list of chemical analyses of groundwater samples collected from the Goliad aquifer in North Central Kleberg County is included within Table 5.2.

In general, the samples were fairly uniform throughout the northwestern portion of Kleberg County. Specific conductance and chloride content generally increased with depth, as a result of brackish or salt water intrusion. The Total Dissolved Solids contents were high and ranged from 894 ppm to 2,000 ppm. Figure 4.16 shows the extent of salt water intrusion from the Gulf of Mexico into the Evangeline (Goliad) aquifer in 1973.

The analytical results of the groundwater samples from the site reported values well within the regional values reported in the studies by Shafer (1973). The highest value for chloride has been reported at 2,600 mg/l, which was within the regional chloride values which ranged from 135 mg/l to 2,700 mg/l. The highest value for TDS has been 5,780 mg/l, well within range of the regional values of 175 mg/l to 21,200 mg/l.



GEOTECHNICAL CHARACTERIZATION 8.0

In order to determine the soil characteristics of the shallow soils at the site and to determine the suitability for site soils for liner material as well as evaluate depths, geotechnical laboratory testing of selected soil samples was performed. In accordance with 30 TAC §330.56(d)(5)(B), the following sections present a summary of the geotechnical properties of shallow soils beneath the site.

Geotechnical Laboratory Testing 8.1

All soil samples collected during the F.E.E., Inc. July, 1997 investigation were transported to the geotechnical laboratory where tests were performed on selected samples in order to evaluate and further classify the samples. Geotechnical laboratory test results are summarized by boring on Table 4.1 and by stratigraphic unit on Table 4.2. Geotechnical tests were performed on samples by Professional Services, Inc. (PSI), of Corpus Christi, Texas. During the second phase of geotechnical studies at the landfill site in April, 1998, additional samples were taken from four (4) deep borings. These samples were also tested for selected geotechnical parameters at PSI laboratories. The complete geotechnical laboratory test results are presented in Appendix G.

Atterberg Limits (ASTM D-4318), percent passing the No. 200 mesh sieve (ASTM D-1140), and full gradation tests (ASTM D-422) were performed on selected soil samples to determine the index of properties on the subsurface materials. A total of 44 Atterberg Limits and 24 grain size analyses were performed. The index and classification test results are summarized on Tables 4.1 and 4.2, and on the individual boring logs included in Appendix B. Grain size distribution curves are presented in Appendix G.1.

Short-term and long-term bearing strength characteristics and the moisture and density of the soils were evaluated by means of unconfined compression tests (ASTM D-2166), and eleven unconsolidated-undrained three-point triaxial compression tests (ASTM D-2850). The strength test results are summarized on Tables 4.1 and 4.2 and on the boring logs in Appendix B. The individual laboratory strength test results are included in Appendix G.2.

Three consolidation (odometer) tests (ASTM D-2435) were performed on samples obtained from the borings to evaluate the compressibility and rebound characteristics of cohesive materials subjected to varying load conditions. Stress-strain curves plotted using the test data are shown in Appendix G.2. Settlements within the soils underlying the landfill due to the imposed waste load were estimated using the information from these curves.

Horizontal and vertical permeability characteristics of the cohesive soils were evaluated

by means of flexible wall permeability tests (ASTM D-5084). Thirteen vertical permeability tests and twelve horizontal permeability tests were performed on samples obtained from the borings. Permeability test results are summarized on Tables 4.1 and 4.2. The individual laboratory permeability test data sheets are presented in Appendix G.4.

8.2 Geotechnical Data Evaluation

This section summarizes the results of the geotechnical laboratory testing performed on soil samples collected during the hydrogeological investigation performed by F.E.E., Inc. at the City of Kingsville, Texas (COK) Municipal Solid Waste Landfill (MSWLF) during the month of July, 1997. A discussion of the geotechnical results for each of the stratigraphic units is presented below.

8.2.1 Top Soil and dark Brown Clay Unit

Very little geotechnical data was determined from top soil samples.

8.2.2 Caliche Bearing Channel (I) Layer

The Caliche Bearing Channel consist of a caliche vein running from the northeast to southwest across the landfill site. The Isopach (Figure 4.29) shows that the thickness varies from 0 to 40 feet thickness across the site. The 40 foot thickness is at the extreme southwest corner. The zero is on the edges of the channel. The channel splits and goes to both sides on monitor wells 18 and 14. The main channel in the new site is approximately 20 feet thick maximum. Much of this layer has already been excavated in the caliche mining process which ceased more than twenty years ago.

The moisture content of this stratum ranged from 8.3 to 11.5 percent with an average of approximately 9.6 percent, and the caliche layer had an average dry density of 81 pounds per cubic foot (pcf). The liquid limits and plasticity indices ranged from 31 to 39 and 13 to 19, respectively, with an average liquid limit and plasticity index of 35 and 16, respectively.

Unconfined compression tests performed on samples from this unit indicate an average cohesion of 5,660 pounds per square foot (psf). Permeability tests performed on samples from this stratum indicated an average horizontal permeability of 3.0x10⁻⁴ cm/sec.

8.2.3 Sand Filled Channel (II) Layer

The Sand Filled Channel (II) is a discontinuous layer located below the main caliche

bearing channel. Where the caliche has been excavated the Sand Filled Channel is exposed in the vicinity of monitoring well #17. The maximum thickness of the layer of approximately 20 feet occurs in the vicinity of monitor wells #10 and #17. The precise location and shape of this discontinuous unit is shown in Isopach map Figure 4.29. The Sand Filled Channel is composed primarily of SC and SP-SC soils.

The moisture content of this stratum ranged from 18 to 35 percent, with an average of approximately 26 percent. The Sand Filled Channel layer had an average dry density of 82 pcf, and an average wet density of 104 pcf. The liquid limits and plasticity indices ranged from 41 to 58 and non to 33, respectively, with an average liquid limit and plasticity index of 47 and 17, respectively (neglecting the non plasticity index readings).

Cohesion intercept from unconsolidated-undrained triaxial compression tests ranged from 3,100 to 13,000 psf with an average of 8,600 psf. Consolidated-undrained triaxial compression tests were performed on samples from this unit indicating an average effective cohesion of 200 psf and an effective angle of internal friction of 24 degrees. Vertical and horizontal permeability tests performed on samples from this stratum indicated an average vertical and horizontal permeability of 3.0x10⁻⁵ cm/sec and 1.0x10⁻⁴ cm/sec, respectively. Percent passing the No. 200 mesh averaged 40 percent.

8.2.4 Clayey Sand (Clay Dune) (III) Layer

The Clayey Sand (Clay Dune) (III) Layer is present at the extreme eastern side of the landfill site. (See Figure 4.30) It is present below the top soil and sandy clay units below monitor well #13. The Clayey Sand (III) Layer and consists SC, SP-SC and CH soils. The unit is encountered typically between elevations 6 and 26 NGVD. This is a discontinuous clay dune unit. The maximum thickness of the unit is estimated to be about 30 feet. (See Figure 4.26)

Moisture tests were performed on samples from this unit, indicating a water content of 23 percent. The liquid limits and plasticity indices ranged from 56 to 63 and 30 to 48, respectively, with an average liquid limit and plasticity index of 59 and 27, respectively. Permeability tests performed on this layer indicated vertical and horizontal permeabilities of 2.3 X 10⁻⁵ and 1.75 X 10⁻⁵ cm/sec, respectively.

8.2.5 Clayey Sand (Clay Dune) (IV) Layer

The Clayey Sand (Clay Dune) (IV) Layer is present under the Caliche Bearing Channel and the Sand Filled Channel and the Sandy Clay unit at the extreme western edge of the landfill site. Section D-D', Figure 4.22, shows the Clay Dune to be of maximum thickness of about 24 feet and centered between monitor wells 16 and 23. The Clayey Sand (IV) Unit consists primarily of SC and SP-SC type soils. Figure 4.30 is the isopach

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of this formation.

The moisture content of the Clayey Sand (IV) Layer ranged from 19 to 25 percent, with an average of approximately 22 percent. The liquid limits and plasticity indices of this layer averaged 52 to 21, respectively. The percent passing the No. 200 sieve mesh ranged between 30 and 46 percent with an average of 19 percent. Compressive strength of this layer was 5,500 psf. Effective cohesion and angle of internal friction for this layer were 200 psf and 24 degrees, respectively. Vertical permeability was 3.3×10^{-6} cm/sec.

8.2.6 Sandy (Silty) Clay Unit

The Sandy (Silty) Clay Unit is the most continuous soil unit above the aquiclude described below. The other discontinuous units (Caliche Bearing Channel, Sand Filled Channel, and two Clay Dunes (III & IV) seem to be located within the Sandy (Silty) Clay Unit. This unit is found in every boring log at the site except 7, 8 and 23. Borings 7 &8 are totally in the Caliche Bearing Channel. Boring 23 penetrates three types of discontinuous units which separate it from the Sandy (Silty) Clay Unit. (See Section D-D', Figure 4.22) The Sandy (Silty) Clay Unit is composed primarily of CH type soils with minor amounts of CL and SC types.

The moisture content of the Sandy (Silty) Clay Unit ranged from 9 to 38 percent with an average moisture content of 23 percent. The Liquid Limit of this soils ranged from 30 to 83% with an average of 60%. The Plasticity Index ranged from 15 to 60% with an average of 39%. The percent passing the No. 200 sieve mesh ranged from 31 to 85% with an average of 60%. Unconfined compressive strength of this soil average 7,680 psf. Effective cohesion and angle of internal friction for this unit were 200 psf and 24 degrees, respectively. The average vertical and horizontal permeabilities were 1.0x10-5 am/sec and 2.8x10-6 cm/sec, respectively.

8.2.7 Light Olive Green Clay Confining Layer - Aquiclude

This Light Olive Green Clay Unit was the only truly continuous layer unit at the landfill site. The top of this layer is shown in Figure 4.28 to vary from 5 feet above MSL at the extreme northeast corner of the landfill site to about 17 feet above MSL at the extreme southwest corner of the landfill site where it is slightly truncated by the Caliche Bearing Channel sloping gently towards the southwest. The Unit is at least 38 feet thick at the landfill site. All of the deep borings terminated in this unit. It forms the aquiclude for the local uppermost aquifer in the vicinity of the landfill site.

The moisture content of this soil varied from 18% to 38% and averaged 29%. The average wet and dry densities of this soil are 125 pcf and 98 pcf, respectively. The liquid

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limit of this soil varied from 51% to 79% and averaged 67%. The Plasticity Index of this soil varied from 25% to 51% and averaged 35%. The average percent passing a number 200 mesh sieve was 81%. The average unconfined compressive strength of this clay was 8,300 psf. The vertical permeability of this clay averaged 3.3×10^{-8} cm/sec. The vertical permeability ranged from 1.33×10^{-9} m/sec to 6.18×10^{-8} cm/sec.

Table 4.1 SUMMARY OF GEOTECHNICAL TESTING RESULTS BY BORING City of Kingsville MSWLF, Permit 235 B

Kingsville, Texas

Г		1	Г	Т	Т	Т	Г	_		Т	Г		Г	Г	Г		1			Г	Г	Г											
	Other Tests Remarks					(1) 200 (2) 26 (3) 3.4		(3) 1.7	(3) 2.4							(1) 200 (2) 26 (3) 6.5										(3) 2.3		(3) 3.2			(3) 0.38		
ability	Horizontal (cm/sec)																		0.0001						5E-06				3E-05				
Permeability	Vertical (cm/sec)																			5.80E-06					3.40E-07				0.00046				
#200	Sieve (%)				09			48	33				51							62	99						48	46				30	
Plastic	lndex (%)					28		28	26		29	24				25			12		26		36	29		29		28			24		NON
Liquid	Limit (%)					41		51	48		53	51				59			30		43		59	59		63		69			99		
Dry	Density (pcf)					112.3		102.3	96.1											100.7					94.8	101.4		94	93.6		6.96		
Wet	Density (pcf)					127.53		121.84	118.76											108.79					114.94	123.27		116.5	112.63		112.92		
Water	Content (%)		7.2		14.1	13.6		19.1	23.6		24.7	23.2	25.2		29	30.2				8	9.4			21.3	21.3	21.6	18.6	23.9	20.3		26.9	24.7	26.7
nscs			CL CL		겅	J		SC	SC		K	HJ.	R		S	CH			CL	CL	ر ا		끙	CH	CH	당	SC	SC	SC		SC	SPSC	SPSC
Depth	(ft bgs)		0-2		2-2	7-8		14-19	19-24		29-34	34-36	36-41		46-47	47-48		0-2	2-4	2-8	8-10		15-20	20-25	25-26	26-27	27-30	30-35	35-36	37-40	40-45	45-46	48-49
Sample	Number		S1	S2	S3	S4	SS	Se	S7	S8	88	S10	S11	S12	S13	S14		S1	S2	S3	S4	SS	Se	87	S8	S9	S10	S11	S12	S13	S14	S15	S16
Boring No.	Ground El. (ft MSL)		B-12	52.38														B-13	59.13														

1 Effective Cohesion (psf)

2 Effective Angle of Internal Friction (degrees) 3 Unconfined Compressive Strength (tsf)

SUMMARY OF GEOTECHNICAL TESTING RESULTS BY BORING City of Kingsville MSWLF, Permit 235 B

Kingsville, Texas

	Fests arks				(3) 4.							(3) 3.	1						(3) 1							(3) 1	1		
	Other Tests Remarks				(2) 26							(2) 24							(2)21							(2) 24			
					(1) 200							(1) 200							(1) 200						(3) 1.56	(1) 200			
bility	Horizontal (cm/sec)				5E-07	5E-07																							
Permeability	Vertical (cm/sec)							6.90E-05	5 70		1.20E-07									3E-07					2.40E-07				
#200	Sieve (%)			99	53				46	99			85				47	51		55		65				53		58	
Plastic	Index (%)			26		37		33		27	33		37	15			19			46	56	56	90			32		35	
Liquid	Limit (%)			44		63		58		20	61		64	41			30			89	79	79	83			50		52	
Dry	Density (pcf)			104.7	95.1	95.1		86.99		88.3	98.54		82.1				112.6		100.4		84.2					100			
Wet	Density (pcf)			116.69	113.11	113.11		108.57		114.2	123.66		104.29				126.4		113.38		97.04					121.79			
Water	Content (%)			11.5	14.4	19	22.2	24.8	28.5	29.3	25.7		26	29.5			12.3	11.6	12.9	15.3	15.3	15.3	21.2		20.1	21.3		26.5	29
nscs		•		TO	CL	HO	CH	CH	SC	CF	HO		CH	CL			SC	CL	CH	CH	CH	CH	CH		СН	H		ᆼ	ᆼ
Depth	(tt bgs)		0-2	5-10	10-11	11-15	15-20	20-25	25-30	30-33	33-34	34-35	35-37	39-40		0-2	5-10	10-12	12-13	13-14	14-16	16-19	19-22		23-24	24-25		25-28	28-29
Sample	Number		S1	S2	S3	S4	SS	Se	S7	S8	83	S10	S11	S12		S1	S2	S3	S4	SS	Se	. S7	S8	83	S10	S11	S12	S13	S14
Boring No.	Ground El. (ft MSL)		B-14	49.94								 W			7	B-15	48.39												

1 Effective Cohesion (psf)

2 Effective Angle of Internal Friction (degrees) 3 Unconfined Compressive Strength (tsf)

Table 4.1 (cont'd)

SUMMARY OF GEOTECHNICAL TESTING RESULTS BY BORING

City of Kingsville MSWLF, Permit 235 B

Kingsville, Texas

_		. –	_		_		_	_	_	_	_	_		_	_	_			_	Т	Т	Т	Т	Т	7
The second secon	Other Tests Remarks		(4) 200 (2) 26 (3) 20	(1) 200 (2) 20 (3) 2.3																					
ability	Horizontal (cm/sec)																								
Permeability	Vertical (cm/sec)																	1000	1.20E-05	4E-06					
#200	Sieve (%)				31					22	24					30			46						83
Plastic	Index (%)				23		1			NON	13					29			24						51
Liquid	Limit (%)				45						43					20			41						79
Dry	Density (pdf)			104.9																					84.3
Wet	Density (pcf)			114.66																					110.03
Water	Content (%)			9.3	11.6					27.3	22.3					24.5			19.4	21					30.6
nscs			CL		SC					SP-SC	SP-SC					SC			SC	SC					CH
Depth	(ft bgs)		0-2	3-5	5-10					16-18	-					26-29			33-35	35-37					45-47
_	Number		S1	S2	S3	S4	SS	Se	S7	SS	SS	S10	S11	S12	S13	S14	S15	S16	S17	S18	S19	S20	S21	S22	223
Boring No.		THE RESIDENCE OF THE PARTY OF T	B-16	55.96																					

1 Effective Cohesion (psf)

2 Effective Angle of Internal Friction (degrees)3 Unconfined Compressive Strength (1sf)

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SUMMARY OF GEOTECHNICAL TESTING RESULTS BY BORING City of Kingsville MSWLF, Permit 235 B Table 4.1 (cont'd)

Texas

		ı		Т	_	_	_	1		_	_	_	1	_	Т	_		7	_	_	1	_	Т	Т	_	_	1	_	_	_	_	_	_
	Other Tests Remarks																00 (2) 24 (3) 2.27					00 (2) 21 (3) 5.4	1		00 (2) 24 (3) 4.91								00 (2) 24 (3) 1.57
	_					L										_	(1) 200					(1) 200			(1) 200		L						(1) 200
ability	Horizontal (cm/sec)					3F-05																											
Permeability	Vertical (cm/sec)					0.0001											6.70E-07												0.0023				
#200	Sieve (%)				25	8	99							83							09		45		57			78				81	
Plastic	Index (%)			NON		NON	19			46				52			41				44				33			47				48	
Liquid	Limit (%)						41			99				74			62				59				58			99				73	
Dry	Density (pcf)					64.6				82.7				78.9			93.8				84.9	110.8			99.3								81.4
Wet	Density (pcf)					85.07				95.09				108.86			115.38				97.82	127.25			122.97								106.75
Water	Content (%)			21.6	35	31.4	32			31.5				38		23					15.2	14.8	18.3		23.8			26.5	31.9			34.9	31.1
nscs				SP-SC	SP-SC	SP-SC	J)			CH				S		CH	CH				K	CL	CH		당			CH	CH			CH	K
Depth	(ft bgs)			2-5	2-8	8-9	9-10			17-18				24-29		31-32	32-33		0-2	3-5	5-9	9-10	10-15	7	12-18			24-29	29-30			34-39	39-42
Sample	Number		S1	S2	S3	S4	SS	Se	S7	88	89	S10	S11	S12	S13	S14	S15		S1	S2	S3	S4	SS	Se	S7	88	89	S10	S11	S12	S13	S14	S15
Boring No.	Ground El. (ft MSL)		B-17	41.35															B-18	50.04													

1 Effective Cohesion (psf)

2 Effective Angle of Internal Friction (degrees) 3 Unconfined Compressive Strength (tsf)

Revision 1

	Other Tests Remarks	
	Permeability ritical Horizontal n/sec) (cm/sec)	
	\ (cu	
	#200 Sieve (%)	
2	Plastic Index (%)	
וב, ובאמט	Liquid Limit (%)	
INORIIN	Dry Density (pcf)	
	Wet Density (pcf)	
	Water Content (%)	
	nscs	
	Depth (ft bgs)	
	Sample Number	
	ng No. und El. MSL)	

	(3) 4.5	(3) 4.5	(3) 4.5	(3) 4.5	(3) 4.5	(3) 4.5	(3) 4.5	(3) 4.5	(3) 2.3	(3) 2.3	(3) 3.5	(3) 4.5	(3) 4.5	(3) 4.5	(3) 4.5				(3) 4.3				(3) 4.5	(3) 4.0	(3) 4.5	(3) 4.5	(3) 4.5	(3) 4.5	(3) 3.8	(3) 4.5
																									1.99x10 ⁻⁹		4			
																									95					
																									40					
																									75					
																									37.8					
1-2	2-4	4-6	8-9	8-10	10-12	12-14	14-16	16-18	18-20	20-22	22-24	24-26	26-28	28-30	30-32	32-34	34-36	36-38	38-40	40-42	42-44	44-46	46-48	48-50	50-52	52-54	54-56	56-58	58-60	60-62
S1	S2	S3	S4	S5	Se	S7	S8	89	S10	S11	S12	S13	S14	S15	S16	S17	S18	S19	S20	S21	S22	S23	S24	S25	S26	S27	S28	S29	S30	S31
B-21	52.41																													

1 Effective Cohesion (psf)
2 Effective Angle of Internal Friction (degrees)
3 Unconfined Compressive Strength (tsf)

Revision 1

Table 4.1 (cont'd) UMMARY OF GEOTECHNICAL TESTING RESULTS BY BORING City of Kingsyille MSWLF, Permit 235 B

	H	Other Tests	Kemarks	
	Permeability	Vertical Horizontal	(cm/sec) (cm/sec)	When the Annual control was a series of the
	#200	U)	(%)	CH DECKE STATE COLUMN TO STATE OF
2	Plastic	Index	(%)	The second secon
וכי, ו כאמט	Liquid	Limit	(%)	N. Bellevine and St.
III ACCIONI	Dry	Density	(bct)	The state of the s
	Wet	Density	(bct)	-
	Water	Content	(%)	Carachine Control of the Control of
	nscs			The state of the s
	Depth	(4, 1, 2, 7)	(sba 11)	
	Sample	Number		

Boring No. Ground El. (ft MSL)

							T												I											
(3) 4.5	(3) 4.5	(3) 4.5	(3) 45	(3) 2.5	(3) 3.5	(3) 2.8	(3) 3.0	(3) 4.0	(3) 4.5	(3) 4.5			(3) 4.5	(3) 4.5	(3) 2.0	(3) 0.8	(3) 0.5						(3) 2.0	(3) 2.3			(3) 4.5		(3) 3.0	(3) 3.8
3.00x10 ⁻⁸								1.56x10 ⁻⁸																						4.4×10-8
86								78																						88
25								33																						37
51								62																						73
27.7								24.6																						36.9
62-64	64-66	89-99	02-89	70-72	72-74	74-76	76-78	78-80	80-82	82-84		1-2	2-4	4-6	8-9	8-10	10-12	12-14	14-16	16-18	18-20	20-22	22-24	24-26	26-28	28-30	30-32	32-34	34-36	36-38
S32	S33	S34	835	S36	S37	838	839	S40	S41	S42	2	51	S2	S3	S4	SS	Se	S7	S8	S9	S10	S11	S12	S13	S14	S15	S16	S17	S18	S19
B-21	52.41	(cont'd.)			14						000	B-23	49.5																	

Effective Cohesion (psf)
 Effective Angle of Internal Friction (degrees)

Revision 1

TING RESULTS BY BORING F, Permit 235 B SUMMARY OF GEOTECHNICAL City of Kingsville M.

Boring No.	Sample	Depth	nscs	Water	Wet	Dry	Liquid	Plastic	#200	Perm	Permeability	F : -
Ground El. (ft MSL)		(ft bgs)		Content (%)	Density (pcf)	Density (pcf)	Limit (%)	Index (%)	Sieve (%)	Vertical (cm/sec)	Horizontal (cm/sec)	Remarks
				u cana	C Barrenser							
B-23	S20	38-40										(3) 4.3
52.41	S21	40-42										(3) 4.5
(cont'd.)	S22	42-44										(3) 4.5
	S23	44-46										(3) 4.5
	S24	46-48								1.6x10-8		(3) 4.5
	S25	48-50										(3) 3.0
	S26	50-52										(3) 4.0
	S27	52-54										(3) 4.5
	S28	54-56										(3) 4.3
	S29	56-58										(3) 4.5
	830	28-60		27.7			62	32	80			(3) 4.5
	S31	60-62										(3) 4.5
	S32	62-64										(3) 4.5
	833	64-66										(3) 4.5
	S34	89-99		24.3			59	31	9/	3.80×10-8		(3) 2.8
	835	68-70										(3) 4.0
	836	70-72										(3) 3.3
	S37	72-74										(3) 2.5
	838	74-76										(3) 4.3
	839	76-78										
	S40	78-80										
	S41	80-82										(3) 4.5
	S42	82-84										(3) 4.5
												100
B-24	S1	1-2										(3) 4.5
47.38	S2	2-4										(3) 4.5
	S3	4-6										(3) 4.5
	S4	8-9										(3) 3.0
	S5	8-10										
	Se	10-12										
	S7	12-14										

Effective Angle of Internal Friction (degrees) 3 Unconfined Compressive Strength (tsf) 1 Effective Cohesion (psf)

NG RESULTS BY BORING Permit 235 B

14-16 16-18 18-20 20-22 22-24 23-25 22-24 22-24 23-25 22-24 23-25 22-24 23-25 22-24 23-25 22-24 23-25 22-24 23-25 22-24 23-25 22-24 23-25 22-24 23-25 22-24 23-25 22-24 23-25 22-24 23-25 22-24 23-25 22-24 23-25 22-24 23-25 23-25 22-24 23-25 22-24 23-25 22-24 23-25	36.4	Liquid Plastic Limit Index (%) (%)	c #200 Sieve (%)	Permeability Vertical Horizontal (cm/sec) (cm/sec)	Other Tests Remarks
36.4 79 38 80 8.30x10 ⁷ 1.33x10 ⁹ 27.7 71 36 68 3.28x10 ⁹ 1.77 50 30 66 6.00x10 ⁷	36.4				
36.4 79 38 80 8.30x10 ⁷ 1.33x10 ⁹ 1.33x10 ⁹ 27.7 71 36 68 3.28x10 ⁹ 1.77 50 30 66 6.00x10 ⁷	36.4				
36.4 79 38 80 8.30x10 ⁻⁷ 1.33x10 ⁻⁹ 27.7 71 36 68 3.28x10 ⁻⁹ 17.7 50 30 66 6.00x10 ⁻⁷ 1.21x10 ⁻⁸	36.4				
36.4 79 38 80 8.30x10 ⁻⁷ 1.33x10 ⁻⁹ 27.7 71 36 68 3.28x10 ⁻⁹ 17.7 50 30 66 6.00x10 ⁻⁷	36.4				(3) 45
36.4 79 38 80 8.30x10 ⁻⁷ 1.33x10 ⁻⁹ 27.7 71 36 68 3.28x10 ⁻⁹ 17.7 50 30 66 6.00x10 ⁻⁷ 1.21x10 ⁻⁸	36.4				(3) 4.3
36.4 79 38 80 8.30x10 ⁻⁷ 1.33x10 ⁻⁹ 27.7 71 36 68 3.28x10 ⁻⁹ 17.7 50 30 66 6.00x10 ⁻⁷ 1.21x10 ⁻⁸	36.4				(3) 4.5
36.4 79 38 80 8.30x10-7 1.33x10-9 27.7 71 36 68 3.28x10-9 17.7 50 30 66 6.00x10-7 1.21x10-8	36.4				(3) 4.5
36.4 79 38 80 8.30x10 ⁻⁷ 1.33x10 ⁻⁹ 27.7 71 36 68 3.28x10 ⁻⁹ 17.7 50 30 66 6.00x10 ⁻⁷ 1.21x10 ⁻⁸	27.7				(3) 4.5
36.4 79 38 80 8.30x10 ⁻⁷ 1.33x10 ⁻⁹ 27.7 71 36 68 3.28x10 ⁻⁹ 17.7 50 30 66 6.00x10 ⁻⁷ 1.21x10 ⁻⁸	27.7				2:: (2)
27.7 71 36 68 3.28x10 ⁻⁹	27.7			8.30×10-7	
27.7 71 36 68 3.28x10-9 71 71 36 68 1.23x10-9 71 71 36 71 71 71 71 71 71 71 71 71 71 71 71 71	27.7				(3) 4.3
27.7 71 36 68 3.28x10.9	27.7			1.33×10-9	(3) 4.5
27.7 71 36 68 3.28x10 ⁻⁹ 17.7 50 30 66 6.00x10 ⁻⁷ 17.7 50 30 66 6.00x10 ⁻⁷ 1.21x10 ⁻⁸	27.7				(3) 4 5
27.7 71 36 68 3.28x10-9 27.7 71 36 68 6.00x10-9 17.7 50 30 66 6.00x10-7 1.21x10-8	27.7				(3) 4 5
27.7 71 36 68 3.28×10-9 27.7 71 36 68 0.00×10-9 17.7 50 30 66 6.00×10-7 1.21×10-8	27.7				(3) 4.5
27.7 71 36 68 3.28×10 ⁻⁹ 17.7 50 30 66 6.00×10 ⁻⁷ 17.1 50 30 66 1.21×10 ⁻⁸	27.7				(3) 3.5
27.7 71 36 68 3.28×10 ⁻⁹ 17.7 50 30 66 6.00×10 ⁻⁷ 17.1 50 30 66 1.21×10 ⁻⁸	7				(3) 4.5
27.7 71 36 68 3.28×10 ⁻⁹ 17.7 50 30 66 6.00×10 ⁻⁷ 17.1 50 30 66 1.21×10 ⁻⁸	7				(3) 4.5
17.7 50 30 66 6.00×10 ⁻⁷ 1.21×10 ⁻⁸	17.7			3.28×10-9	(3) 4.5
17.7 50 30 66 6.00×10 ⁻⁷ 1.21×10 ⁻⁸	17.7				(3) 4.5
17.7 50 30 66 6.00×10-7 1.21×10-8	17.7				(3) 4.5
17.7 50 30 66 6.00×10 ⁻⁷ 1.21×10 ⁻⁸	17.7				(3) 2.3
50 30 66 6.00×10 ⁻⁷ 1.21×10 ⁻⁸	17.7				(3) 4.5
17.7 50 30 66 6.00×10-7 1.21×10-8	17.7				(3) 4.3
17.7 50 30 66 6.00x10 ⁻⁷ 1.21x10 ⁻⁸	17.7				(3) 1.8
17.7 50 30 66 6.00x10-7 1.21x10-8	17.7				(3) 4.5
1.21x10 ⁻⁸		90		6 6.00x10-7	(3) 4.5
				1.21x10 ⁻⁸	(3) 3.5
					(3) 3.0

1 Effective Cohesion (psf)

2 Effective Angle of Internal Friction (degrees) 3 Unconfined Compressive Strength (1st)

Revision 1

ULTS BY BORING

	Cto Toda	Remarks		(3) 4.5	2:1 (2)	(3) 4 5	0.1 (0)													(3) 3 8	0.0 (0)	(3) 2 8	(3) 8.3	(3) 2.5	(3) 4.3	(3) 4.3	(3) 3.3	0:0 (0)	(3) 3.0	(3) 4.5	(3) 4.5	(3) 4.5	(3) 4.5	(3) 4.5
	Permeability	Vertical Horizontal (cm/sec)																												2 45×10-8	0.00.1			
	#200																													87	T			
dente discontinuo	Plastic	Index (%)																												43				
	Liquid	Limit (%)																												77				
	Dry	Density (pcf)																																
	Wet	Density (pcf)																																
	Water	Content (%)																												31.8		¥ -		
	nscs															5		20																
	Depth	(ft bgs)	0	7-1	2-4	4-6	8-9	8-10	10-12	12-14	14-16	16-18	18-20	20-22	22-24	24-26	26-28	28-30	30-32	32-34	34-36	36-38	38-40	40-42	42-44	44-46	46-48	48-50	50-52	52-54	54-56	56-58	58-60	60-62
	Sample	Number	20	0	S2	S3	S4	S5	Se	S7	88	88	S10	S11	S12	S13	S14	S15	S16	S17	S18	S19	S20	S21	S22	S23	S24	S25	S26	S27	S28	S29	S30	S31
	Boring No.	Ground El. (ft MSL)	20.00	C7-G	61.12																													

1 Effective Cohesion (psf)

2 Effective Angle of Internal Friction (degrees) 3 Unconfined Compressive Strength (tsf)

nt'd) TING RESULTS BY BORING F, Permit 235 B SUMMARY OF GEOTECHNICAL City of Kingsville MS

		- Augusta		I	T	T	1					Γ	T				Γ	T	I			T	T		I
Other Tests	Remarks		(3) 4.5	(3) 4 5	(3) 4.5	(2) 4.5	(3) 4.3	(3) 4.3	(3) 4.5	(3) 4.5	(3) 4.5	(3) 4 5	2.4 (0)	(3) 4.3	(3) 4.5	(3) 4.5									
Permeability Herizontal	(cm/sec)																								
Perme	(cm/sec)			2 30×10-8								6 18×10-9	0.00												
#200 Sieve	(%)			92								83													
Plastic	(%)			39								31													
Liquid	(%)			77								58													
Dry	(pcf)																								
Wet	(pcf)																								
Water	(%)			30.5								20.5													
SOSO																									
Depth	(ft bgs)		62-64	64-66	89-99	68-70	70-72	72-74	74 76	70.70	8/-9/	08-8/	80-82	82-84	04 00	04-00									
Sample			S32	S33	S34	S35	S36	S37	638	000	023	240	S41	S42	CVO	040									
Boring No. Ground El.	(ft MSL)		B-25	61.12	(cont'd.)																				

Revision 1

2 Effective Angle of Internal Friction (degrees) 3 Unconfined Compressive Strength (Isf) Effective Cohesion (psf)

Other Tests Remarks (3) 4.5 (3) 4.5 (3) 4.5 SUMMARY OF GEOTECHNICAL TESTING RESULTS BY STRATIGRAPHIC UNIT City of Kingsville MSWLF, Permit 235 B Kingsville, Texas Horizontal (cm/sec) 1.6×10-4 2.0x10⁻⁴ 1.0x10⁻⁴ Permeability Vertical (cm/sec) 5.8×10-6 #200 Sieve (%) Top Soil (Dark Brown Clay) Uni Plastic Index (%) 17 Liquid Limit (%) 34 Dry Density (pcf) Wet Density (pcf) Water Content (%) 8.3 **USCS** (ft bgs) Depth 3-4 1-2 1-3 1-3 1-3 1-3 3-5 1-2 0-5 0-2 2-3 7-8 Sample Number \$\frac{1}{2}\$\frac Boring No. Ground El. (ft MSL) B-13 B-10 B-11 B-12 B-5 B-1 B-2 B-4

1 Effective Cohesion (psf)

² Effective Angle of Internal Friction (degrees)

|--|--|

1 Effective Cohesion (psf)
2 Effective Angle of Internal Friction (degrees)
3 Unconfined Compressive Strength (tsf)

Table 4.2 (cont'd.) SUMMARY OF GEOTECHNICAL TESTING RESULTS BY STRATIGRAPHIC UNIT City of Kingsville MSWLF, Permit 235 B

Kingsville, Texas

1 -			e e	r	_		1	_	_		_	_	1	_	_		-1	-	_	_	_	_	_		_	_	_
	1	Other Tests Remarks												12) 4 5	(3) 4.3			(2) 4 5	(3) 4.3								
_	ability	(cm/sec)		-																						3.0x10-4	
	Permeability	Vertical (cm/sec)																									
	#200	(%)	I) Unit																			T	T				
	Plastic	(%)	annel (13	2		19																		16	
	Liquid Limit	(%)	ing Ch	,	31			39																		35	
	Dry	(pcf)	Caliche Bearing Channel (I) Unit																							81	
	Wet	(pcf)	Calic																								1
	Water	(%)			9.1			8.3			ica.															11.5	
Ī	nscs			0	22	.5	12	3	10	_	+	10			10		100		1.5	6	.0		10		10	0	
	Depth	(ft bgs)		6.5-7.0	7.0-8.5	8.5-10.5	10.5-12	12-13	14-1	20-21	23-24	24-25	30-31	8-10	13-15	8-10	14-16	8-10	12.5-14.5	18-19	23-25	8-9	13-15	18-20	23-25	29-30	
	Sample	-		9-S	S-7	S-8	8-6 8-6	S-10	S-11	S-12	S-13	S-14	S-15	S-3	S-4	S-1	S-2	S-3	S-4	S-5	9-S	S-3	S-4	S-5	9-S	S-7	
	Boring No.	(ft MSL)		B-1										B-2		B-3		B-4				B-5					

Effective Cohesion (psf)

² Effective Angle of Internal Friction (degrees)
3 Unconfined Commercial

Unconfined Compressive Strength (tsf)

(3) 4.5 (3) 4.5 (3) 4.5 (3) 4.5 (3) 4.5 Other Tests Remarks Table 4.2 (cont'd.) SUMMARY OF GEOTECHNICAL TESTING RESULTS BY STRATIGRAPHIC UNIT City of Kingsville MSWLF, Permit 235 B Kingsville, Texas Horizontal (cm/sec) Permeability Vertical (cm/sec) #200 Sieve (%) Plastic Index (%) Caliche Bearing Channel Liquid Limit (%) Dry Density (pcf) Wet Density (pcf) Water Content (%) **USCS** 17.5-19.5 23.5-25.5 28-30 0-8 (ft bgs) Depth 8-18 18-24 24-28 28-30 31-36 36-43 0-10 12-14 10-20 5-10 10-15 3-5 4-6 Sample Number \$25 \\ \frac{1}{2} \\ Boring No. Ground El. (ft MSL) B-11 B-21 B-6 B-8 B-9

Revision 1

Effective Cohesion (psf)

Effective Angle of Internal Friction (degrees) 3 Unconfined Compressive Strength (tsf)

ESÚLTS BY STRATIGRAPHIC UNIT F, Permit 235 B SUMMARY OF GEOTECHNICAL TESTII City of Kingsyille M

		-	1	-	_	_	T	T	_	1	_	-	_	_	_	_	_	_		_	_	_	_	_	_	т
Other Tests Remarks			(3) 4.5	(3) 4.5	(3) 2.0	(3) 0.8	(3) 0.5		(3) 3.0	255 (2)																0000
ability Horizontal (cm/sec)																										7000
Permeability Vertical Horiz (cm/sec) (cm/																										
#200 Sieve (%)	Unit)	F													-		-							H		
Plastic Index (%)	nnel (I																									-
Liquid Limit (%)	ng Cha																							*		L
Dry Density (pcf)	Caliche Bearing Channel																									30
Wet Density (pcf)	Calic																								*	2
Water Content (%)	ALCO MANAGEMENT OF THE PROPERTY OF THE PROPERT																									000
USCS																								Barre		
Depth (ft bgs)		0-5	2-4	4-6	6-8	8-10	10-12	12-14	14-16	8-9	8-10	10-12	12-14	14-16	16-18	18-20	8-9	8-10	10-12	12-14	14-16	16-18				
Sample Number		S-1	S-2	S-3	S-4	S-5	S-6	S-7	8-8	S-4			S-7			S-10		S-5			8-8	8-9				
Boring No. Ground El. (ft MSL)		B-23								B-24							B-25							75		V. 10 20 20 20 20 20 20 20 20 20 20 20 20 20

Revision 1

1 Effective Cohesion (psf)

2 Effective Angle of Internal Friction (degrees)

3 Unconfined Compressive Strength (1sf)

Table 4.2 (cont'd)
SUMMARY OF GEOTECHNICAL TESTING RESULTS BY STRATIGRAPHIC UNIT City of Kingsville MSWLF, Permit 235 B Kingsville, Texas

Company Comp			;			1000			ā	000	d		
Sand Filled Channel (II) Unit SP-SC 27.3 SP-SC 27.3 A3 13 24 SP-SC 21.6 NON 22 SP-SC 31.4 85.07 64.6 NON 25 SP-SC 31.4 85.07 64.6 NON 25 CL 32 41 19 66	Sample Number		Depth (ft bgs)	SCS	Water Content (%)	Wet Density (pcf)	Dry Density (pcf)	Liquid Limit (%)	Plastic Index (%)	#200 Sieve (%)	Vertical (cm/sec)	eability Horizontal (cm/sec)	Other Tests Remarks
SP-SC 27.3 NON 22 SP-SC 21.6 NON 25 SP-SC 35 SP-SC 31.4 85.07 64.6 NON 25 CL 32 SP-SC						Sa	nd Filled	Chan	nel (III) L	Jnit			
SP-SC 27.3	S-2	-	10-20					_					
SP-SC 27.3	S-3		20-28										
SP-SC 27.3 NON 22 SP-SC 22.3 43 13 24 SP-SC 21.6 NON 25 SP-SC 31.4 85.07 64.6 NON 25 CL 32 CL 32 SP-SC 31.4 85.07 64.6 NON 25 CL 32 CL 32 SP-SC 31.4 85.07 64.6 NON 25 CL 32 CL 32 CL 32 CL 32 SP-SC 31.4 85.07 64.6 NON 25 CL 32 CL	S-4		28-36										
22-24 26-28 31-34 10-11 11-12 12-14 14-16 16-18 SP-SC 27.3 18-20 SP-SC 22.3 18-20 SP-SC 21.6 2-5 SP-SC 21.6 8-9 SP-SC 31.4 85.07 64.6	S-1		2-2										
15-20 22-24 26-28 31-34 10-11 11-12 12-14 14-16 16-18 SP-SC 27.3 18-20 SP-SC 22.3 18-20 SP-SC 21.6 2-5 SP-SC 21.6 5-8 SP-SC 35 8-9 SP-SC 31.4 85.07 64.6 9-10 CL 32 8-9 SP-SC 31.4 85.07 64.6	S-3		2-11										
26-28 31-34 10-11 11-12 12-14 14-16 16-18 SP-SC 27.3 18-20 SP-SC 22.3 18-20 SP-SC 21.6 2-5 SP-SC 21.6 5-8 SP-SC 31.4 85.07 64.6 8-9 SP-SC 31.4 85.07 64.6 9-10 CL 32	S-4		15-20										
26-28 31-34 10-11 11-12 12-14 14-16 16-18 18-20 SP-SC 22.3 18-20 SP-SC 2-5 SP-SC 35 8-9 8-9 8-10 CL 32 41 41 19	S-5		22-24										
31-34 10-11 11-12 12-14 14-16 16-18 SP-SC 27.3 18-20 SP-SC 22.3 18-20 SP-SC 21.6 2-5 SP-SC 21.6 5-8 SP-SC 35 8-9 SP-SC 31.4 85.07 64.6 9-10 CL 32 8-9 SP-SC 31.4 85.07 64.6 9-10 CL 32	9-S		26-28										
10-11 11-12 12-14 14-16 16-18 SP-SC 27.3 18-20 SP-SC 22.3 18-20 SP-SC 21.6 2-5 SP-SC 21.6 5-8 SP-SC 31.4 8-9 SP-SC 31.4 8-10 CL 32 8-9 SP-SC 31.4 8-10 CL 32 8-20 SP-SC 31.4 8-30 SP-SC 31.4 8	S-7		31-34										
11-12 12-14 14-16 16-18 SP-SC 27.3 NON 22 18-20 SP-SC 22.3 43 13 24 0-2 2-5 SP-SC 21.6 NON 25 5-8 SP-SC 35 43 13 24 0-2 5-8 SP-SC 31.4 85.07 64.6 NON 25 8-9 SP-SC 31.4 85.07 64.6 NON 25 8-9 SP-SC 31.4 85.07 64.6 NON 25 8-9 SP-SC 31.4 85.07 64.6 NON 60001	S-4		10-11										
12-14 14-16 16-18 SP-SC 27.3 18-20 SP-SC 22.3 18-20 SP-SC 21.6 2-5 SP-SC 21.6 5-8 SP-SC 31.4 85.07 64.6 8-9 SP-SC 31.4 85.07 64.6 9-10 CL 32 8-9 SP-SC 31.4 85.07 64.6	S-5		11-12					-					
14-16 SP-SC 27.3 NON 22 18-20 SP-SC 22.3 43 13 24 0-2 NON 22 2-5 2-5 SP-SC 21.6 NON 25 8-9 SP-SC 31.4 85.07 64.6 NON 25 9-10 CL 32 41 19 66	9-8		12-14										
16-18 SP-SC 27.3 NON 22 18-20 SP-SC 22.3 43 13 24 0-2 SP-SC 21.6 NON 25 5-8 SP-SC 35 64.6 NON 25 8-9 SP-SC 31.4 85.07 64.6 NON 0.0001 9-10 CL 32 41 19 66	S-7		14-16										
18-20 SP-SC 22.3 43 13 24 0-2 0-2	8-8		16-18	SP-SC	27.3				NON	22			
0-2 2-5 SP-SC 21.6 5-8 SP-SC 35 8-9 SP-SC 31.4 85.07 64.6 NON 25 9-10 CL 32 41 19 66	8-9		18-20	SP-SC	22.3			43	13	24			
2-5 SP-SC 21.6 5-8 SP-SC 35 8-9 SP-SC 31.4 85.07 64.6 NON 25 9-10 CL 32 41 19 66	S-1		0-2										
5-8 SP-SC 35 64.6 NON 25 0.0001 8-9 SP-SC 31.4 85.07 64.6 NON 0.0001 9-10 CL 32 41 19 66	S-2		2-5	SP-SC	21.6				NON				
8-9 SP-SC 31.4 85.07 64.6 NON 0.0001	S-3		2-8	SP-SC	1000					25			
9-10 CL 32 41 19	3-4		8-9	SP-SC		85.07	64.6		NON		0.0001	3x10-5	
	S-5		9-10	CL	32			41	19	99			
		1											

1 Effective Cohesion (psf)

2 Effective Angle of Internal Friction (degrees)3 Unconfined Compressive Strength (1sf)

SÚLTS BY STRATIGRAPHIC UNIT Permit 235 B

ON Soin O	-					(7 :: ::		000		. 4:1:40	
Ground El.	Sample	Depth (ft bgs)	SSSO	Water Content	Wet Density	Density (ncf)	Limit (%)	Plastic Index	#200 Sieve	Vertical Horiz	Horizontal (cm/sec)	Other Tests
(it in CE)			CHICATOR CONTRACTOR CONTRACTOR	(0/)	(bel)	1	(27)	111	_ .	(cill/sec)	(OBC/IIIO)	кетагкз
9	1				Sal	- 1	Channel					
B-18	S-5	11-15	СН	18.3					45			
	S-6	15-17										
	S-7	17-18	CH	23.8	122.97	99.3	58	33	57			(1) 200 (2) 24 (3) 4 91
B-21	S-8	14-16										(3) 45
	8-9	16-18	1									(3) 4.5
B-23	S-9	16-18										2: (2)
	S-10	18-20										
B-25	S-9	16-18										
	S-10	18-20										
	S-11	20-22										
	S-12	22-24										
	S-13	24-26										
	S-14	26-28										
87	S-15	28-30										
	S-16	30-32		in the								
	S-17	32-34										(3) 4 5
Average:				26.46	104.02	81.95	47.3	17.3	39.8	0 0001	3x10-5	(1) 200 (2) 24 (3) 4 6

Part III, Attachment 4, Appendix 1, p.g. 108

1 Effective Cohesion (psf)

2 Effective Angle of Internal Friction (degrees)3 Unconfined Compressive Strength (1st)

Table 4.2 (cont'd)
SUMMARY OF GEOTECHNICAL TESTING RESULTS BY STRATIGRAPHIC UNIT City of Kingsville MSWLF, Permit 235 B

Kingsville, Texas

			T	T	T	T	T	T	T				1		T	T	T		T	T	T	T	T	T	T
	Other Tests Remarks		0 0/0/	(0)77.0	00(0)	(3) 3.2		000	(2) 0.30						(3) 4.3										700 (6)
	ontal (sec)		6.0240-6	0.000		3240-5	0170																		4 7Ev40-5
Permeability	cal Horizontal sec) (cm/sec)		2 1240-7	2		4 Rv40-5	2,40.1																		41 3 2 3 4 1 0 - 5
	Vertical (cm/sec)	it		48	46	2			00	00	1	1	T		1				T		1		1	Ī	113
	Sieve (%)	III) Un	-	+	-	+	+	-			2	1	1	+	1	1	+	+	-		+	+	+		27
Plastic	Index (%)	une) (20	-	28	Í		24	1	1014	NON				-			-	1	-					~
Liquid	Limit (%)	Slay Di	63		59	3		56																	593
Dry	Density (pcf)	Clayey Sand (Clay Dune) (III) Unit	101.4		94	93.6		6.96																	96.48
	Density (pcf)	Clayey	123.97		116.5	112.63		112.92																	111.51
Water			21.6	18.6	23.9	20.3		26.9	24.7	787															23.24
nscs	0		H	SC	SC	SC		SC	SPSC	SPSC															
Depth	(ft bgs)		26-27	27-30	31-35	35-36	37-40	40-45	45-46	48-49	32-34	34-36	36-38	38-40	40-42	42-44	44-46								
Sample	Number		S-9	S-10	S-11	S-12	S-13	S-14	S-15	S-16	S-17	S-18	S-19	S-20	S-21	S-22	S-23								
Boring No.	Ground El. (ft MSL)		B-13								B-21														Average:

1 Effective Cohesion (psf)

2 Effective Angle of Internal Friction (degrees)

3 Unconfined Compressive Strength (tsf)

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SUMMARY OF GEOTECHNICAL TESTING RESULTS BY STRATIGRAPHIC UNIT City of Kingsville MSWLF, Permit 235 B Table 4.2 (cont'd) Kingsville. Texas

Wet Dry Liquid Plastic (pcf) (pcf) (%) (%) (%) (%) (%) (%) (%) (%) (%) (%	The second second												
Number (ft bgs)	Boring No.	_	Depth	USCS	Water	Wet	Dry	Liquid	Plastic	#200	Perme	ability	
S-9 18-20 Sp-SC 22.3	Ground El. (ft MSL)		(tt bgs)		Content (%)	Density (pcf)	Density (pcf)	Limit (%)	Index (%)	Sieve (%)	Vertical (cm/sec)	Horizontal (cm/sec)	Other Tests Remarks
S-9 18-20 Sp-SC 22.3 43 13 24 S-10 20-22 20-23 43 13 24 S-11 23-24 24-25 50 29 30 S-13 25-26 50 29 30 S-16 29-31 50 29 30 S-16 31-33 5C 19.4 41 24 46 S-17 33-35 5C 21 41 24 46 S-18 35-37 5C 21 41 24 46 S-19 37-39 5C 21 41 24 46 S-19 37-39 5C 21 41 24 46 S-10 37-39 5C 21 41 24 46 S-11 20-22 5-14 26-28 5-14 46 5-14 5-14 5-14 46 S-16 30-32 5-14 30-32 5-14 46 5-14 46 5-14 46 5-14 46 5-14						Claye	y Sand (Clay Du	ne) (IV)	Unit			
S-10 20-22 S-11 23-24 S-12 24-25 S-13 25-26 S-14 26-29 SC 24.5 S-16 31-33 S-17 33-35 SC 19.4 S-18 34-36 S-18 34-36 S-18 34-36 S-10 20-22 S-10 30-32 S-11 32-34 S-12 22-34 S-13 24-26 S-14 26-28 S-15 28-30 S-16 30-32 S-17 32-34 S-18 34-36 S-18 34-36 S-11 20-22 S-12 22-34 S-13 24-26 S-14 26-28 S-15 28-30 S-16 30-32 S-17 32-34 S-18 34-36 S-19 30-32 S-11 20-22 S-12 22-34 S-13 24-26 S-14 26-28 S-15 28-30 S-16 30-32 S-17 32-34 S-18 34-36	B-16	S-9	18-20	Sp-SC	22.3			43	13	NC.			
S-11 23-24 S-12 24-25 S-13 25-26 S-14 26-29 SC 24.5 S-16 31-33 S-17 33-35 SC 19.4 S-18 35-37 SC 21 S-19 37-39 S-20 39-41 S-21 41-43 S-11 20-22 S-12 22-24 S-13 24-26 S-14 26-28 S-15 28-30 S-16 30-32 S-17 32-34 S-18 34-36 S-18 34-36 S-17 23-24 S-18 34-36 S-18 34-36 S-17 23-24 S-18 34-36 S-18 34-36 S-17 22-24 S-18 34-36 S-17 32-34 S-18 34-36		S-10	20-22					2	2	+7			
S-12		S-11	23-24										
S-13 25-26 S-14 26-29 SC 24.5 S-15 29-31 S-16 31-33 S-17 33-35 SC 19.4 S-18 35-37 SC 21 S-19 37-39 S-20 39-41 S-21 41-43 S-11 20-22 S-12 22-24 S-13 24-26 S-14 26-28 S-15 28-30 S-16 30-32 S-17 32-34 S-18 34-36 S-18 34-36 S-14 26-29 S-18 34-36 S-18 34-36 S-14 26-29 S-17 32-34 S-18 34-36 S-18 34-36 S-14 26-29 S-17 32-34 S-18 34-36 S-18 34-36		S-12	24-25										
S-14 26-29 SC 24.5 50 29 30 S-16 29-31 S-16 31-33 SC 19.4 41 24 46 S-17 33-35 SC 19.4 41 24 46 S-18 35-37 SC 21 41 24 46 S-19 37-39 S-21 41-43 46 47 46 46 47 46 46 47 46 46 47 46 46 46 47 46 46 47 46 46 47 46 47 46 47 47 47 47 47 47 47 47 47 47 47		S-13	25-26										
S-15 29-31 S-16 31-33 S-17 33-35 SC 19.4 S-18 35-37 SC 21 S-20 39-41 S-21 41-43 S-11 20-22 S-12 22-24 S-13 24-26 S-14 26-28 S-15 28-30 S-16 30-32 S-17 32-34 S-18 34-36 S-16 31-33 S-16 31-33 S-17 32-34 S-18 34-36 S-18 34-36		S-14	26-29	SC	24.5			50	20	30			
S-16 31-33 S-17 33-35 SC 19.4 41 24 46 S-18 35-37 SC 21 41 24 46 S-19 37-39 S-20 39-41 41 24 46 S-20 39-41 S-20 39-41 46	355	S-15	29-31					3	67	200			
S-17 33-35 SC 19.4 41 24 46 S-18 35-37 SC 21 46 46 S-19 37-39 39-41 41-43 41-43 S-21 41-43 41-43 41-43 S-11 20-22 22-24 42-26 S-13 24-26 24-26 S-14 26-28 25-14 S-16 30-32 30-32 S-17 32-34 43-36 S-18 34-36 57 21.8 116.5 9648 50 21.13 18 83		S-16	31-33										
S-18 35-37 SC 21 S-19 37-39 S-20 39-41 S-21 41-43 S-11 20-22 S-12 22-24 S-13 24-26 S-14 26-28 S-16 30-32 S-16 30-32 S-17 32-34 S-18 34-36 S-18 57 21.13 18 83		S-17	33-35	SC	19.4			41	24	180	3040-5		
S-19 37-39 S-20 39-41 S-21 41-43 S-11 20-22 S-12 22-24 S-13 24-26 S-14 26-28 S-15 28-30 S-16 30-32 S-17 32-34 S-18 34-36 S-18 116.5 96.48 57 21.3 18.83		S-18	35-37	SC	21				1	t	4710-6		
S-20 39-41 S-21 41-43 S-11 20-22 S-12 22-24 S-13 24-26 S-14 26-28 S-15 28-30 S-16 30-32 S-17 32-34 S-18 34-36 S-18 116.5 96.48 57 21.3 18.83		S-19	37-39								1410		
S-21 41-43 S-11 20-22 S-12 22-24 S-13 24-26 S-14 26-28 S-15 28-30 S-16 30-32 S-17 32-34 S-18 34-36 21.8 116.5 96-48 57 21.3 18 823		S-20	39-41										
S-11 20-22 S-12 22-24 S-13 24-26 S-14 26-28 S-15 28-30 S-16 30-32 S-17 32-34 S-18 34-36 S-18 116.5 96.48 57 21.13 18.83		S-21	41-43										
S-12 22-24 S-13 24-26 S-14 26-28 S-15 28-30 S-16 30-32 S-17 32-34 S-18 34-36 21.8 116.5 96.48 57 21.3 18.83	B-23	S-11	20-22										
S-13 24-26 S-14 26-28 S-15 28-30 S-16 30-32 S-17 32-34 S-18 34-36 21.8 116.5 96.48 57 21.13 18.83		S-12	22-24							86	1		0000
S-14 26-28 S-15 28-30 S-16 30-32 S-17 32-34 S-18 34-36 21.8 116.5 96.48 57 21.13 18.83		S-13	24-26										(3) 2.0
S-15 28-30 S-16 30-32 S-17 32-34 S-18 34-36 21.8 116.5 96.48 57 21.13 18.83		S-14	26-28			18							(3) 2.3
S-16 30-32 S-17 32-34 S-18 34-36 21.8 116.5 96.48 57 21.13 18.83		S-15	28-30										
S-17 32-34 S-18 34-36 21.8 116.5 96.48 52 21.13 18.83		S-16	30-32										1.7 (0)
S-18 34-36 21.8 116.5 96.48 52 21.13 18.83		S-17	32-34										(3) 4.5
21.8 116.5 96.48 52 21.13 18.83		S-18	34-36										
21.8 116.5 96.48 52 21.13 18.83													(3) 3.0
	\verage:				21.8	116.5	96.48	52	21 13	18 83	2740-6		110 (0)

Effective Cohesion (psf)

2 Effective Angle of Internal Friction (degrees) 3 Unconfined Compressive Strength (tsf)

L	Other Tests	Remarks	2			(3) 4.5						(3) 4.2													
EOTECHNICAL TESTING RESULTS BY STRATIGRAPHIC UNIT City of Kingsville MSWLF, Permit 235 B Kingsville, Texas	Permeability tical Horizontal	(cm/sec)																							
RATIG	Perm	(cm/sec)			0	5.6X10-0																			
BY ST 235 B	#200 Sieve	(0/)																							
SULTS SULTS Permii (as	Plastic Index (%)	, Init																							
NSWLF WSWLF	Liquid Limit (%)	iltv) Clar	DIO (6																1						
L TEST Igsville I Kingsv	Dry Density (pcf)	Sandy (Silfy) Clay Ilnit			66	8							Ī											T	
CHNICA iv of Kir	Wet Density (pd)																								
GEOTE	Water Content (%)				8.3																				
RY OF	uscs																								
SUMMARY OF GI	Depth (ft bgs)		35-36	40-41	23-25	25-27	29-31	32-34	28-30	33-35	38-40	33-35	38-40	46-48	33-35	38-40	36-48	10-12	15-17	11-12	13-14	14-15	15-16	17-19	19-29
o)	Sample Number		S-17	S-18	9-8	S-7	S-3	S-4	S-7	S8	S-9	S-8	8-9	S-10	S-7	S-8	S-5	S-2	S-3	S-4	S-5	S-6	S-7	8-8	S-9
	Boring No. Ground El. (ft MSL)		B-1		B-2		B-3		B-4			B-5			B-6	90	B-9	B-9R		B-10					

1 Effective Cohesion (psf)
2 Effective Angle of Internal Friction (degrees)
3 Unconfined Compressive Strength (tsf)

SÚLTS BY STRATIGRAPHIC UNIT Permit 235 B SUMMARY OF GEOTECHNICAL TEST City of Kingsville A

ng No.	Sample	Depth	nscs	Water	Wet	Dry	l	Plastic	#200	Permeability	ability	
Ground El. (ft MSL)				Content (%)	Density (pcf)	Density (pcf)	Limit (%)	Index (%)	Sieve (%)	Vertical (cm/sec)	Horizontal (cm/sec)	Other Tests Remarks
					S	andy (Si	Sandy (Silty) Clay Unit	Unit				
B-11	S-7	31-35										
	8-8	36-40										
	8-9	41-45										
	S-10	46-48					K					
B-12	9-S	14-19	SC	19.1	121.84	102.3	51	28	48			(3) 1.7
	S-7	19-24	SC	23.6	118.76	96.1	48	26	33			(3) 2.4
	8-8	24-29	CH									
	8-9	29-34	공	24.7			53	29				
	S-10	34-36	F	23.2			51	24				
	S-11	36-39	공	25.2					51			
B-13	9-8	15-20	CH				59	36				
	S-7	20-25	CH	21.3			59	29				
	8-8	25-26	CH	21.3	114.94	94.8				3.4×10-7	5x10-6	
B-14	S-4	11-15	H)	19	113.11	95.1	63	37			5x10-7	
	S-5	15-20	CH	22.2								
	9-8	20-25	H)	24.8	108.57	86.99	58	33		6.9x10 ⁻⁵		
	S-7	25-30	SC	28.5					46			
	S-8	30-33	ರ	29.3	114.2	88.3	20	27	99			
	8-9	33-34	E E	25.7	123.66	98.64	61	33		1.2x10 ⁻⁷		
	S-10	34-35										
	S-11	35-37	H	26	104.29	82.1	64	37	85			
	S-12	39-40	CL	29.5			41	15				

1 Effective Cohesion (psf)

2 Effective Angle of Internal Friction (degrees)

Hanson Professional Services Inc. Submittal Date: September 2018 Revision: 1 - November 2018

ILTS BY STRATIGRAPHIC UNIT 9rmit 235 B Table SUMMARY OF GEOTECHNICAL TEST City of Kingsyille

Boring No.	Sample	Depth	nscs	Water	Wet	Dry	Liquid	Plastic	#200	Permeability	ability	
Sround El. (ft MSL)	Number	(ft bgs)		Content (%)	Density (pcf)	Density (pcf)	Limit (%)	Index (%)	Sieve (%)	Vertical (cm/sec)	Horizontal (cm/sec)	Other Tests Remarks
					0,	Sandy (Silty) Clay Unit	ilty) Clay	Unit				
B-15	S-1	0-2										
	S-2	5-10	SC	12.3	126.4	112.6	30	19	47			
	S-3	10-12	ر ت	11.6					51			
	S-4	12-13	CH	12.9	113.38	100.4						(1) 200 (2) 21 (3) 1.55
	S-5	13-14	СН	15.3			89	46	55	3x10-7		
	9-S	14-16	СН	15.3	97.04	84.2	79	56				
	S-7	16-19	СН	15.3			79	56	65			
	S-8	19-22	СН	21.2			83	09				
	8-9	22-23										
	S-10	23-24	СН	20.1						2.4×10-7		(3) 1.56
	S-11	24-25	СН	21.3	121.79	100	20	32	53			(1) 200 (2) 24 (3) 1.53
	S-12	25-28	СН	26.5			52	35	58			
	S-13	28-29	CH	29								
	S-14	29-31										
	S-15	31-37										
B-16	S-1	0-2	ر ا									
	S-2	3-5		9.3	114.66	104.9						(1) 200 (2) 24 (3) 2.9
	S-3	2-8	SC	11.6			45	23	31			
B-17	S-6	10-15										
	S-7	15-17										
	8-8	17-18	CL	31.5	95.09	82.7	99	46				
	S-9	19-22										
	S-10	22-23										
	S-11	23-24										
	S-12	24-29	HS	38	108.86	78.9	74	52	83			

Effective Cohesion (psf)
 Effective Angle of Internal Friction (degrees)

TINI	Stock T sould	Offier Tests Remarks									(1) 200 (2) 24 (3) 1.57	(3) 2.3	(3) 2.3	(3) 3.5	(3) 4.5	(3) 4.5	(3) 4.5	(3) 4.5	(3) 4.5	(3) 4.3	(3) 4.5	(3) 4.5	(3) 4.5		
Table 4.2 (cont'd) GEOTECHNICAL TESTING RESULTS BY STRATIGRAPHIC UNIT City of Kingsville MSWLF, Permit 235 B Kingsville, Texas	Permeability	(cm/sec)																							
RATIGR	Perme	(cm/sec)					2.3×10-7									0 10									80 8.3×10-7
BY ST F 235 B	#200 Sieve	(%)				78				81															
r'd) SULTS Permit as	Plastic	(%)	Unit			47				48															38
I.2 (continue) ING REMARKE ASWLF, ille. Tex	Liquid	(%)	ilty) Clay			99				73															79
Table 4 L TEST gsville M Kingsv	Dry	(pcf)	Sandy (Silty) Clay Unit								81.4	David Control	25 - 25												
HNICA v of Kin	Wet	(pcf)	0,								106.75														
EOTEC	Water	(%)				26.5	31.9			34.9	31.1														36.4
IY OF G	nscs					СН	СН			CL	CH														
SUMMARY OF	Depth	(ft bgs)		19-21	21-23	24-29	29-30	30-31	31-34	34-39	39-42	18-20	20-22	22-24	24-26	26-28	28-30	30-32	20-22	22-24	4-26	26-28	28-30	30-32	32-34
S	Sample			S-8	S-9	S-10	S-11	S-12	S-13	S-14	S-15	S-10	S-11	S-12	S-13	S-14	S-15	S-16	S-11	S-12	S-13	S-14	S-15	S-16	S-17
	Boring No. Ground El	(ft MSL)		B-18								S-21							B-24						

1 Effective Cohesion (psf)
2 Effective Angle of Internal Friction (degrees)
3 Unconfined Compressive Strength (tsf)

93

(1) 200 (2) 24 (3) 3.84 (3) 3.8 (3) 2.5 (3) 4.3 (3) 4.3 (3) 3.3 Other Tests Remarks (3)3.8(3)2.83.0 (3) Table 4.2 (cont'd) SUMMARY OF GEOTECHNICAL TESTING RESULTS BY STRATIGRAPHIC UNIT City of Kingsville MSWLF, Permit 235 B Kingsville, Texas 2.75x10-6 Horizontal (cm/sec) Permeability 1.02×10-5 Vertical (cm/sec) 59.5 #200 Sieve (%) Plastic Index (%) 39.1 Unit Silty) Clay Liquid Limit (%) 60.1 Dry Density (pcf) 93.1 Sandy 112.7 Wet Density (pcf) Water Content (%) 23.3 USCS (ft bgs) 44-46 46-48 48-50 50-52 Depth 36-38 38-40 40-42 42-44 34-36 32-34 Sample Number S-18 S-20 S-20 S-21 S-23 S-23 S-24 S-25 S-26 S-17 Boring No. Ground El. (ft MSL) Average: B-25

1 Effective Cohesion (psf)

Unconfined Compressive Strength (tsf)

94

² Effective Angle of Internal Friction (degrees)

SUMMARY OF GEOTECHNICAL TESTING RESULTS BY STRATIGRAPHIC UNIT City of Kingsville MSWLF, Permit 235 B Table 4.2 (cont'd)

	Other Tests Remarks										(3) 2.27	(3) 4.5	(3) 4.0	(3) 4.5	(3) 4.5	(3) 4.5	(3) 4.5	(3) 3.8	(3) 4.5	(3) 4.5	(3) 4.5	(3) 4.5		
	Horizontal (cm/sec)																							
	Vertical Horiz (cm/sec) (cm/													1.99x10 ⁻⁹						86 3x10-8				Ī
1	Sieve (%)) Unit						83						95 1						86 3				1
1	Plastic Index (%)	Light Olive Green Clay (Aquiclude) Unit			25			51						40						25				
1	Limit (%)	Clay (A			59			79						75			0.0			51				
	Density (pcf)	Green																			94.2			
100	wet Density (pcf)	ht Olive																			119.8			
∥ ⊢	Water Content (%)	Lig		29	30.2			30.6		23				37.8						27.7				
	SSS																							
; - -	Depth (ft bgs)		41-46	46-47	47-48	41-43	43-45	45-47	29-31	31-32	32-33	46-48	48-50	50-52	52-54	54-56	56-58	58-60	60-62	62-64	64-66	89-99	68-70	
	Sample		S-12	S-13	S-14	S-21	S-22	S-23	S-13	S-14	S-15	S-24	S-25	S-26	S-27	S-28	S-29	S-30	S-31	S-32	S-33	S-34	S-35	
. –	Ground El. (ft MSL)		B-12			B-16			B-17			B-21												

1 Effective Cohesion (psf)

2 Effective Angle of Internal Friction (degrees)

Number Count El. Number (# begin Depth USCS Usc) (# begin USC) (# begin		Ø	SUMMARY OF		SEOTE Ci	CHNICA ty of Kin	Table 4.2 (L TESTING MSV Kingsville	1.2 (cor ING RE WSWLF	SULTS SULTS Permit	BY ST 235 B	RATIGR	Table 4.2 (cont'd) GEOTECHNICAL TESTING RESULTS BY STRATIGRAPHIC UNIT City of Kingsville MSWLF, Permit 235 B Kingsville Texas	LIZ	
Number (ft bgs) Content Density Density Density Density Density Density Content Content Density Density Density Content Content Density Density Content Cont	Boring No.		∥ <u>⊢</u>		Water	Wet	Drv	Liquid	Plastic	#200	Perme	ability		
S-36 70-72 Light Olive Green Clay (Aquiclude) Unit S-37 72-74 S-38 76-78 S-39 76-78 S-40 78-80 24.6 S-20 38-40 S-21 44-46 S-22 44-46 S-22 44-46 S-22 54-56 S-22 S-24 44-46 S-25 S-24 44-46 S-25 S-26 S-	Ground El (ft MSL))	Content (%)	Density (pcf)	Density (pcf)	Limit (%)	Index (%)	Sieve (%)	Vertical (cm/sec)	Horizontal (cm/sec)	Other Tests Remarks	
S-36 70-72 Page 1 Page 2 Page 2 Page 3 Page 2 Page 3						_ight Oliv	ve Green		quiclude	Unit				
S-37 72-74 Person Person <td>B-21</td> <td>S-36</td> <td>70-72</td> <td>16 E3</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>(3) 2.5</td> <td></td>	B-21	S-36	70-72	16 E3									(3) 2.5	
S-38 74-76 62 33 78 1.56x10*8 S-30 76-78 24.6 62 33 78 1.56x10*8 S-40 78-80 24.6 62 33 78 1.56x10*8 S-41 80-84 36.9 73 37 88 4.4x10*8 S-20 38-40 73 37 88 4.4x10*8 1.6x10*8 S-21 40-42 8 4.4x10*8 1.6x10*8 1.6x10*8 1.6x10*8 S-23 44-46 8 8 4.4x10*8 1.6x10*8 1.6x10*8 S-24 46-48 8 9 1.6x10*8 1.6x10*8 1.6x10*8 S-25 48-50 8 1.6x10*8 1.6x10*8 1.6x10*8 1.6x10*8 S-26 50-54 8 8 8 8 1.6x10*8 1.6x10*8 <td></td> <td>S-37</td> <td>72-74</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>(3) 3.5</td> <td></td>		S-37	72-74										(3) 3.5	
S-39 76-78 6 33 78 1.56x10° S-40 78-80 24.6 62 33 78 1.56x10° S-41 80-82 36.9 73 37 88 4.4x10° S-20 38-40 73 37 88 4.4x10° S-21 40-42 8 4.4x10° 8 S-23 44-46 8 4.4x10° 8 S-24 46-48 8 4.4x10° 8 S-25 48-50 8 4.4x10° 8 S-26 48-50 8 4.4x10° 8 S-26 48-50 8 4.4x10° 8 S-26 48-50 8 1.6x10° 8 S-28 54-56 8 8 1.6x10° 8 S-30 58-60 8 8 1.6x10° 8 S-31 60-62 3 3 3 8 8 S-33 66-68 <		S-38	74-76										(3) 2.8	
S-40 78-80 24.6 62 33 78 1.56x10-8 S-41 80-82 36.9 73 73 78 1.56x10-8 S-42 82-84 36.9 73 73 78 4.4x10-8 S-20 38-40 73 73 88 4.4x10-8 78 S-21 40-42 70 70 70 70 70 S-22 42-44 70 70 70 70 70 70 70 S-24 48-48 70		S-39	76-78										(3) 3.0	
S-41 80-82 73 73 37 88 4.4x10-8 S-20 38-38 36.9 73 37 88 4.4x10-8 S-20 38-40 8 4.4x10-8 8 S-21 40-42 8 4.4x10-8 8 S-23 44-46 8 4.4x10-8 8 S-24 46-48 8 4.4x10-8 8 S-25 48-50 8 4.4x10-8 8 S-26 50-52 8 1.6x10-8 8 S-26 50-52 8 1.6x10-8 8 S-27 52-54 8 1.6x10-8 8 S-28 56-58 8 1.6x10-8 8 S-29 56-68 3 8 1.6x10-8 8 S-30 56-68 3 80 8 1 S-31 66-68 24.3 69 8 1 1 S-34 66-68 3 1		S-40	78-80		24.6			62	33	78	1.56×10-8		(3) 4.0	
S-42 82-84 36.9 73 37 88 4.4x10-8 S-20 38-40 36.9 73 37 88 4.4x10-8 S-21 40-42 6 6 6 6 6 S-22 42-44 7 7 7 7 7 S-24 46-48 7 7 7 7 7 7 7 S-25 48-50 7 8 <t< td=""><td></td><td>S-41</td><td>80-82</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>(3) 4.5</td><td></td></t<>		S-41	80-82										(3) 4.5	
S-19 36-38 36-9 73 37 88 4.4x10** S-20 38-40 36-9 9 73 37 88 4.4x10** 9 S-21 40-42 9 9 9 9 9 9 S-22 42-44 9		S-42	82-84										(3) 4.5	
38-40 40-42 6-44 6-6-68 6-6-68 1.6x10-8 6-6-68 6-6-68 9 <td>B-23</td> <td>S-19</td> <td>36-38</td> <td></td> <td>36.9</td> <td></td> <td></td> <td>73</td> <td>37</td> <td>88</td> <td>4.4×10-8</td> <td></td> <td>(3) 3.8</td> <td></td>	B-23	S-19	36-38		36.9			73	37	88	4.4×10-8		(3) 3.8	
40-42 40-42 44-46 44-46 44-46 44-46 44-46 46-48 46-48 1.6x10 ⁻⁸ 1.6x10		S-20	38-40					2 6					(3) 4.3	
42-44 44-46 1.6x10-8 1.6x10-8 46-48 1.6x10-8 1.6x10-8 1.6x10-8 48-50 1.6x10-8 1.6x10-8 1.6x10-8 50-52 1.6x10-8 1.6x10-8 1.6x10-8 52-54 1.6x10-8 1.6x10-8 1.6x10-8 56-58 1.6x10-8 1.6x10-8 1.6x10-8 60-62 1.6x10-8 1.6x10-8 1.6x10-8 66-68 24.3		S-21	40-42										(3) 4.5	
44-46 1.6x10-8 1.6x10-8 46-48 1.6x10-8 1.6x10-8 48-50 1.6x10-8 1.6x10-8 50-52 1.6x10-8 1.6x10-8 52-54 1.6x10-8 1.6x10-8 56-58 1.6x10-8 1.6x10-8 56-68 27.7 62 32 80 60-62 1.6x10-8 1.6x10-8 1.6x10-8 66-68 24.3 59 31 76 3.8x10-8 66-68 24.3 24		S-22	42-44										(3) 4.5	
46-48 46-48 1.6x10-8 1.6x10-8 48-50 20-52 1.6x10-8 1.6x10-8 52-54 1.6x10-8 1.6x10-8 1.6x10-8 54-56 1.6x10-8 1.6x10-8 1.6x10-8 54-56 1.6x10-8 1.6x10-8 1.6x10-8 66-64 1.6x10-8 1.6x10-8 1.6x10-8 66-68 24.3 24.3 24.3 24.3 24.3		S-23	44-46										(3) 4.5	
48-50 48-50 60-52 <td< td=""><td></td><td>S-24</td><td>46-48</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>1.6x10-8</td><td></td><td>(3) 4.5</td><td></td></td<>		S-24	46-48								1.6x10-8		(3) 4.5	
50-52 60-52 62-54 62 32 80		S-25	48-50										(3) 3.0	
52-54 62-58 80 80 56-58 80 80 80 58-60 27.7 62 32 80 80 60-62 80-62 80		S-26	50-52										(3) 4.0	
54-56 65-58 80		S-27	52-54										(3) 4.5	
56-58 62-58 32 80		S-28	54-56										(3) 4.3	
58-60 27.7 62 32 80 80 60-62 3 80		S-29	56-58										(3) 4.5	
60-62 62-64 82-64 82-64 82-64 82-64 82-64 82-64 82-64 82-64 82-64 82-64 82-70 <td< td=""><td></td><td>S-30</td><td>58-60</td><td></td><td>27.7</td><td>2</td><td></td><td>9</td><td></td><td>0</td><td>0</td><td></td><td>(3) 4.5</td><td></td></td<>		S-30	58-60		27.7	2		9		0	0		(3) 4.5	
62-64 64-66 76 3.8x10 ⁻⁸ 64-66 31 76 3.8x10 ⁻⁸ 66-68 24.3 59 31 76 3.8x10 ⁻⁸		S-31	60-62										(3) 4.5	
66-68 24.3 59 31 76 3.8x10 ⁻⁸ 68-70		S-32	62-64										(3) 4.5	
66-68 24.3 59 31 76 3.8x10 ⁻⁸ 68-70		S-33	64-66										(3)4.5	
08-70		S-34	89-99		24.3	3		5			6 3.8×10 ⁻⁸		(3) 2.8	
		S-35	68-70										(3) 4.0	- 1

² Effective Angle of Internal Friction (degrees) 3 Unconfined Compressive Strength (Isf)

SUMMARY OF GEOTECHNICAL TEST City of Kingsyille

S-36 70-72 S-36 70-72 S-37 72-74 S-38 74-76 S-39 76-78 S-40 S-40 78-80 S-41 80-82 S-41 80-82 S-42 82-84 S-17 32-34 S-18 S-19 36-38 S-20 38-40 S-20 50-52 S-26 50-52 S-26 50-52 S-20 58-50 S-20 S-20 58-50 S-20 S-20 S-20 S-20 S-20 S-20 S-20 S-2	Boring No.		Depth	nscs	Water	Wet	Dry	Liquid	Plastic	#200	Perme	Permeability	
S-36 70-72 S-38 74-76 S-42 82-84 S-43 84-86 S-20 38-40 S-21 40-42 S-22 42-44 S-23 5-56 S-26 50-52 S-26 50-52 S-26 58-56 S-30 S-66 S-66 S-70 S-70 S-66 S-70 S-70 S-70 S-66 S-70 S-70 S-70 S-70 S-70 S-70 S-70 S-70	Ground El.	Number)	Content	Density	Density	Limit (%)	Index	Sieve	Vertical	Horizontal	Other Tests
S-36 70-72 Light Olive Green Clay (Aquiclude) Unit S-38 70-72 A-76	(IL INIOL)		(-6:)		(%)	(pci)	(pci)	(0/)	(%)	(%)	(cm/sec)	(cill/sec)	Kemarks
S-36 70-72 9 70-72 9 <t< td=""><td></td><td></td><td></td><td></td><td></td><td>ight Oliv</td><td>e Green</td><td>Clay (Aq</td><td></td><td>Unit</td><td></td><td></td><td></td></t<>						ight Oliv	e Green	Clay (Aq		Unit			
S-37 72-74 Percentage	B-23	S-36	70-72						-				(3) 3.3
S-38 74-76 9<		S-37	72-74										(3) 2.5
S-39 76-78 Permitted Permitt		S-38	74-76										(3) 4.3
S-40 78-80 125.8 105.3		S-39	76-78										
S-41 80-82 125.8 105.3 9 9 9 9 9 9 9 9 9 8 9 9 9 8 9		S-40	78-80			40							
S-42 82-84 125.8 105.3 9		S-41	80-82										
S-43 84-86 36.4 79 38 80 80 S-18 34-36 36.4 79 38 80 80 S-19 36-38 36.4 79 38 80 80 S-20 38-40 80.38 80 1.33x10-9 80 S-21 40-42 80.2 80 80 80 80 S-23 44-46 80		S-42	82-84			125.8	105.3						(3) 4.5
S-17 32-34 36.4 79 38 80 80 S-18 34-36 84-36 1.33x10-9 1.33x10-9 1.33x10-9 S-20 38-40 1.33x10-9 1.33x10-9 1.33x10-9 1.33x10-9 S-21 40-42 1.33x10-9 1.33x10-9 1.33x10-9 1.33x10-9 S-22 42-44 1.33x10-9 1.33x10-9 1.33x10-9 1.33x10-9 S-23 44-46 1.33x10-9 1.33x10-9 1.33x10-9 1.33x10-9 S-24 46-48 1.33x10-9 1.33x10-9 1.33x10-9 1.33x10-9 S-25 48-50 1.446 1.		S-43	84-86										(3) 4.5
34-36 1.33x10° 36-38 1.33x10° 38-40 1.33x10° 40-42 1.33x10° 42-44 1.33x10° 44-46 1.33x10° 46-48 1.33x10° 48-50 1.33x10° 50-52 27.7 52-54 114.5 86.2 1.33x10° 54-56 114.5 56-58 114.5 58-60 114.5	B-24	S-17	32-34		36.4			79	38	80			
36-38 1.33x10-9 38-40 1.33x10-9 40-42 1.33x10-9 42-44 1.33x10-9 46-48 1.33x10-9 48-50 1.33x10-9 50-52 27.7 50-54 114.5 56-56 86.2 56-58 114.5 58-60 114.5		S-18	34-36										(3) 4.3
38-40 40-42 64-46 64-46 64-46 64-48 68 3.28x10.9 68 3.28x10.9<		S-19	36-38								1.33×10-9		(3) 4.5
40-42 40-42 64-46 64-46 64-48 <td< td=""><td></td><td>S-20</td><td>38-40</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>(3) 4.5</td></td<>		S-20	38-40										(3) 4.5
42-44 44-46 64-48 64-48 64-48 64-48 68-48 68-52 <td< td=""><td></td><td>S-21</td><td>40-42</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>(3) 4.5</td></td<>		S-21	40-42										(3) 4.5
44-46 46-48 64-48 68 3.28x10-9 68 3.28x10-9 48-50 27.7 71 36 68 3.28x10-9 68 3.28x10-9 52-54 114.5 86.2 68 3.28x10-9 68 3.28x10-9 54-56 56-58 68 3.28x10-9 68 3.28x10-9 68 3.28x10-9 56-58 68 3.28x10-9 68 3.28x10-9 68 3.28x10-9		S-22	42-44										(3) 4.5
46-48 46-48 71 36 68 3.28x10-9 85.25 86.2		S-23	44-46										(3) 3.5
48-50 27.7 71 36 68 3.28x10-9 86.2		S-24	46-48										(3) 4.5
50-52 27.7 71 36 68 3.28x10-9 52-54 114.5 86.2 86.2 86.2 54-56 56-58 86.2 86.2 86.2 86.2 56-58 86.2		S-25	48-50										(3) 4.5
52-54 114.5 86.2 <t< td=""><td></td><td>S-26</td><td>50-52</td><td></td><td>27.7</td><td></td><td></td><td>71</td><td>36</td><td>89</td><td>3.28×10⁻⁹</td><td></td><td>(3) 4.5</td></t<>		S-26	50-52		27.7			71	36	89	3.28×10 ⁻⁹		(3) 4.5
54-56 56-58 58-60		S-27	52-54			114.5	86.2						(3) 4.5
56-58		S-28	54-56										(3) 4.5
09-89		S-29	56-58										(3) 2.3
		S-30	58-60										(3) 4.5

2 Effective Angle of Internal Friction (degrees) 3 Unconfined Compressive Strength (Isf)

BY STRATIGRAPHIC UNIT 235 B SUMMARY OF GEOTECHNICAL City of Kin

		٦																										
	Other Tests	Kemarks		(3) 4.3	(3) 1.8	(3) 4.5	(3) 4.5	(3) 3.5	(3) 3.0	(3) 4.5	(3) 4.5	(3) 4.5	(3) 4.5	(3) 4.5	(3) 4.5	(3) 4.5	(3) 4.5	(3) 4.5	(3) 4.5	(3) 4.5	(3) 4.5	(3) 4.5	(3) 4.5	(3) 4.5	(3) 4.5	(3) 4.5	(3) 4.5	(3) 4.15
ability	Horizontal	(CIII/SeC)																									5=0	
Permeability	Vertical	(cm/sec)						1.21×10-8		2.45×10 ⁻⁸			2- 20			2.3×10-8							6.18×10 ⁻⁸					3.31×10-8
#200	Sieve	(0/)	Unit				99			87						92							68					80.54
Plastic	Index (%)	(0/)	Clay (Aquiclude)				30			43						39							31					35.07
Liquid	Limit (%)	(0/)	Clay (Ac				20			77						77					v.		58					66.57
Dry	Density	(bcl)	re Green										104.3															97.5
Wet	Density (ncf)	(lbd)	Light Olive Green										139															124.78
Water	Content (%)		_				17.7			31.8						30.5							20.5					28.53
nscs			90																	4-15								
Depth	(ft bgs)	(-6)		60-62	62-64	64-66	89-99	68-70	70-72	52-54	54-56	56-58	58-60	60-62	62-64	64-66	89-99	68-70	70-72	72-74	74-76	76-78	78-80	80-82	82-84	84-86	86-88	
Sample	Number		A CONTRACTOR OF THE PERSON	S-31	S-32	S-33	S-34	S-35	S-36	S-27	S-28	S-29	S-30	S-31	S-32	S-33	S-34	S-35	S-36	S-37	S-38	S-39	S-40	S-41	S-42	S-43	S-44	
Boring No.	Ground El.	(IK INIOE)	Annual Contract City	B-24						B-25									9									Average:

98

1 Effective Cohesion (psf)

2 Effective Angle of Internal Friction (degrees)3 Unconfined Compressive Strength (tsf)

(elevation 60 NGVD) and proceeding up at a 4H:1V slope to elevation 119 feet NGVD, then along a 6 percent slope to a maximum peak elevation of 125 feet NGVD. After determining the maximum landfill height and side slopes, hundreds of trial failure surfaces were generated to verify the slope stability. The assumptions made for the slope stability analyses are as follows:

- 1) The potentiometric head will be one and one half feet below the elevation of the top of the protective soil cover above the sumps. (The Protective Soil cover above the sump is 42.5' MSL; GW level is 410' MSL)
- The landfill will slope approximately two percent along the base. The slope stability 2) analyses was performed assuming a flat bottom.
- A two-foot compacted cohesive soil liner (covered by synthetic geoclay liner) with 3) a cohesion intercept of 200 psf and a total density of 112 pcf will be placed along the excavation sideslopes and over the bottom of the landfill.
- A textured (double-sided) 60-mil HDPE geomembrane will be placed over the 4) compacted cohesive soil liner along the base and sideslopes of new landfill cells 2 through 7. An angle of internal friction of 20 degrees was assumed for the soil/HDPE geomembrane interface.
- The granular drainage blanket for the leachate collection system was conservatively 5) assumed to have a similar strength characteristics as the solid waste.
- Various resources were investigated to determine geotechnical design strength 6) values for the solid waste. A significant amount of research has been conducted since 1988 on the subject of slope stability modeling techniques for waste fills. Based on these resources, F.E.E., Inc. used an average total density of 32 pcf, a cohesion intercept of 1000 psf, and an angle of internal friction of 20 degrees for the solid waste.
- The final cover load was not included in the analyses since it's contribution to the 7) driving force will be negligible.
- The minimum allowable factor of safety will be 2.0 for static loading conditions. 8)
- Based on excavation depths, the relatively strong underlying in-situ soils, and the 9) low interface friction angle of the cohesive soil/smooth HDPE liner, the most critical failure will be a block-type failure along the compacted cohesive soil/smooth HDPE geomembrane interface located in the existing landfill area.
- The perimeter levee fill was assumed to have the same geotechnical properties as 10)

as the compacted cohesive soil liner.

8.3.1.2 Open Cut Excavation Slopes

Slope stability analyses were performed on temporary open cut excavations from crest of perimeter levee elevation 60 feet NGVD to average base grade elevation 40 feet NGVD at both 4H:1V and 3H:1V sideslopes. The 3H:1V was selected. The cross sections consist of a typical open cut excavation. A perimeter levee was included in the model. The excavation sideslopes were analyzed using short-term soil strength properties based on the sampling and testing of soils underlying the landfill area. A longterm strength analysis was not performed since the excavation will be backfilled with refuse prior to the development of long-term strength characteristics. Minimum factor of safety of 2.55 was calculated for circular-type failure surfaces, respectively. Both exceed the minimum design factor of safety requirement of 2.0 for static loading conditions. The open cut excavation slope stability calculations are presented in Appendix H.1.

8.3.2 Settlement Analysis

The settlement analysis was performed by Mr Ralph N. Lewis of Professional Services, Inc. (PSI). His calculations show that conservatively the final landfill cover will settle 3.0 inches at the center and 1.5 inches at the edge of the landfill. The settlement calculations are shown in Appendix H.2

8.3.3 Perforated Pipe

The maximum anticipated deflection of the leachate collection system pipe due to the loads imposed by the waste overburden was analyzed using the Driscopipe Design Manual and Spangler's modified formula. The sections where pipes are under maximum loading conditions were analyzed for the six-inch diameter, SDR 17 HDPE or Schedule 80 PVC perforated collection lines that are located in trenches along the floor of the landfill. The results of the calculations indicated an estimated maximum deflection of approximately 1.0 percent (0.064 inches) for the six-inch diameter collection lines under maximum loading conditions. These deflections are within the maximum allowable cross-sectional deflection of 4.2 percent for HDPE, as recommended by Driscopipe and 5.0 percent for PVC, as recommended by American Water Works Association. The perforated pipe deflection calculations are presented in Appendix H.3.

8.3.4 Liner Puncture Resistance

The puncture resistance of the protective geotextile fabric wrapped around the gravel in the leachate collection system was analyzed. The most critical case for puncture will occur when the drainage sand is placed over the geotextile. During placement of the

8.4.2 Composite Liner System

In accordance with the requirements of the 30TAC §330.200, the liner system to be installed in cells 2 through 7 will consist of a minimum one -foot thick compacted soil liner with a hydraulic conductivity of 1x10⁻⁵ cm/sec or less, overlain by a GeoClay synthetic liner, overlain by a 60-mil HDPE liner. This composite liner system will be installed over the entire floor and sideslope areas of the cells. A plan view of the completed liner system (base grades) is shown on Figures 15.2 through 15. 7 of Attachment 15. The composite liner system (compacted cohesive soil and flexible membrane liner) shall be constructed using the guidelines of the Soils and Liner Quality Control Plan presented as Attachment 10 of the Site Development Plan (Part III).

8.4.3 Leachate Collection System

The design of the leachate collection system (LSC) for new cells within the landfill includes two-foot deep leachate collection trenches designed to collect leachate from a granular drainage layer on each side of the cell. The floor area on each side of the leachate collection pipe is sloped toward the pipe at a minimum grade of two percent. The leachate collection trenches will contain perforated, six-inch diameter SDR-17 HDPE or Schedule 80 PVC pipe surrounded by gravel. Filter geotextile will completely surround the gravel to prevent clogging of the leachate collection pipes.

A cross section through the collection trench and LCS pipe detail is shown on Figures 15.9 and 15.10 of Attachment 15. The gravel-filled collection trench is sloped on a minimum one half percent slope toward a LCS sump, located at the outer edge of the cells. A one-foot thick granular drainage layer, with a minimum permeability of 6x10⁻³ cm/sec, overlies the geomembrane liner and LCS trenches. A one-foot thick protective cover layer, with a minimum permeability of 1x10⁻⁴ cm/sec, will overlie the granular drainage blanket to provide protection for the LCS. Two feet of protective cover will overlie the geocomposite drainage layer if utilized in place of the granular drainage layer (see Figure 15.11).

8.4.4 Landfill Closure System

The final cover design and placement will be in accordance with the final closure plan requirements. The thickness and design of the final cover are given in Attachment 12. This design is based upon the design of a combination synthetic Geoclay and 60 mil HDPE Flexible Membrane bottom liner. The final cover system is comprised of, from the bottom up, 18 inches of compacted \cdot earthen material with a hydraulic conductivity of 1×10^{-5} cm/sec or less, a flexible membrane liner, a geonet/geotextile drainage layer, and 18 inches of protective soil cover, of which the uppermost 6 inches will be soil capable of supporting native vegetation. Six inches of permeable soil (hydraulic conductivity \geq

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of 72 to 88 feet below ground surface (BGS). One of these borings (No. 24) was converted into a monitor well and plugged back to the top of the aquiclude clay.

Ten (10) of the seventeen (17) monitor wells which exist at the time of this permit application are completed in or within one foot of the Light Olive Green Clay aquiclude. These ten wells include all of the wells drilled for this permit application (MW-12 through MW-18 and MW-24). Monitor well #1 is also within one foot of the aquiclude. Seven wells terminate within at least eight feet above the aquiclude. Monitor well #6 will eventually have to be moved about 45 feet south of its current location to remove it from CR 2040 right-of-way. Any wells deepened will be terminated in the aquiclude clay. The rest of the wells should be maintained but not plugged and abandoned. They will be useful for water level information. Monitor wells# 10 or #11 could be deepened by the time sector 5 becomes active as they can serve as exterior well to the active landfill. If #10 is chosen to be deepened, it should be moved south about 20 feet and out of the active area when sector 6 is activated.

As discussed in section 6.1, all of the fluvial-deltaic sand bodies above the light olive green clay aquiclude are in communication with each other. These units essentially act as one body from a hydrogeologic standpoint. The caliche bearing channel running northeast to southwest is the primary avenue for pollutant migration as indicated by the rather steep gradients in those two directions. However, the groundwater flows away from the landfill in all directions except to the northwest, currently. There were some earlier dates in which the ground water flowed toward the northwest also. Thus, the point of compliance must be around the entire landfill site. The ground water flow to the northeast (MW #14) is strongly influenced by the clay environment surrounding that well and possibly by the clay dune (III) on top of the aquiclude clay at the northwest corner of the site.

Since this is an unconfined aquifer, there is direct recharge from the surface by percolation through the soil. Ponding in the area will create hydrostatic head to accelerate this recharge process. As discussed in section 6.3.2, there are a significant number of ponds in the area of the landfill. There are fourteen potential ponds in the area of the landfill. Nine of these are permanent ponds in which the ground water intersects the surface. One of these is in the northwest quadrant of the landfill. The other eight are off site. In addition, there are five depressions on the landfill site which will hold water after extensive rainfall, but which do not intersect with the ground water table. The plan for this permit is to properly fill and compact the pond on site which intersects the ground water table, and to obtain pumps to rapidly remove water from the temporary ponds outside of the waste area to surface drainage to minimize infiltration. This is shown in Attachment 15. Both of these will serve to drastically reduce the water level in this uppermost unconfined aquifer.

Background values have been established for this MSWLF site as from the six quarters of background data from MW-1, 3, 4, 10, and 11 for permit

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235-A. That data has been submitted. Present data suggest a groundwater flow direction away from the landfill site in all directions except to the northwest. Therefore, the points of compliance for the water table aquifer will be located on all sides of the MSWLF site as indicated above. It may be necessary periodically to alter the use of northwest perimeter monitor wells depending on the direction of ground water flow. The drainage ditch on FM 2619 next to MW #15 should be deepened and lined in order to minimize the infiltration on of water removed from the landfill site and pumped into surface drainage.

At the present time (235-A), this is a single unit facility. The proposed new landfill (235-B) is comprised of several sectors which will be activated in various stages of operation (i.e. closure, active, and proposed expansion).

The construction and operation of the new landfill should have a minimal impact on ground water flow with the possible exception of the extreme northwest corner. This may also be prevented by removing ponded water in depressions to surface water and by lining the ditch next to MW# 15 as described above.

The current monitor well network for Cell 1 includes existing monitor wells MW-1, 3, 4, 10, & 11. New monitor wells will be activated and the new monitor well network certified as each individual cell is activated. These certifications will be submitted to the Executive Director as required in TAC regulations. Monitor Well Site Survey data is shown in Appendix M.

The Monitor Wells have been completed as specified in TAC 330.242 specifications. The certification for these new monitor wells is given in Appendix M. Monitor wells will be constructed following ASTM guidelines. A schematic for proposed monitor wells in included as Appendix I.

As previously discussed, the Light Olive Green Clay layer in this report is the aquiclude beneath the uppermost aquifer at the site. It is, therefore, proposed that the groundwater monitoring for City of Kingsville MSWLF monitor the local uppermost aquifer as bounded by the Light Olive Green Clay. Proposed groundwater monitoring well locations, which comprise a network designed to monitor groundwater quality around the permitted landfill and expansion area, are shown on Figure 5.2 in Attachment 5. Point of compliance wells are also shown on this figure. Recommended elevations for well screens along with approximate horizontal survey coordinates at each proposed location are summarized in Table 5.3 and Table

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5.6 in Attachment 5.

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As required by §330.231(e)(3), the Executive Director will be notified in writing of any changes in the direction and rate of groundwater flow that may require the installation of additional monitor wells. Any additional monitor wells installed will be addressed in a modification to the Site Development Plan.

The site groundwater monitoring network will be sampled for constituents listed in the Groundwater Sampling and Analysis Plan (GWSAP), presented as Attachment 11 of Part III. The development of background values for each constituent, and the sampling, analysis and statistical comparison procedures to be utilized in evaluation of groundwater monitoring data, are also addressed in the GWSAP.

9.3 Landfill Design

The information presented within this report was used in developing a geotechnical characterization of the site for utilization in the landfill design process. The characterization was used in the foundation analysis of the landfill design as related to slope stability, settlement, and constructability. The information presented in Section 7.0 "Geotechnical Characterization" and Appendix H "Engineering Design Calculation and Analysis" is provided in accordance with 30 TAC §330.203(d), to the executive director as demonstration of the foundation evaluation for the design presented within the Permit Amendment Application.

Ground Water Monitor Well #1 Measured Total Depth is 41.67 ft from top of PVC All Measures from Top of PVC Well Pipe Elevation** Top PVC 61.867 Feet, MSL

	277.1		
<u>Date</u>	Depth to Water feet	Elevation of water feet,MSL	Comments
03-29-91	35.6	26.27	
07-30-91	34.5	27.37	
08-08-91	34.69	27.18	
04-14-92	36.88	24.99	
08-11-92	30.02	31.85	
09-28-92	30.6	31.27	
04-05-93	28.61	33.26	
03-14-94	31.4	30.47	
05-10-95	29.02	32.85	
07-11-96	29	32.87	
12-23-96	29.85	32.02	74
03-20-97	30.53	31.34	
06-25-97	27.79	34.08	
08-04-97	27.67	34.2	
08-18-97	22.94	38.93	
09-02-97	35.64	26.23	
11.4.1.4.1.1.4.1.1.1.1.1.1.1.1.1.1.1.1.	28.28	33.59	
09-15 - 97	28.39	33.48	
10-16-97	28.57	33.3	
10-28-97	27.5	34.37	
11-10-97	27.1	34.77	
11-24-97	26.69	35.17	
12-08-97	26.36	35.5	
12-22-97	26.19	35.67	
01-05-98	26.05	35.81	
01-20-98	25.88	35.98 35.94	
02-02-98 02-18-98	25.92 25.67	36.19	
05-18-98	25.21	36.65	
06-16-98	25.54	36.32	

^{*} City of Kingsville was responsible for the measurements during this period. (used plopper)

^{**} All top of PVC casing elevation have been corrected to McCumber elevation survey of 07-29-97.

Ground Water Monitor Well #3 Measured Total Depth is 37.75 ft from top of PVC All Measures from Top of PVC Well Pipe Elevation** Top PVC 59.173 Feet, MSL

<u>Date</u>	Depth to Water feet	Elevation of water feet	Comments
03-29-91	25.59	33.58	
07-30-91	26.69	32.48	
08-08-91	26.86	32.31	
04-14-92	26.75	32.42	
08-11-92	25.54	33.63	
09-28-92	25.7	33.47	
04-05-93	27.02	32.15	
03-14-94	26	33.17	
05-10-95	22.98	36.19	
07-11-96	22	37.17	
12-23-96	26.03	33.14	
03-20-97	27.08	32.09	
06-25-97	22.11	37.06	
08-04-97	22.83	36.34	
08-18-97	23.26	35.91	
09-02-97	23.63	35.54	
09-15-97	23.79	35.38	
09-29-97	23.9	35.27	
10-16-97	22.31	36.86	
10-28-97	21.89	37.28	
11-10-97	21.2	37.97	
11-24-97	20.6	38.57	
12-08-97	20.36	38.81	
12-22-97	20.48	38.69	
01-05-98	20.65	38.52	
01-20-98	20.73	. 38.44	
02-02-98	21	38.17	
02-22-98	20.43	38.74	
05-18-98	21.04	38.13	
06-16-98	21.58	37.59	

^{*}The City of Kingsville (COK) was responsible for depth measurements during this period. (used plopper)

^{**} All top of PVC casing elevations have been corrected to McCumber elevation survey of 07-29-97.

Ground Water Monitor Well #4 Measured Total Depth is 40.32 ft from top of PVC All Measures from Top of PVC Well Pipe Elevation** Top PVC 60.125 Feet, MSL

			86
<u>Date</u>	Depth to Water feet	Elevation of water feet***	Comments
03-29-91	23.98	35.15	
07-30-91	23.77	35.36	
08-08-91	24.56	34.57	
04-14-92	27.39	31.74	
08-11-92	26.79	32.34	
09-28-92	30.4	28.73	
04-05-93	30.11	29.02	
03-14-94	28	31.13	
05-10-95	25.02	34.11	
07-11-96	26.13	33	
12-23-96	26.32	32.81	
03-20-97	27.33	31.8	
06-25-97	22.28	36.85	
08-04-97	24.24	35.89	
08-18-97	24.76	35.37	
09-02-97	25.04	35.09	
09-15-97	23.84	36.29	
09-29-97	24.6	35.53	
10-16-97	23.16	36.97	
10-28-97	21.81	38.32	
11-10-97	22.19	37.94	
11-24-97	20.65	39.47	
12-08-97	20.52	39.60	
12-22-97	20.73	39.39	
01-05-98	20.99 -	39.13	
01-20-98	21.24	38.88	
02-02-98	21.52	38.60	
02-18-98	20.72	39.40	
05-18-98	21.96	38.16	
06-16-98	22.69	37.43	

^{*}The City of Kingsville (COK) was responsible for depth measurements during this period. (used plopper)

^{**} All top of PVC casing elevations have been corrected to McCumber elevation survey of 07-29-97.

^{***} One foot has been subtracted from the calculated water depth for MW #4, due to the addition of a 12.00" extension to the top of the well casing between the time of measurement of depth to water and the time of the McCumber elevation survey.

Ground Water Monitor Well #6 Measured Total Depth is 39.15 ft from top of PVC All Measures from Top of PVC Well Pipe Elevation** Top PVC 56.604 Feet, MSL

<u>Date</u>	Depth to Water feet	Elevation of water feet	Comments
00.00.01	21.35	35.25	
03-29-91			
07-30-91	22.02	34.58	
08-08-91	21.44	35.16	
04-14-92	21.92	34.68	
08-11-92	25.25	31.35	
09-28-92	27	29.6	
04-05-93	27.11	29.49	
03-14-94	25.25	31.35	
05-10-95	- Not	measured	
07-11-96	26.29	30.31	
12-23-96	28.19	28.41	
03-20-97	28.06	28.54	
06-25-97	Not	measured	
08-04-97	23.31	33.29	
08-18-97	24.01	32.59	
09-02-97	24.53	32.07	
09-15-97	24.69	31.91	
09-29-97	24.48	32.12	
10-16-97	17.74	38.86	
10-28-97	17.59	39.01	
11-10-97	18.3	38.3	
11-24-97	18.23	38.37	
12-08-97	18.35	38.25	
12-22-97	19.11	37.49	
01-05-98	19.42	37.18	
01-20-98	19.55	37.05	
02-02-98	19.11	37.49	
02-18-98	18.64	37.96	
05-18-98	19.30	37.30	
06-16-98	20.38	36.22	

^{*}The City of Kingsville (COK) was responsible for depth measurements during this period. (used plopper)

^{**} All top of PVC casing elevations have been corrected to McCumber elevation survey of 07-29-97.

Ground Water Monitor Well #8 Measured Total Depth is 43.65 ft from top of PVC All Measures from Top of PVC Well Pipe Elevation** Top PVC 61.178 Feet, MSL

<u>Date</u>	<u>Depth</u> to Water feet	Elevation of water feet	Comments
03-29-91	Not	Drill'd	
07-30-91	27.67	33.51	
08-08-91	27.5	33.68	
04-14-92	26.77	34.41	
08-11-92	27.52	33.66	
09-28-92	28.3	32.88	
04-05-93	29.17	32.01	
03-14-94	28.1	33.08	
05-14-94	28.46	32.72	
Electronic management	29.4	31.78	
07-11-96	30.38	30.8	
12-23-96	30.22	30.96	161.11
03-20-97	E-91	Measured	
06-25-97	Not	33.81	
08-04-97	27.37	25.82	
08-18-97	35.36	25.42	
09-02-97	35.76	32.76	
09-15-97	28.42	33.04	
09-29-97	28.14	39.11	
10-16-97	22.07 22.74	38.44	
10-28-97	22.74	38.45	
11-10-97	23.06	38.11	
11-24-97	23.83	37.34	
12-08-97	24.38	36.79	
12-22-97	24.72	36.45	
01-05-98	24.72	36.26	
01-20-98 02-02-98	24.72	36.45	
	23.14	38.03	8
02-18-98 05-18-98	25.19	35.98	
06-16-98	25.89	35.28	

^{*}The City of Kingsville (COK) was responsible for depth measurements during this period. (used plopper)

^{**} All top of PVC casing elevations have been corrected to McCumber elevation survey of 07-29-97.

Ground Water Monitor Well #9R Measured Total Depth is 18.29 ft from top of PVC All Measures from Top of PVC Well Pipe Elevation** Top PVC 44.849 Feet, MSL

				1.7
	<u>Date</u> .	Depth to Water feet	Elevation of water feet	Comments
	03-29-91	Not	Drill'd	
	07-30-91	Not	Drill'd	
	08-08-91	Not	Drill'd	
	04-14-92	Not	Drill'd	
	08-11-92	Not	Drill'd	
	09-28-92	Not	Drill'd	
	04-05-93	Not	Drill'd	
	03-14-94	Not	Drill'd	
		0.0000000000000000000000000000000000000	Drill'd	
	05-10-95	Not	32.28	
	07-11-96	12.57		
	12-23-96	14.02	30.83	
	03-20-97	13.76	31.09	
	06-25-97	Not	Measured	
	08-04-97	10.49	34.36	
	08-18-97	10.56	34.29	
	09-02-97	10.45	34.4	
	09-15-97	10.43	34.42	
	09-29-97	9.85	35	
	10-16-97	9.85	35	
	10-28-97	9.85	35	
	11-10-97	9.85	35	
	11-24-97	6.10	38.74	
	12-08-97	6.35	38.49	
	12-22-97	6.60	38.24	
	01-05-98	6.93	. 37.91	
	01-20-98	7.35	37.49	
	02-02-98	6.24	38.60	
	02-18-98 05-18-98	6.23 7.93	38.61 36.91	
	06-16-98	8.65	36.19	
	50 10 00	0.00	000	

^{**} All top of PVC casing elevations have been corrected to McCumber elevation survey of 07-29-97.

Ground Water Monitor Well #10 Measured Total Depth is 31.48 ft from top of PVC All Measures from Top of PVC Well Pipe Elevation*** Top PVC 52.684 Feet, MSL

	<u>Date</u>	Depth to Water feet	Elevation of water feet	Comments
	03-29-91	Not	Drill'd	
	07-30-91	Not	Drill'd	
	08-08-91	Not	Drill'd	*
	04-14-92	18.49	34.19	9
	08-11-92	16.59	36.09	
	09-28-92	18.9	33.78	
	04-05-93	17.76	34.92	
*	03-14-94	17.5	35.18	
*	05-10-95	19.02	33.66	
le	07-11-96	19.36	33.32	
	12-23-96	20.91	- 31.77	
	03-20-97	21.33	31.35	
	06-25-97	17.35	35.33	
	08-04-97	18.16	34.52	
	08-18-97	18.16	34.52	
	09-02-97	18.31	34.37	
	09-15-97	18.32	34.36	
	09-29-97	18.26	34.42	
	10-16-97	16.56	36.12	
	10-28-97	15.58	37.1	
	11-10-97	15.35	37.33	
	11-24-97	15.01	37.67	
	12-08-97	15.06	37.62	
	12-22-97	15.19	37.49	
	01-05-98	15.24	37.44	
*	01-20-98	15.25	37.43	
	02-02-98	15.23	37.45	
	02-18-98	14.70	37.98	
	05-18-98 06-16-98	15.18 15.58	37.50 37.10	
	00-10-30	10.00	37.10	

^{*}The City of Kingsville (COK) was responsible for depth measurements during this period. (used plopper)

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^{**} Due to surface water infiltration, a riser was installed and a taller casing protector was added. Three (3) foot was added to the "Top of PVC" datum point.

^{***} All top of PVC casings have been corrected to McCumber elevation survey of 07-29-97.

Ground Water Monitor Well #11 Measured Total Depth is 35.21 ft from top of PVC All Measures from Top of PVC Well Pipe Elevation** Top PVC 62.401 Feet, MSL

			100
<u>Date</u>	Depth to Water feet	Elevation of water feet	Comments
	27	77 Tag 77	
03-29-91	Not	Drill'd	
07-30-91	Not	Drill'd	
08-08-91	Not	Drill'd	
04-14-92	Not	Drill'd	
08-11-92	Not	Drill'd	
09-28-92	Not	Drill'd	
04-05-93	Not	Drill'd	
03-14-94	Not	Drill'd	
05-10-95	Not	Drill'd	
07-11-96	28.77	33.63	
12-23-96	30.2	32.2	
03-20-97	30.69	31.71	
	26.03	36.37	
06-25-97	-	35.3	
08-04-97	27.1	35.09	
08-18-97	27.31	34.95	
09-02-97	27.45 27.35	35.05	
09-15-97	27.35	35.4	
09-29-97	23.76	38.64	
10-16-97	22.25	40.15	
10-18-97 11-10-97	21.92	40.48	
11-10-97	21.72	40.68	
12-08-97	22.23	40.08	
12-08-97	22.69	39.71	
01-05-98	22.99	00.44	
01-05-98	23.22	39.41	
02-02-98	23.02	39.38	
02-02-98	22.22	40.18	100
05-18-98	24.02	38.38	
06-16-98	24.90	37.50	

^{**} All top of PVC casing elevations have been corrected to McCumber elevation survey of 07-29-97.

Ground Water Monitor Well #12 Elevation** Top PVC 54.879 Feet, MSL

<u>Date</u>	Depth to Water feet	Elevation of water feet	Comments
03-29-91	Not	Drill'd	
07-30-91	Not	Drill'd	
08-08-91	Not	Drill'd	
04-14-92	Not	Drill'd	
08-11-92	Not	Drill'd	
09-28-92	Not	Drill'd	
04-05-93	Not	Drill'd	
03-14-94	Not	Drill'd	
05-10-95	Not	Drill'd	
07-11-96	Not	Drill'd	
12-23-96	Not	Drill'd	
03-20-97	Not	Drill'd	
06-25-97	Not	Drill'd	
08-04-97	20.97	33.91	
08-18-97	21.42	33.46	
09-02-97	21.82	33.06	
09-15-97	22.01	32.87	
09-29-97	22.09	32.79	
10-16-97	19.58	35.3	
10-28-97	19.61	35.27	
11-10-97	19.34	35.54	
11-24-97	18.65	36.22	
12-08-97	18.51	36.36	
12-22-97	18.54	36.33	
01-05-98	18.51	36.36	
01-20-98	18.49	36.38	
02-02-98	18.42	36.45	
02-18-98	17.81	37.06	
05-18-98	18.09	36.78	
06-16-98	18.82	36.05	

^{**} All top of PVC casing elevations have been corrected to McCumber elevation survey of 07-29-97.

Ground Water Monitor Well #13 Elevation** Top PVC 62.096 Feet, MSL

<u>Date</u>	Depth to Water feet	Elevation of water feet	Comments
03-29-91	Not	Drill'd	
07-30-91	Not	Drill'd	
08-08-91	Not	Drill'd	
04-14-92	Not	Drill'd	
08-11-92	Not	Drill'd	
09-28-92	Not	Drill'd	
04-05-93	Not	Drill'd	
03-14-94	Not	Drill'd	
05-10-95	Not	Drill'd	
07-11-96	Not	Drill'd	
12-23-96	Not	Drill'd	
03-20-97	Not	Drill'd	
06-25-97	Not	Drill'd	
08-04-97	28.86	33.24	
08-18-97	29.15	32.95	
09-02-97	29.16	32.94	
09-15-97	29.33	32.77	
09-29-97	29.26	32.84	
10-16-97	28.53	33.57	
10-28-98	27.55	34.55	
11-10-97	27.12	34.98	
11-24-97	26.68	35.41	
12-08-97	26.49	35.60	
12-22-97	26.61	35.48	
01-05-98	26.71	35.38	
01-20-98	26.81	35.28	
02-02-98	27.17	34.92	
02-18-98	26.62	35.47	
05-18-98	26.62	35.47	
06-16-98	27.10	34.99	

^{**} All top of PVC casing elevations have been corrected to McCumber elevation survey of 07-29-97.

Ground Water Monitor Well #14 Elevation** Top PVC 52.677 Feet, MSL

<u>Date</u>	Depth to Water	Elevation of water	Comments
	<u>feet</u>	<u>feet</u>	
03-29-91	Not	Drill'd	
07-30-91	Not	Drill'd	
08-08-91	Not	Drill'd	
04-14-92	Not	Drill'd	
08-11-92	Not	Drill'd	
09-28-92	Not	Drill'd	
04-05-93	Not	Drill'd	
03-14-94	Not	Drill'd	
05-10-95	Not	Drill'd	
07-11-96	Not	Drill'd	
12-23-96	Not	Drill'd	
03-20-97	Not	Drill'd	
06-25-97	Not	Drill'd	
08-04-97	25.65	27.03	
08-18-97	25.88	26.8	
09-02-97	26.05	26.63	
09-15-97	25.95	26.73	
09-29-97	25.77	26.91	
10-16-97	25.46	27.22	
10-28-97	25.08	27.6	
11-10-97	24.66	28.02	
11-24-97	24.25	28.42	
12-08-97	23.89	28.78	
12-22-97	23.64	29.03	
01-05-98	23.63	29.04	
01-20-98	23.37	29.30	
02-02-98	23.51	29.16	
02-18-98	23.10	29.57	
05-18-98	22.52	30.15	¥
06-16-98	22.67	30.00	

^{**} All top of PVC casing elevations have been corrected to McCumber elevation survey of 07-29-97.

Ground Water Monitor Well #15 Elevation** Top PVC 51.624 Feet, MSL

<u>Date</u>	Depth to Water feet	Elevation of water feet	Comments
03-29-91	Not	Drill'd	
07-30-91	Not	Drill'd	
08-08-91	Not	Drill'd	
04-14-92	Not	Drill'd	
08-11-92	Not	Drill'd	
09-28-92	Not	Drill'd	
04-05-93	Not	Drill'd	
03-14-94	Not	Drill'd	
05-10-95	Not	Drill'd	
07-11-96	Not	Drill'd	
12-23-96	Not	Drill'd	
	Not	Drill'd	
03-20-97			
06-25-97	Not	Drill'd	
08-04-97	17.47	34.15	
08-18-97	18.17	33.45	
09-02-97	18.47	33.15	
09-15-97	18.68	32.94	
09-29-97	18.65	32.97	
10-16-97	10.19	41.43	
10-28-97	10.16	41.46	
11-10-97	8.14	43.48	
11-24-97	8.19	43.43	
12-08-97	7.62	44.00	
12-22-97	9.05	42.57	
01-05-98	9.89	41.73	
01-20-98	10.54	41.08	
02-02-98	9.54	42.08	
02-18-98	8.91	42.91	
05-18-98	11.98	39.64	
06-16-98	13.16	38.46	

^{**} All top of PVC casing elevations have been corrected to McCumber elevation survey of 07-29-97.

Ground Water Monitor Well #16
Elevation** Top PVC 58.839 Feet, MSL

			0 4-
<u>Date</u>	<u>Depth</u>	Elevation	Comments
	to Water	of water	95
	<u>feet</u>	<u>feet</u>	
03-29-91	Not	Drill'd	
07-30-91	Not	Drill'd	
08-08-91	Not	Drill'd	
04-14-92	Not	Drill'd	
08-11-92	Not	Drill'd	
09-28-92	Not	Drill'd	
04-05-93	Not	Drill'd	
03-14-94	Not	Drill'd	
05-14-94	Not	Drill'd	
	Not	Drill'd	
07-11-96	1 0.07(67)(57)	Drill'd	
12-23-96	Not	17000 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	
03-20-97	Not	Drill'd	
06-25-97	Not	Drill'd	
08-04-97	24.21	34.63	
08-18-97	24.63	34.21	
09-02-97	24.94	33.9	
09-15-97	24.95	33.89	
09-29-97	24.81	34.03	
10-16-97	23.32	35.52	
10-28-97	22.75	36.09	
11-10-97	22.46	36.38	
11-24-97	21.94	36.89	
12-08-97	21.70	37.13	
12-22-97	21.71	37.12	
01-05-98	21.66	37.17	
01-20-98	21.67	37.16	
02-02-98	21.74	37.09	
02-18-98	21.28	37.55	<u></u> 85
05-18-98	21.62	37.21	
06-16-98	22.27	36.56	ita Mac

^{**} All top of PVC casing elevations have been corrected to McCumber elevation survey of 07-29-97.

Ground Water Monitor Well #17 Elevation** Top PVC 43.868 Feet, MSL

<u>Date</u>	Depth to Water feet	Elevation of water feet	Comments
03-29-91	Not	Drill'd	
07-30-91	Not	Drill'd	
08-08-91	Not	Drill'd	
04-14-92	Not	Drill'd	
08-11-92	Not	Drill'd	
	Not	Drill'd	
09-28-92	Not	Drill'd	
04-05-93		Drill'd	
03-14-94	Not		
05-10-95	Not	Drill'd	
07-11-96	Not	Drill'd	
12-23-96	Not	Drill'd	
03-20-97	Not	Drill'd	
06-25-97	Not	Drill'd	
08-04-97	9.33	34.54	
08-18-97	9.69	34.18	
09-02-97	9.92	33.95	
09-15-97	9.68	34.19	
09-29-97	8.99	34.88	
10-16-97	4.28	39.59	0.0
10-28-97	4.44	39.43	
11-10-97	3.64	40.23	
11-24-97	4.01	39.85	
12-08-97	4.45	39.41	
12-22-97	4.91	38.95	
01-05-98	5.58	38.28	
01-20-98	6.13	37.73	
02-02-98	3.82	40.04	
02-18-98	4.37	39.49	<u></u>
05-18-98	6.40	37.46	
06-16-98	7.40	36.46	

^{**} All top of PVC casing elevations have been corrected to McCumber elevation survey of 07-29-97.

Ground Water Monitor Well #18 Elevation** Top PVC 52.438 Feet, MSL

<u>Date</u>	Depth to Water feet	Elevation of water feet	Comments
03-29-91	Not	Drill'd	
07-30-91	Not	Drill'd	
08-08-91	Not	Drill'd	
04-14-92	Not	Drill'd	
08-11-92	Not	Drill'd	
09-28-92	Not	Drill'd	
04-05-93	Not	Drill'd	
03-14-94	Not	Drill'd	
	Not	Drill'd	
05-10-95	Not	- 1.00	
07-11-96	20000000000	Drill'd	
12-23-96	Not	Drill'd	
03-20-97	Not	Drill'd	
06-25-97	Not	Drill'd	
08-04-97	18.61	33.83	
08-18-97	18.47	33.97	
09-02-97	18.92	33.52	
09-15-97	18.78	33.66	
09-29-97	18.71	33.73	
10-16-97	16.65	35.79	
10-28-97	15.8	36.64	
11-10-97	15.14	37.3	
11-24-97	14.62	37.81	
12-08-97	14.25	38.18	
12-22-97	14.48	37.95	
01-05-98	14.67	37.76	
01-20-98	14.88	37.55	
02-02-98	15.16	37.27	
02-18-98	14.23	38.20	
05-18-98	15.09	37.34	
06-16-98	15.92	36.51	

^{**} All top of PVC casing elevations have been corrected to McCumber elevation survey of 07-29-97.

THE CITY OF KINGSVILLE LANDFILL TCEQ PERMIT MSW 235C

PERMIT AMENDMENT APPLICATION Volume 3 of 6



CITY OF KINGSVILLE, KLEBERG COUNTY, TEXAS

September 2018

Revision 1 – November 2018

Revision 2 – February 2019

Revision 3 – April 2019

Prepared by



TBPE Firm No. F-417



TBPE F-417

HANSON PROJECT NO. 16L0438-0003

ATTENTION OWNER: Confidentiality Privilege Notice on on reverse side of Well Owner's copy (pink)		State WELL				Texas We	ester Well Drille MC P.O. Box Austin, TX 7 512-239	177 x 13087 78711-3087	/ Cou
1) OWNER 114 OF KILLS (No. 1) ADDRESS OF WELL. County Kirs Shill									
3) TYPE OF WORK (Check): New Well Deepening Reconditioning Plugging	4) PROPOSED USE	(Check):	Monitor	D Pub	Environmental Soil Borin blic Supply De-water FNRCC? Yes D	ng Don	mestic 5	5) MW-1 (58-1	12
Diameter of Hole Diameter of Hole Dia. (in.) From (ft.) To (ft.) Surface Of Completed 7-7 1997		0	Air R	ING METHOD (Check): Rotary	Jetted	d -			
From (ft.) To (ft.) Description and color of formation material		8) (Boreho Und If Gravi	ole Completion (Check): derreamed	Packed from 35	Hole G	Straight Wall 3 51 10 3 5-1	0	
			CASING, BLANK PIPE, AND WELL SCREEN I			SCREEN DA			
			Dia. (in.)	New or Used	Steel, Plastic, etc. Perf., Slotted, etc. Screen Mfg., if comm	nercial	Settin	ng (ft.)	000
			4	N	100 SCHARA 121- LOC 120 RISSOR	(150	72,5	
(Use reverse side of Well Ow	wner's copy, if necessary)			Method Cement Distance	tused	SZ J	Lt. No. of sar	acks used	
☐ Turbine ☐ Jet ☐ Submers ☐ Other Depth to pump bowls, cylinder, jet, etc.,	Sible Cylinder		10) 5	SURFA Spec	ACE COMPLETION acified Surface Slab Install	lled [Rule 33			
14) WELL TESTS: V/A Type test: Pump Bailer Yield: gpm with				Pitte Appr	ess Adapter Used [Rule proved Alternative Proced	338.44(3)(b)]	1		
15) WATER QUALITY: Did you knowingly penetrate any strata constituents?			-		evelft. bek	gpm.	Date_		th
Type of water?	PORT OF UNDESIRABLE Depth of strata Yes No	WATER'	_		NITE PELLE		<i>i-</i> ·		
	thru 15 will result in the log		ed for com	mpletion		,	of my knowledg		
7.550-	rpe or print)				5 (421577		12		-

ATTENTION OWNER: Confidentiality Privilege Notice on on reverse side of Well Owner's copy (pink)		State of WELL			Т	Texas Wei	P.O. Box Austin, TX 7 512-231	x 13087 78711-3087	Coun	
1) OWNER 1-1 0= KILL (No. 2) ADDRESS OF WELL: County 1 1 2 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	KINGSVILLE	122.001	16	KI	GSVICIA 7					
3) TYPE OF WORK (Check): New Well Despering Reconditioning Plugging		Check):	Monitor	□ Pub	(State) Environmental Soll Bo lic Supply De-wat NRCC? Yes [ering Testw		15B-		
	DIAMETER OF H									
Started 1977 Completed 1977	Dia. (in.) From (ft.)	To (ft.)	7) DRILLING METHOD (Check):							
From (ft.) To (ft.) Description and color of formation material			Unde	Packed give interval	el Packed from 4C	Other 161	Straight Wall	2/1/		
			CAS	New New	ANK PIPE, AND WEL	L SCHEEN DAT	A: Settin	n/ft)	Gag	
			Dia. (in.)	or Used	Pert., Slotted, etc. Screen Mfg., if con	nmercial	From	To	Cas	
			Ų	,0	PUC SCHAG.		NA.0	EA.0	.01	
			4	N	PUC RISA		30.0	74.5		
(Use reverse side of Well On	wner's copy, if necessary)			Method Cement Distance	used	t to O-C t t to t to t lines or other co	t. No. of sa	cks used		
☐ Turbine ☐ Jet ☐ Submers ☐ Other ☐ Depth to pump bowts, cytinder, jet, etc. 14) WELL TESTS: U/A Type test: ☐ Pump ☐ Bailer	,ft.	- tod		Spec	CE COMPLETION dified Surface Stab Inst dified Steel Sleeve Inst ss Adapter Used (Ru roved Alternative Proc	alled [Rule 338. le 338.44(3)(b)]	.44(3)(A)]	e e e e e e e e e e e e e e e e e e e		
Yield:gpm with 15) WATER QUALITY:			11) WATER LEVEL: NA Static level							
Did you knowingly penetrate any strata constituents?				PACKE			уре	Depti		
Type of water?	Depth of strata	WATER*			NITE YELL		1/2	۔ن چربہ		
I hereby certify that this well was drilled by r understand that failure to complete items 1	thru 15 will result in the log(s	s) being returned	d for cor	mpletion	and resubmittal.				1	
(IV)	pe or print)						694-		. /	
	1 / 1		-4	Sul	("H.C 157)	/ ×	_	1.5 4!	6	
ADDRESS(Street of	or RFD)		- 1	Clivi	CH.2 1571	-	State)	(7)	0)	

K-2 MW-13

lease use black ink. ille WHITE COPY with: NRCC \ Box 13087, MC 177 stin, TX 78711-3087 12-239-0530		(This form must be complete	Texas Water Well Drillers Advisory Council P.O. Box 13087 (This form must be completed and filed with the TNRCC within 30 days following the date the well is plugged as required by current statutory law.) A. WELL IDENTIFICATION AND LOCATION DATA ADDRESS ADD 1058 ADD 105		
12-255 0000		A. WELL IDENTIFICATIO	N AND LOCATION DATA		
	11 011 011	\$ ADDRESS	P.O. BOX 1458	Praisville TX	18363
) OWNER	(Name)	ADDRESS	(Street or RFD)	(City)	(State) (Zip)
ADDRESS OF WELL:	el Vind	Consul Harrice	(City) (State)	(Zip) GRID#	x3.3.4.4
CONTROL COLL		Street, Ar B of other)	Water D'Monitor D Ini		5)
170			the state of the state of the small ter	othin a specific grid on a full	
Oriller, Pump Installer, or Land cale-gridded County map ava placing a corresponding dot in	owner performing the plug llable from the TNRCC/Ins the grid to the right. The le	ging operations must locate and stallers Certification Program. The gal description section below is	e location of the well should be do optional.	enoted within the grid by	
☐ LEGAL DESCRIPTION:	with				
Section No.	Block No	Township			
Abstract No.	Survey Nam	ne			
Distance and direction fro	m two				
intersecting section lines	or survey lines:		. TO DE DI UCCED (if availah	le)	
	В.	HISTORICAL DATA ON WEI	LLTO BE PLUGGED (if availabel (194–177) Cinches; 9) Total d	City F. A. A.	ペジングでノ
6) Driller 7 7 4 7 6	J(F4,5)-	License No		City	feet
7) Drilled	19;	8) Diameter of hole	inches; 9) Total o	epth of well	10011
		C. CURRENT P	LUGGING DATA		
Date well plugged	7- 78	19 9 -			
Date well plugged					
	as at right, show method		12 1 171 E 10		
as of the structor Heing en	ace at right, show method		1700 1766 W	ni (L. Lent)	PULKD
Sketch of well: Using spa including all casing and c	ace at right, show method emented intervals.	of plugging the well	100 2500	ii le leits Litssork	COURD CROSTES
Sketch of well: Using spaincluding all casing and c Name of Driller/Pump Ins	ace at right, show method emented intervals. taller actually performing t	of plugging the well	full with	in the second of	FOUTES
Sketch of well: Using spaincluding all casing and c Name of Driller/Pump Ins	ace at right, show method emented intervals. taller actually performing t	of plugging the well	FOR ECT	inite suits Fillstock Ten To S	COURD CROUTES CREACE.
Sketch of well: Using spaincluding all casing and casing all casing all casing and casing all casing all casing and casing all	ace at right, show method emented intervals. taller actually performing to the state of the sta	of plugging the well	FOR LET	nice with liverships to the li	FOUTES
Sketch of well: Using spaincluding all casing and c Name of Driller/Pump Ins	ace at right, show method emented intervals. taller actually performing to the first state of the plugging attar relative to the plugging	of plugging the well he plugging operations operations:	1500 1766 U 1600 2566 Tecm Ect	ine with Energy or a Ten To I	ECCED ECCUTED ECCECE
Sketch of well: Using spaincluding all casing and compared to the spain s	ace at right, show method emented intervals. taller actually performing to the first state of the plugging attar relative to the plugging	of plugging the well	Tacm Ect	inder south	ECUTED EFFECT.
Sketch of well: Using spaincluding all casing and	ace at right, show method emented intervals. taller actually performing to the first state of the plugging that relative to the plugging CASING LE	of plugging the well he plugging operations operations:	Tacm Ect	in the second of	FOUTES FOUTES
Sketch of well: Using spaincluding all casing and	ace at right, show method emented intervals. taller actually performing to the first state relative to the plugging CASING LE FROM (feet)	of plugging the well he plugging operations operations: FT IN WELL TO (feet)	FROM ECT	in a contract of the contract	COURD CROSTES CRESCE
11) Sketch of well: Using spaincluding all casing and countries. 12) Name of Driller/Pump Institute License number License number DIAMETER (inches)	ace at right, show method emented intervals. taller actually performing to the properties of the plugging casing LE FROM (feet)	of plugging the well he plugging operations operations: FT IN WELL TO (feet)	FUD LIFE	niec with Firstwik Ten To	COUNTES CECACE
.1) Sketch of well: Using spincluding all casing and control of the control of th	ace at right, show method emented intervals. taller actually performing to the first state relative to the plugging CASING LE FROM (feet)	of plugging the well he plugging operations operations: FT IN WELL TO (feet)	FUD LESS	inie with intersection	COUTES COUTES
12) Sketch of well: Using spaincluding all casing and countries. 12) Name of Driller/Pump Institutes number License number DIAMETER (inches) CEMENT PLUG FROM (feet)	ace at right, show method emented intervals. taller actually performing to the plugging casing Le FROM (feet) (S) PLACED IN WELL	of plugging the well the plugging operations operations: FT IN WELL TO (feet) SACK(S) OF	TROM ECT	inite senti initestinik initestinik	ELLAD FOUTES WIFEE
12) Sketch of well: Using spaincluding all casing and control of the spain spa	ace at right, show method emented intervals. taller actually performing to the plugging cash relative to the plugging casing LE FROM (feet) (S) PLACED IN WELL TO (feet)	of plugging the well the plugging operations operations: FT IN WELL TO (feet) SACK(S) OF CEMENT USED	TOO ECT	inite senti interpretation to the senting	POUTES
12) Name of Drillar/Pump Ins License number DIAMETER (inches) CEMENT PLUG FROM (feet)	ace at right, show method emented intervals. taller actually performing to the plugging cash relative to the plugging casing LE FROM (feet) (S) PLACED IN WELL TO (feet)	of plugging the well the plugging operations operations: FT IN WELL TO (feet) SACK(S) OF CEMENT USED	FOR ECT	in the second of	FOUTES
11) Sketch of well: Using spaincluding all casing and countries. 12) Name of Driller/Pump Institute License number License number DIAMETER (inches) CEMENT PLUG FROM (feet)	ace at right, show method emented intervals. taller actually performing to the plugging cash relative to the plugging casing LE FROM (feet) (S) PLACED IN WELL TO (feet)	of plugging the well the plugging operations operations: FT IN WELL TO (feet) SACK(S) OF CEMENT USED	Tacm Ect	in the second of	FRATES
11) Sketch of well: Using spaincluding all casing and countries. 12) Name of Driller/Pump Institute License number License number DIAMETER (inches) CEMENT PLUG FROM (feet)	ace at right, show method emented intervals. taller actually performing to the plugging cash relative to the plugging casing LE FROM (feet) (S) PLACED IN WELL TO (feet)	of plugging the well he plugging operations operations: FT IN WELL TO (feet) C. C. SACK(S) OF CEMENT USED	Tacm Ect		FRATES FRACE
12) Sketch of well: Using spaincluding all casing and countries. 12) Name of Driller/Pump Institutes number License number DIAMETER (inches) CEMENT PLUG FROM (feet)	at relative to the plugging CASING LE FROM (feet) (S) PLACED IN WELL TO (feet)	of plugging the well he plugging operations operations: FT IN WELL TO (feet) C C SACK(S) OF CEMENT USED ////////////////////////////////////	RMATION INCLUDED IN FORM		TETECT.
12) Sketch of well: Using spaincluding all casing and countries. 12) Name of Drillet/Pump Institutes number License number DIAMETER (inches) CEMENT PLUG FROM (feet)	ace at right, show method emented intervals. taller actually performing to the plugging casing LE FROM (feet) (S) PLACED IN WELL TO (feet)	of plugging the well he plugging operations operations: FT IN WELL TO (feet) C. C. SACK(S) OF CEMENT USED / C. D. D. VALIDATION OF INFO	RMATION INCLUDED IN FORM	n are true to the best of my kr	TETECT.
12) Name of Drillar/Pump Ins License number DIAMETER (inches) CEMENT PLUG FROM (feet)	ace at right, show method emented intervals. taller actually performing to the plugging casing LE FROM (feet) (S) PLACED IN WELL TO (feet)	of plugging the well the plugging operations operations: FT IN WELL TO (feet) SACK(S) OF CEMENT USED COMENT USED D. VALIDATION OF INFOI der my supervision) and that ear result in the report(s) being retur	RMATION INCLUDED IN FORM ch and all of the statements hereined for completion and resubmit	n are true to the best of my kr	TETECT.
12) Sketch of well: Using spincluding all casing and control of the second of the seco	ace at right, show method emented intervals. taller actually performing to the plugging cash at relative to the plugging cash (see the p	of plugging the well the plugging operations operations: FT IN WELL TO (feet) SACK(S) OF CEMENT USED COMENT USED D. VALIDATION OF INFOI der my supervision) and that ear result in the report(s) being retur	RMATION INCLUDED IN FORM ch and all of the statements hereined for completion and resubmit	n are true to the best of my kr	
12) Sketch of well: Using spincluding all casing and control of the second of the seco	ace at right, show method emented intervals. taller actually performing to the plugging cash at relative to the plugging cash (see the p	of plugging the well the plugging operations operations: FT IN WELL TO (feet) SACK(S) OF CEMENT USED COMENT USED D. VALIDATION OF INFOI der my supervision) and that ear result in the report(s) being retur	RMATION INCLUDED IN FORM	n are true to the best of my kr	
12) Name of Drillet/Pump Ins License number License number DIAMETER (Inches) CEMENT PLUG FROM (feet) U (i C) I hereby certify that this well understand that failure to cor Company or Individual's Nan Address: Street or RFD	ace at right, show method emented intervals. taller actually performing to the plugging cash at relative to the plugging cash (see the p	of plugging the well the plugging operations operations: OPERATION OF INFO OPERATIO	RMATION INCLUDED IN FORM ch and all of the statements hereined for completion and resubmit	n are true to the best of my kr	
11) Sketch of well: Using spaincluding all casing and control of the spain shadow of Driller/Pump Institutes a control of the spain shadow of Driller/Pump Institutes and Casing and cementing do DIAMETER (inches) CEMENT PLUG FROM (feet) CONTROL OF THE STANDARD OF THE S	ace at right, show method emented intervals. taller actually performing to the plugging cash at relative to the plugging cash (see the p	of plugging the well the plugging operations operations: FT IN WELL TO (feet) SACK(S) OF CEMENT USED COMENT USED D. VALIDATION OF INFOI der my supervision) and that ear result in the report(s) being retur	RMATION INCLUDED IN FORM ch and all of the statements hereined for completion and resubmit	in are true to the best of my krital.	
Sketch of well: Using spincluding all casing and coulding all casing and coulding all casing and coulding all casing and coulding all casing and cementing down and cementing down and cementing down and could be	ace at right, show method emented intervals. taller actually performing to the plugging cash at relative to the plugging cash (see the p	of plugging the well the plugging operations operations: OPERATION OF INFO OPERATIO	RMATION INCLUDED IN FORM ch and all of the statements hereined for completion and resubmit	n are true to the best of my kr	nowledge and belief. I
11) Sketch of well: Using spincluding all casing and countries of Driller/Pump Institutes and countries of DIAMETER (inches) DIAMETER (inches) CEMENT PLUG FROM (feet) COMPANY of The True of True	ace at right, show method emented intervals. taller actually performing to the plugging casing LE FROM (feet) (S) PLACED IN WELL TO (feet) was plugged by me (or unaplete items 1 thru 13 will nee (type or print)	of plugging the well the plugging operations operations: OPERATION OF INFO OPERATIO	RMATION INCLUDED IN FORM ch and all of the statements hereined for completion and resubmit	in are true to the best of my krital.	nowledge and belief. I

			Texas Water Well Drillers Advisory Cou MC 177 P.O. Box 13087 Austin, TX 78711-3087 512-239-0530					
1) OWNER 21+1 27 K. 665	UILLE ADDR	ESS Pa	D.E	OX 148 KILLSU	141 7	2 78 (State)	930	
2) ADDRESS OF WELL County								
3) TYPE OF WORK (Check):	4) PROPOSED USE (Check):					5) MW-		
New Well Deepening Reconditioning Plugging		njection [] Publ	lic Supply De-watering Ter		153-1		
6) WELL LOG:	DIAMETER OF HOLE	7 0	21111	NG METHOD (Check): Drive				
Date Orilling:	Dia. (in.) From (ft.) To (ft.)	7		lotary Mud Rotary Bore				
Started 7 - 2 19 777	O O Surface 42.0	_		lammer Cable Tool Jett				
Completed 7-3 19 97		-	Othe	or	_			
		+						
	on and color of formation material		7 Unde	erreamed Gravel Packed	an Hole	Straight Wall	cie	
210 4.17.1) 1865	- "	Grave	Packed give interval from 35	7. 0 n.	23.0		
				ANK PIPE, AND WELL SCREEN D			P.	
			New	Steel, Plastic, etc.	Settin	ng (fL)	G	
		Dia (in.)	or Used	Perf., Slotted, etc. Screen Mfg., if commercial	From	То	S	
		4.	N	TRI-LOC	350	25.0	- (
		4	N	PUC RISKA	250	+25		
		1		700 100		1		
(Use reverse side of Well Own		M C D	lethod i ementi		_tt. No. of sa	acks used		
☐ Turbine ☐ Jet ☐ Submersib☐ Other		1	-	CE COMPLETION				
Depth to pump bowls, cylinder, jet, etc.,			Spec Pittes	cified Surface Slab Installed [Rule 3 crited Steel Sleeve Installed [Rule 3 iss Adapter Used [Rule 338.44(3)(t roved Alternative Procedure Used [Rule 3 roved Procedure Used [Rule 3	38.44(3)(A)]))]			
	ft. drawdown after hrs.	_		RLEVEL: N'A	ace Date			
15) WATER QUALITY: Did you knowingly penetrate any strata w constituents?	hich contained undesirable			n flowgpm.	Date			
☐ Yes ☐ No If yes, submit "REPC	ORT OF UNDESIRABLE WATER		ACKE		Туре	Depth	1	
Type of water?		JF.	VIC	DUTTE PALLATS	/@	4 7. C	ر -	
I hereby certify that this well was drilled by me understand that failure to complete items 1 the	ru 15 will result in the log(s) being returne	ed for comp	pletion	and resubmittal.			1	
COMPANY NAME	フルC or print)	w	ELL D	RILLER'S LICENSE NO.	1694-	""		
ADDRESS C/O	OT C	7. 17	2115	CHRISTI	72	78416		
(Street or	ryr by	(0	ity)	(1156-21-	(State)	(2)	9).	
(Signed) 4224 122	1 -				-			

and original copy by carafied return receipt request	TNRCC, MC 177, P.O. Br	oz 130 67 ,	Austin	, TX 78	7			MW	K-5 /-15	
of Well Owners copy (pink) WELL F			of Texas REPORT					fell Drillers Advisory Coun 16C 177 P.O. Box 13067 sin, TX 78711-3067 812-239-0530		
1) OWNER 11.1 / C ULSU (Name) 2) ADDRESS OF WELL:	MILLA ADDRE	ss PC) B.	treet or RFD	158 K.	(City)	ici f	72 7 (Sude) 83-3)	723 124	
2) ADDRESS OF WELL: County	(Street, RFD or other) PROPOSED USE (Check): industriat impation in liquid in Public Supply well, were plans su	Monitor ection [() E () Pub#k	nvironmental Supply []	Soil Boring De-watering	☐ Dome	stic !	5), 161-1 (53-1	15.	
6) WELL LOG: Date Drilling:	DIAMETER OF HOLE III (In) From (it.) To (it.) CO Surface 57.0	7) D	RILLINI Air Ro Air Ha	G ALETHÓD (Check): (i ud Rotary (i Cable Tool	_				
From (ft.) To (ft.) Description (end color of formation material	٦ .	3 Under	necount 1	(Check): GravelPac nterval from	□ Open (ked 個 (<u>多多</u>)	Other 16	Straight Wall / 30 S/ to	411	
		Ola	Naw or	Steet Plass Pert., Slotte				ng (ft)	Ga Ca Sc	
		4			CR444 1		=3.0	705		
(Use reverse side of Weil Owner:	s copy. d necessary)	, M	fethodus (emente) Pistance	seddby	Fruite 338.444	ブ・レ or other co	t. No of sa	acks used		
Turbine Jet Submersible Other Depth to pump bowls, cylinder, jet_etc 14) WELL TESTS: 6/.4 Type test Pump Ballet		10) \$	Specific Pitles:	E COMPLET fied Surface S fied Steel Steel s Adapter Use		{Rule 338 {Rule 338 44(3)(0)}	44(2)(A)) 44(3)(A)]			
15) WATER QUALITY: Did you knowingly penetrate any strata whice	772-21	1 s	itatic levi		//A ft. below la					
Type of water? Del Was a chemical analysis made? Yes		1 "	ACKER		FF (C)		уре / 2	Depti		
i hereby certify that this well was diffied by me to understand that failure to complete items 1 thru (d for comp	pletion a	ind resubmitte		,	my knowledg		ı	
(Type or	print)				_				11	
ADDRESS Street or RF	<u>, , , , , , , , , , , , , , , , , , , </u>	· ^ /	کر رہائش (tvi	- CH,	511		State)	(Z)	0)	

Revision: 3 - April 2019

			Texas Water Well Drillers Advisory Co MC 177 P.O. Box 13087 Austin, TX 78711-3087 512-239-0530					
1) OWNER 144 AF KIND (No. 2) ADDRESS OF WELL:							7836 (State) 83-	
County CECF26	(Street, RFD)	or other)	1	City)	(State) (Zlp)	GRID#	0 -	_
3) TYPE OF WORK (Check): (P New Well Despening Reconditioning Plugging	☐ Industrial ☐	Irrigation 🗆 In	njection	☐ Pub	Environmental Soil Boring : Silc Supply De-watering : NRCC7 Yes No		5), nW- (5B-)	
6) WELL LÖG:	DIAMETER OF	HOLE	12	DRILLI	NG METHOD (Check):	riven		
Date Drilling: Started 7-10 19 97 Completed 7-10 19:77	Dia. (in.) From (ft.	110		AIR	Rotary Mud Rotary Solarnmer Cable Tool J	ored		
From (ft.) To (ft.) Descrip	tion and color of formati	ion material	-	☐ Unde	erreamed Gravel Packed	Open Hole U	Straight Wall /30 S/ to 28.0	12
		0	CAS	ING, BL	ANK PIPE, AND WELL SCREE		ng (fL)	
			Dia. (in.)	New or Used	Steel, Plastic, etc. Perl., Slotted, etc. Screen Mig., if commercial	Settir	ntting (ft.)	
			4	N	PUC BULLEN MY	40.0	300	F
			4	N	PUC RISHR	0:0	+3.5	T
(Use reverse side of Well On	wner's copy, if necessary)			Method Cement Distance	used	ft. No. of sa	acks used	
☐ Turbine ☐ Jet ☐ Submers ☐ Gitter ☐ Depth to pump bowls, cylinder, jet, etc.	☐ Turbine ☐ Jet ☐ Submersible ☐ Cylinder		10)	SURFA	CE COMPLETION cified Surface Slab Installed [Rui			
14) WELL TESTS: U/A Type test: Pump Bailer Yield: gpm with				Pitle	ess Adepter Used [Fittle 338.44() roved Alternative Procedure Used	3)(b)]		
15) WATER QUALITY: Did you knowingly penetrate any strata constituents?	which contained undesire	able		Static le Artesiar	rvelft. below land s			_
☐ Yes ☐ No If yes, submit "REPORT OF UNDESIRABLE WATER" Type of water? Depth of strata Was a chemical analysis made? ☐ Yes ☐ No			PACKE ENT	irs: TONITE - FILET.	Type / /2	Dept		
I hereby certify that this well was drilled by understand that failure to complete items 1 COMPANY NAME	thru 15 will result in the log	g(s) being returne	ed for cor	mpletion	and resubmittal.	41.94	- n	1
E(D) (Ty	pe or print)	(72	205	CH.21511	D	784	/
ADDRESS	, — —							

ATTENTION OWNER: Confidentiality Privilege Notice on on reverse side of Well Owner's copy (pink)	State of Texas WELL REPORT					P.O. Box	177 x 13067 78711-3087	y
1) OWNER CITY OF HINE	SUILLE ADDRE	ss /	0. 1	BOX 1458 K	'intesvice	4 TS	2 7%	F
County KLAE Tall	(Street, RFD or other)	=16	K/	CSVICIA THE	(Zip)	GRID #	F3-3	
3) TYPE OF WORK (Check):	4) PROPOSED USE (Check):			Environmental Soil Bonn			5),114)-	,
New Well Despening	☐ Industrial ☐ Irrigation ☐ In				_	pll	153-	1
Reconditioning Plugging		Dustrer	10 ине т	NACCI LI TES L	NO		-	
6) WELL LOG:	DIAMETER OF HOLE Dia. (in.) From (ft.) To (ft.)	7		NG METHOD (Check):	☐ Driven			
Date Drilling: 9 19 97	8 0 Surface 33.0	1	-	lotary Mud Rotary				
Completed 7-9 1997	0 0 0000	1		lammer Cable Too	Jetted			
Competed			L Out					_
From (ft.) To (ft.) Descripti	on and color of formation material	8)	Boreho	le Completion (Check):	☐ Open I	tole 🗆	Straight Wall	
341 1177,161185	2065	1	☐ Und	erreamed 🔲 Gravel	Packed 2	Other 16	130 5	2
			If Grave	l Packed give interval	from <u>32.</u>	O R t	10.0	2
		CAS	ING, BL	ANK PIPE, AND WELL	SCREEN DAT	A:		-
		Dia.	New	Steel, Plastic, etc.		Settin	ng (ft.)	
4		(in.)	Used	Perf., Slotted, etc. Screen Mfg., if comm	nercial	From	То	1
		2	N	PUC SCRA		=3.0	13-0	I
				MFG. TR				1
		3	N	PUC RISA	R	13.0	+20	1
	ble Cylinder	10)	Cement Distance Method SURFA Spec Spec Pitte Appl WATER Static le	ed by et o septic system field line of verification of above de CE COMPLETION cified Surface Slab Installicified Steel Sleeve Installies Adapter Used [Rule coved Alternative Proced LEVEL: V A to be fit. beker et a septiment of the beker steel fit. beker et a septiment of the se	nes or other constance led [Rule 338. led [Rule 338. 338.44(3)(b)] ure Used [Rule	44(2)(A)] 44(3)(A)] 338.71]	ontamination	_
Did you knowingly penetrate any strata constituents?	which contained undesirable	-		flow		Date		_
	ORT OF UNDESIRABLE WATER		PACKE			Abe .	Dept	_
Type of water?	Pepth of strataYes ☐ No	1/2		DUITE FE	(Ut/)			1
	hru 15 will result in the log(s) being returned	d for co	mpletion WELL D			1694	1- M	
		45. 0	200	11111	//	-	1211	8
ADDRESS (Street or	(AFD)	1	(City)		(\$	State)	(Zi	P

and original copyloy certified return receipt rec ATTENTION OWNER: Confidentiality Privilege Natice on on reverse side of Wall Owner's copy (pink)	Transis, II	State WELL	of To	exas	The State	2 1-4-2	P.O. Bo	Hers Advisory 177 IX 13067	Cou
					- 11		512-23	78711-3087 19-0530	
1) OWNER CHY OF KINGS	y/C(A	ADDRE	:88 <u></u>	-O · E	Street or RFD)	(City)	5 H	(State)	96
2) ADDRESS OF WELL: County Kire Shall									
3) TYPE OF WORK (Check): New Well Deepening	4) PROPOSED USE (C		Monito	_	Environmental Soil Boring		stic	15B-1	181
Reconditioning Plugging	If Public Supply well	l, were plans su	bmitted	to the T	NRCC? Yes	No		130 1	D)
6) WELL LOG:	DIAMETER OF H		1		NG METHOD (Check):	☐ Driven			
Date Drilling: 9-7	Dia. (in.) From (ft.)	Jo (ft.)	1	_	lotary	_			
Completed 7 - 9 19.77			1	Othe	_				
From (ft.) To (ft.) Descript	ion and color of formation	n material	8)	☐ Und	le Completion (Check): erreamed Gravell il Packed give interval 1	Packed P	other 16.	Spreight Wall 130 SIC to 19.0	10
			CAS	ING, BL	ANK PIPE, AND WELL !	SCREEN DATA	\:		
			Din. (in.)	New 70 Used	Steel, Plastic, etc. Perf., Slotted, etc. Screen Mig., if comm	ercial	Setti	ng (fL)	G
			2	N	PUC SCRAGE		420	220	. 0
			2	N	PUC RIS	he			
(Use reverse side of Well Ow	mer's copy, if necessary)			Method Cement Distance	rTING DATA [Rule 338. red from	3.0 ft	No. of se	acks used	
O Other	Turbine			10) SURFACE COMPLETION Specified Surface Slab Installed [Rule 338.44(2)(A)] Specified Steel Sleeve Installed [Rule 338.44(3)(A)] Pitiess Adapter Used [Rule 338.44(3)(b)] Approved Alternative Procedure Used [Rule 338.71]					
15) WATER QUALITY: Did you knowingly penetrate any strata			11) WATER LEVEL: U/A Static tovel ft. below land surface Date Artesian flow gpm. Date						
constituents?	PORT OF LINDESIDARI E V	VATED.	12)	PACKE	RS:	T	/pe	,, Depti	h
Type of water?	Type of water? Depth of strata Was a chemical analysis made?			,070	וף בי ודו עים	(873	12	17.1	1 - ,
I hereby certify that this well was drilled by munderstand that failure to complete flems 1 to COMPANY NAME	hru 15 will result in the log(s) being returne	d for co	mpletion	and resubmittal.	11	all	- 1/80	
ADDRESS PIN	r RFD)	60	20	05	CHRISTI	75	2	7841	16
/644-44									

K-9

ATTENTION OWNER: Confidentiality Privilege Notice on on reverse side of Well Owner's copy (pink)			State WELL			Γ ,	Texas W	ater Well Drill MC - P.O. Box Austin, TX 7 512-239	177 : 13087 :8711-3087	/ Council
1) OWNER City of Kingsvii	le lame)		ADDRE	ss P	.O. Bo	x 1458 Street or RFD)	Kingsville (Ci	lex	ac 753 (State)	63 (Zip)
2) ADDRESS OF WELL: County Kleberg	Kingsv	11e Lan	dfill other)					GRID#		
3) TYPE OF WORK (Check): New Well Deepening Reconditioning Plugging	☐ Indus	trial 🗌 Irri	igation 🗌 In	jection	☐ Publ		oil Boring Dor e-watering Test	market hands)	
6) WELL LOG:	DIAME	ETER OF H	DLE	7)	DRILLIN	IG METHOD (Ch	eck): Driven	1		
Date Drilling: Started 4-27 19 98 Completed 4-27 19 98	Dia. (in.)	From (ft.) Surface	To (ft.) 84 • 0		☐ Air H	otary Mud ammer Ca r				ĸ
	ption and color o	f formation	material		☐ Unde	erreamed Packed give inte	Check): ☐ Ope Gravel Packed , grval from	Other gr	out	
				CAS	ING, BL	ANK PIPE, AND	WELL SCREEN DA	ATA: N/A		
				Dia.	New	Steel, Plastic, Perf., Slotted,		Settin	g (ft.)	Gage Castin
				(in.)	Used	Screen Mfg.,		From	То	Screen
(Use reverse side of Well 0 13) TYPE PUMP: N/A □ Turbine □ Jet □ Subme	Owner's copy, if ne				Method of Distance Method	used mi ed by to septic system of verification of a	ft. to 6.0 ft. to xed with 5% b PS1 inc.	ft. No. of sa	cks used	ft
	☐ Jetted				☐ Spec ☐ Spec ☐ Pitles	ified Steel Sleeve ss Adapter Used	N H/A b Installed [Rule 33 l Installed [Rule 33 [Rule 338.44(3)(b) Procedure Used [Ru	B.44(3)(A)]]	7.	
Yield:gpm with 15) WATER QUALITY: Did you knowingly penetrate any strain	2 - 20 - 20 - 20 - 20 - 20 - 20 - 20 -	a ov 25 voca			Static le Artesian	flow	ft. below land surface			
constituents? ☐ Yes Æ No If yes, submit "Ri Type of water? Was a chemical analysis made? [_ Depth of strata			12)	PACKE	RS: N/A		Туре	Depti	h
		supervision)	and that each	and all	npletion	and resubmittal.				I
I hereby certify that this well was drilled by understand that failure to complete items 1 OMPANY NAME	thru 15 will result		**************************************	_ \	VELL DE	RILLER'S LICEN	SE NO	4694	17	
understand that failure to complete items 1	thru 15 will result					pus Christ		Texas (State)		78416

Part III

K-10 MW-23

ATTENTION OWNER: Confidentiality Privilege Notice on on reverse side of Well Owner's copy (pink)		State WELL	REF	PORT		P.O Austin,	Drillers Advisor MC 177 . Box 13087 TX 78711-3087 2-239-0530	y Council	
1) OWNER Kingsmille City of		ADDRE	ESS	P.C. E	Box 1458 Kin	gsvijje Texas 7	8363		
(Name)				(8	Street or RFD)	(City)	(State)	(Zip)	
2) ADDRESS OF WELL: County Kleberg	Kingsville Lar	ndfili	Kings	ville '	Texas	GRID #	83-34-4		
County 17 County	(Street, RFD or	USS THE STREET		City)	(State)	(Zip)	-		
3) TYPE OF WORK (Check): 4) Property New Well Deepening Reconditioning Plugging	☐ Industrial ☐ In	rigation In	jection	☐ Public	environmental Soil Borin CSupply	ing Testwell	5)		
6) WELL LOG:	DIAMETER OF H	IOLE	7)	DRILLIN	G METHOD (Check):	☐ Driven			
	ia. (in.) From (ft.)	To (ft.)		☐ Air Ro	tary Mud Rotary	Bored	1		
Started 19	E.U Surface	16.0		☐ Air Ha	mmer Cable Too	Jetted	1		
Completed 4-24 19 95			-	○ Other			1	1	
					S Park Park	Was the same of th		v	
From (ft.) To (ft.) Description	and color of formation	n material	8)		Completion (Check)		Straight Wal	1	
see attached lbc Mw-23			1		rreamed Gravel				
			1	If Gravel	Packed give interval	from	ft. to	ft.	
			CAS	ING. BLA	NK PIPE, AND WELL	SCREEN DATA: N/A			
				New	Steel, Plastic, etc.		Setting (ft.)	Gage	
			Dia.	or	Perf., Slotted, etc.			Castir	
			(in.)	Used	Screen Mfg., if comm	nercial Fro	m To	Scree	
					- 1910				
(Use reverse side of Well Owner's	s copy, if necessary)		1	Method us Cementer Distance	sed mixed	with 5% benton	te	2	
☐ Turbine ☐ Jet ☐ Submersible	☐ Cylinder			Wethod o	A TO SEE TO SECURE OF THE PROPERTY OF THE	TATION CONTROL OF			
Other			10)	SURFAC	E COMPLETION 11	iA			
Depth to pump bowls, cylinder, jet, etc.,	ft.	_	☐ Specified Surface Slab Installed [Rule 338.44(2)(A)]						
1100 W COULD WE SEE THE OWN CONTROL OF THE OWN COUNTY			1	☐ Specif	fied Steel Sleeve Install	ed [Rule 338.44(3)(A)]		
N/A 14) WELLTESTS:				☐ Pitless	s Adapter Used [Rule	338.44(3)(b)]			
	Jetted Estimat	ed		☐ Appro	ved Alternative Proced	ure Used [Rule 338.71]	l		
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K-11

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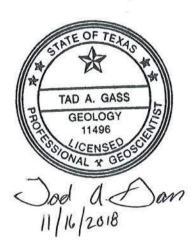
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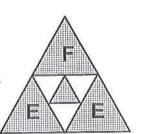
ATTACHMENT 5

Groundwater Characterization Report

For Permitting Purposes Only. Applies to pages of Attachment 5 - Finch Energy & Environmental Services, Inc. Groundwater Characterization Report, sealed by Ray N. Finch, P.E. on 6-26-98 and 9-30-98 altered to provide a clean and legible copy and includes pages: ii, 1, 3 - 8, 10, 34 and B-1 - B-15. No information or data was altered or changed from the original 6-26-98 and 9-30-98 Groundwater Characterization Report.



Finch Energy & Environmental Services, Inc. P.O. Box 73/1204 W. King, Kingsville, TX 78364 Phone: (512) 592-9810 Fax: (512) 592-5552



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Appendix E	In-Situ Hydraulic Conductivity Test Data
Appendix F	Monitor Well Schematic
Appendix G	Ground Water Direction, Gradient, & Flow Rate
Appendix H	Boring Cross Sections



THIS DOCUMENT IS ISSUED FOR PERMITTING PURPOSES ONLY.
INCLUDING PAGES 1 THROUGH 51 AND APPENDICES.

Revision 2 - September 1998

1.0 GROUNDWATER CHARACTERIZATION

This section describes the historical groundwater conditions that have existed at the City of Kingsville MSWLF site as required in 30 TAC §330.56(e). A delineation of the waste management area, the property boundary, the proposed "point of compliance" and the proposed locations of all groundwater monitoring wells are shown on Figure 5.2.

1.1 Background

Currently, five (5) from a total of eight (8) active groundwater monitoring wells are being used to monitor quality in the uppermost aquifer sands along the perimeter of the currently permitted fill area. A series of sampling and analysis events to characterize the background quality of the groundwater occurred in the third and fourth quarters of 1996, and the first, second, third and fourth quarters of 1997. The detection monitoring program has been in place since 1985.

Beginning in the third quarter of 1996, the groundwater monitoring requirements included the annual sampling of each well for nine (9) metals, forty seven (47) volatile organic compounds (VOCs), nine (9) water parameters and three (3) field measured parameters. The metals analyzed were arsenic, barium, cadmium, chromium, lead, mercury, selenium, iron, and manganese. The VOCs analyzed have been non-detectable. pH, specific conductance and temperature are field measured parameters. A groundwater elevation measurement is made at each sampling event. The following additional water parameters were sampled: calcium, magnesium, sodium, potassium, alkalinity as CaCO3, sulphate, chloride, total dissolved solids (TDS) and ammonia nitrogen. For a complete listing of the sampled parameters, please consult the Groundwater Sampling and Analysis Plan included as Attachment 11.

No known plumes of contamination have been identified as entering the groundwater from the facility. Levels of arsenic, barium, and selenium have been detected in the ground water at the MSWLF. The arsenic detected is most likely due to the past use of defoliant on the surrounding cotton fields. This should probably decrease with the cease of use of arsenic based defoliant and the rmoval of cotton fields for the site expansion. The barium levels can most likely be attributed to the past use of drilling muds present on the facility site (four plugged and abandoned wells). The barium levels should decrease with time and are well below the MCLs. Selenium is a naturally occurring metal most likely found in the soil present on the site. No other known reason for the levels of selenium found is apparent.

2.0 HYDROGEOLOGIC CONDITIONS

2.1 Uppermost Aquifer

Eleven new borings were completed to obtain basic data necessary to complete a Soil Characterization. Six of these wells were subsequently completed as Monitor Wells. Nine other previous soil borings were available to assist in the subsurface investigation. The completions will be discussed in the Ground Water Characterization Section. The first seven borings were completed to a depth approximately 10 feet above Mean Sea Level (MSL). The second four borings were completed to depths varying from 72 feet to 88 feet below ground surface (bgs). A generalized description of the sediments encountered follows.

The section describes the characteristics of the soil samples collected and tested during the investigation. The locations of all subsurface boring explorations performed for the design of engineered cells, and for the Geological/Geotechnical investigation are shown on Figure 5.16. Subsurface geologic correlations showing stratigraphy and structure beneath the site are presented on the following exhibits included herein; Figures 5.3 through 5.15. These figures include a Cross Section Location Map, Geologic Cross sections A-A' through I-I' (9 total), [Note Maximum ground water levels.], A Structure Map of the Top "Light Olive Green Clay", Isopach Map Sand Units I & II, and Isopach Map Sand Units III & IV.

The primary geologic formations exposed at the surface of the site are recent Holocene South Texas Eolian Plain Deposits. The topsoil (approx 0 feet - 20 feet) consists of a clay which is black, silty and contains humic material. This soil is overlain in the extreme northeast corner with a veneer of loess. Sediments encountered in borings at the site are Holocene to Pleistocene in age and consist of clays, silts, sands, and caliches deposited in two (2) separate and distinct environments of deposition. Cross section A – A' serves to illustrate theses environments of deposition. The cross section traverses the MSWLF site using four (4) deep borings all deep enough to penetrate a minimum thickness of 38' of a massive, low permeability, light olive green clay ("Light Olive Green Clay") believed to have been deposited in a marine (estuarian) environment.

The "Light Olive Green Clay" is the aquiclude for the MSWLF facility. In turn, the "Light Olive Green Clay" is capped by a sheet sand ("Orange sand") possibly 2 to 10' thick across the site of the MSWLF. Stratigraphically above the "Orange sand", the environment of deposition changes to fluvial-deltaic for the remaining 40 to 50' of section, measured back to surface. These beds are comprised of sands, silts, caliches and clays deposited as superimposed channel sands and clayey dunes or bars. A detailed cross section net was constructed using all sample borings at the MSWLF and four significant sand bodies are believed to be present within the fluvial-deltaic sequence. Location of these sand bodies

are shown on isopach maps included herewith. Bodies I & II are superimposed, caliche or sand filled channels with Body I having the larger areal extent. Bodies III & IV are interpreted as dunes or bars of limited extent and are comprised of clayey sand. All of the above sand bodies are incised into, or embedded within, a tan, silty clay containing abundant mottles of organic matter.

Taken together, the marine clay section ("Light Olive Green Clay") overlain by fluvial-deltaics section represents a single regressive cycle, with respect to sea level, at the top of the Pleistocene Beaumont formation. It is believed that the entire fluvial-deltaic section is comprised of Holocene sediments with Holocene – Pleistocene boundary represented by the top of the "Light Olive Green Clay" or "Orange sand".

The shallow subsurface geological structure at the Kingsville MSWLF site is shown by the Structure Map- Top "Light Olive Green Clay" to be monoclinal dip to the northeast at approximately 20 feet per mile. The horizon was chosen as most representative of structure affecting and underlying the MSWLF site. Any structural mapping on beds above the "Light Olive Green Clay" are less correlative and would reflect local scouring of channel sands causing structural inconsistencies due to stratigraphic variation within the fluvial-deltaic section. Correlations are excellent on the top of the "Light Olive Green Clay" and the surface is the most likely to be planar in nature. Some scouring of this surface probably occurs at the extreme southwest corner of the MSWLF site due to the incisement of the overlying Body I, caliche bearing channel.

Deposition of the above sediments postdates uplift of the Kingsville Dome.

2.2 Aquiclude

Detailed correlation of borings show that the Holocene sediments which will host the proposed City Kingsville MSWLF were deposited in a fluvial-deltaic environment. The massive "Light Olive Green Clay" which is believed to be of Pleistocene age and deposited in a near shore marine environment underlies the section. As noted previously, the clay serves as the aquiclude between the Holocene sediments hosting the MSWLF and the underlying, saline, "Chicot" sand and the even deeper regional "Evangeline" (Goliad) aquifer.

Although excellent vertical separation exists between the Holocene sediments which will host the MSWLF and underlying Pleistocene beds, lateral migration of groundwater occurs within the through the host beds. From a potentiometric standpoint, it is evident from existing monitor well data that migration of groundwater with the Holocene host sediments is occurring in almost all directions away from the MSWLF site, the exception being the northwest.

From a geologic perspective, it is evident that migration of groundwater should occur

Part III

primarily away from the MSWLF site to the northeast and southwest. Controlling this trend is the presence of the incised channel containing sands, clays and caliche noted on cross sections and maps as Sand Body I. This body, which hosts the thin to massively bedded caliche deposits in the area, strikes northeast and is approximately ½ mile in width. Body I trends directly through both the existing and proposed landfill sites. Other sand bodies in the host section are noted on the cross sections as II, III and IV. Sand body II is, again an incised, sand filled channel with limited areal extent. Sand Body II is truncated along its strike on the northeast and southwest by the overlying Body I. Sand Bodies III and IV are interpreted as being clay dunes or bars of limited areal extent. It should be noted that the entire Holocene section which contains all of the above sand bodies is permeable and therefore all are in communication. Even so, the orientation of Sand Body I should exert an influence on preferential ground water migration to the northeast and southwest and away from the City of Kingsville's MSWLF site.

Note that ground water modeling using site specific data was performed using HELP3 and Multi-Media computer models. The results of these studies are given in Attachment 15, Appendices B & C, and in Attachment 10, Appendices C & D.

2.3 Groundwater Flow Direction and Rate

2.3.1 Basis

The local groundwater flow regime at the site was determined by the collection of physical data (such as the elevation of the potentiometric surface) and the completion of in-situ hydraulic conductivity (slug) testing from on-site groundwater monitoring points. Depth-to-water measurements were obtained from existing on-site monitor wells and piezometers on June 16, May 18, February 18, February 2, January 20, January 5, 1998; December 22, December 8, November 24, November 10, October 24, October 16, September 29, September 15, August 15, and August 4, 1997; and December 23, 1996, May 10, 1995, March 14, 1994 and April 5, 1993. The depth-to-water measurements were subtracted from a surveyed reference datum (top of PVC casing) to establish a potentiometric surface relative to 1929 National Geodetic Vertical Datum (NGVD). The groundwater elevation data and resultant potentiometric contour maps for the uppermost permeable stratum are presented in Appendices A, B & C. The water level data measured from soil boring and monitoring well measurements are presented in Appendix B and in Table 5.4.

Analysis of the ground water level data over the period past ten months indicate that the ground water flow tends to leave the MSWLG site in all directions expect the northwest. However, prior to the major rainfall event ground water actually flowed toward the northwest also. The table below determined from the data referred to above gives the following summary of average values of ground water direction, gradient and flow rate.

Part III

Landfill Quadrant	Direction degrees	Gradient ft/ft	Flow Rate ft/yr	Well Used No.	Hydr. Cond. Cm/sec
N/E	36	0.00799	1.200	6, 14, 13	0.000127
S/E	257.3	0.00144	3.124	1, 12, 13	0.000724
S/W	204.3	0.00216	1.503	1, 8, 16	0.000674
N/W	202.6	0.00387	2.137	6, 15, 16	0.000531

From the above table it can be shown that the flow is predominantly away from the MSWLF along the axis of the caliche bearing channel (I). The flow from the Northeast quadrant flows on average at 36 degrees or to the north-northeast with a relatively strong gradient of 0.008 ft/ft. However, the flow rate is fairly low (1.2 ft/yr) due to the relatively lower permeability. On the other hand, the direction from the southwest quadrant is at 204 degrees or south-southwest. The gradient is above 1/4 as large, but the flow rate is slightly larger (1.5 ft/yr) due to the higher permeability. The unexpected conclusion from this study is that, on average, both the northwest quadrant and the southeast quadrant flow toward the southwest and along the caliche bearing channel axis. The Southwest quadrant average direction of flow is 257 degrees or west- southwest. The Northeast quadrant average direction is 203 degrees of south-southwest. In other words, both are being pulled into the flow along the Caliche bearing channel. At this point it is important to mention the ponding effect study of on-site and off-site ponds in the area. The off-site contour map shows that the gradient becomes much stronger to the southwest and the deeper caliche pits after it passes under the cross roads of CR-2030 and FM-2619. Thus, even though the strongest gradient on-site is to the northeast, the greatest rate of flow is to the southwest. The northwest and southeast quadrants actually change flow directions depending on the rate of recharge from the surface of from the loss of water through evapotranspiration during drouth periods. Even though these flows are relatively greater to the southwest, all of the flow rates are very low, i,e, a few feet per year. Graphs of daily versus average flow rates are given in Appendix G as are the tabulated calculations for directions, gradients and flow rates.

F.E.E., Inc prepared a hydrograph of existing monitor wells on site using data collected from previous ground water sampling events since March 1991, and data collected during this investigation. Based on the seasonal data from the site collected to date, the potentiometric surface was slightly lower during periods of low precipitation (summer and early fall) and slightly higher during periods of excess precipitation (winter and spring). Given the minimal seasonal fluctuations, the horizontal gradients and flow directions for the uppermost aquifer are more strongly influence by excessive rainfall events (October 11 & 12, 1997 and September 14 & 15, 1967. The hydrograph indicated no significant changes in groundwater elevations since 1991 until recent excessive rainfall events during

the period of October 8 through 12, 1997. (Appendix D), [See Section 2.3.4]

2.3.2 Evaluation of Horizontal Hydraulic Gradients

Aquifer (bail) tests were performed in piezometers and monitor wells screened in the uppermost groundwater aquifer utilizing falling head methodology. Results of these tests are presented in Appendix E. Based upon these results, the average (geometric mean) horizontal hydraulic conductivity of the uppermost aquifer is approximately 4.12 x 10⁻⁴ cm/sec (1.17 ft/day). The In-Situ hydraulic conductivities for MW's 12,14 and 15 were used in the flow studies for the S/E, N/E and N/W quadrants, respectively. An average of MW-16 and MW-12 was used for the hydraulic conductivity for the S/W quadrant.

The horizontal flow velocity of ground water within each stratum can be estimated using an equation derived from Darcy's Law,

 $V=(Ki/n_e)$, where:

V=velocity (length/time);

K=Hydraulic conductivity (length/time);

i=hydraulic gradient (length/length); and,

n_a=effective porosity (decimal).

As calculated from the potentiometric maps of groundwater flow within each stratum (See Appendix G), the horizontal hydraulic gradient across the site ranges from 1.44×10^{-3} to 7.99×10^{-3} ft/ft horizontal hydraulic conductivity values within each stratum, which are stated above, were obtained from in-situ hydraulic conductivity tests (Appendix E). An effective porosity for a silty clay loam (the predominant lithology screened by piezometers in each stratum) is estimated to be 0.43 (Dean, et. al., 1989). Using these parameters, the horizontal velocity of ground water within the uppermost aquifer deposits beneath the site is estimated to range from 0.0033 ft/day to 1.0086 ft/day, or 1.2 ft/year to 3.1 ft/year, respectively.

2.3.3 Evaluation of Vertical Hydraulic Gradients

No hydraulic connection was found between uppermost local aquifer (separated by the Light Olive Green Clay aquiclude) and the Chicot Aquifer . (Beaumont Clay, Beaumont Clay-Lissie Formation). The deepest borings did not reach the bottom of the Chicot aquifer. However, the deepest borings did locate the Light Olive Green Clay aquiclude which has a minimum thickness of 38' of low permeability clay (3.31x10-8cm/sec) below the uppermost local aquifer., Deeper information was obtained from deeper well logs (URI) and

from water well data in the vicinity (AIC Survey). These elevations show that the bottom of the Chicot aquifer is located approximately 200 feet below ground surface in the MSLWF vicinity. These elevation further show that there is at least 38' and probably 140' of a low permeability clay between the uppermost aquifer at the landfill site and the Chicot aquifer. Further there is 200' to 300' of shale /clay below the Chicot aquifer before reaching the Evangeline (Goliad) aquifer. The light Olive Green Clay described above and in Attachment 4 is the aquiclude for the MSWLF facility. There are no water wells in the area with screens set above 524 feet below ground surface. Further, TAC Rule 33.56(d)(S)(A)(ii) states that "Aquifers more than 300 feet below the lowest excavation and where the estimated travel for constituents to the aquifer are in excess of 30 years plus the estimated life of the site, need not be identified by borings." This is the case for the COK MSWLF.

2.3.4 Relationship of Ponded Water to Water Table

During the six day period from September 19 through September 25, 1967 massive amount of rainfall fell in South Texas which exceeded annual average rainfall (30 inches). This large rainfall resulted in numerous ponds of water in the relatively flat South Texas area. A joint study of the relationship of this ponded water to groundwater levels in the uppermost, unconfined aquifer was made jointly by the United States Geological Survey and the Texas Water Development Board, (TDWB, #138, December, 1971). This date is relevant to water levels below the City of Kingsville, Texas (COK) Municipal Solid Waste Landfill (MSWLF) site.

The King Ranch site was most representative of the COK MSWLF site. It had water in ponds well above the normal water level in the uppermost aquifer. The massive rainfall from Hurricane Beulah (15 inches) resulted in water table levels continuing to rise below and around the pond for a period of eight months after these above normal rainfall events. The COK MSWLF had a similar large rainfall event during the period October 8 through 12, 1997.

The COK MSWLF site has several excavations which are adjacent to the currently permitted MSWLF and on the same land for which MSWLF expansion is proposed. These excavations were prepared for two reasons: first to provide cover soil for the existing MSWLF; second, to prepare the excavations for future MSWLF cells. The net result of these excavations was to provide depressions in the earth's surface which collect ponded water from rainfall events. This ponded water provides recharge to the uppermost, confined aquifer by percolation through the unsaturated zone to the around water table. This recharge causes higher than normal water levels (mounding) below and near these ponds. This the same result as experienced in the 1968-69 TDWB studies of ponded water on the King Ranch.

3.0 GROUNDWATER MONITORING PROGRAM

3.1 Proposed Monitoring Well Network

As previously discussed, the uppermost aquifer beneath the site is confined by the Light Olive Green Clay aquiclude located at 5 to 15 foot above MSL below the landfill. This clay extends at least 38 feet and probably 140 feet below the uppermost aquifer. It is, therefore, proposed that the groundwater monitoring system monitor the uppermost aquifer above the Light Olive Green Clay aquiclude. Proposed groundwater monitoring well locations, which comprise a network designed to monitor groundwater quality around the permitted landfill and expansion area, are shown on Figure 5.2. Monitor wells should have their screens located within one foot or less of the aquiclude clay. Recommended elevations for well screens along with approximate horizontal survey coordinates at each proposed location are summarized in Table 5.6.

Based upon an understanding of the local ground water regime and site stratigraphy, the site groundwater monitoring network will monitor the uppermost aquifer separated from below by the Light Olive Green Clay aquiclude. The monitor well network completed within the uppermost aquifer will ultimately be comprised of a total of twenty four (24) monitor wells. Monitor well locations are illustrated on Figure 5.2. A ground water monitor well sequencing table showing required installation and removal times is shown in Table 5.7.

As required by TAC §330.231(e)(3), the Executive Director will be notified in writing of any changes in the direction and rate of groundwater flow that my require the installation of additional monitor wells. Any additional monitor wells installed will be addressed in a modification to the Site Development Plan.

3.2 Groundwater Sampling and Analysis

A detailed plan and engineering report describing the proposed groundwater monitoring program is presented in Attachment 11 of Part III, Groundwater Sampling and Analysis Plan (GWSAP). The goal of the GWSAP is to establish consistent sampling and analysis procedures that ensure monitoring results are representative of groundwater quality at the background and down gradient monitoring well locations. The procedures in the GWSAP are considered applicable for all groundwater wells included in the administratively approved monitoring network.

The site groundwater monitoring network will be sampled for constituents listed in the GWSAP. As discussed the GWSAP, semi-annual sampling of groundwater within the Chicot unit will ensure that samples are independent. The development of background values for each constituent, and the sampling, analysis and statistical comparison

Hanson Professional Services Inc. Submittal Date: September 2018 Revision: 1 - November 2018

City of Kingsville MSWLF - Permit 235 B Attachment 5 - Groundwater Characterization Report

TABLE 5.6

Status P&A P&A P&A P&A Y X X A V A V A K V X X A V A 4 Revision 1 Up/Down Gradient D(POC) D(POC) D(POC) D(POC) 0 0 0 0 0 0 0 0 0 0 0 0 Filter Pack (ft,bgs) 18.00 28.00 20.00 25.00 28.00 16.00 16.00 23.00 23.50 21.00 29.00 10.00 19.00 26.00 6.00 29 SUMMARY OF PROPOSED GROUND WATER MONITOR WELLS Screen Elev (ft, MSL) 27.25 24.10 30.78 42.70 29.13 24.94 28.85 28.04 29.38 22.46 26.79 27.38 25.89 25.96 24.01 34.41 Screen Depth (ft,bgs) 32.00 19.00 30.00 12.50 22.00 18.00 34.00 17.50 25.00 30.00 25.00 22.50 32.00 33.00 33.00 7.00 Depth to GW (ft,bgs) 31.00 27.70 31.20 29.10 32.02 19.50 26.30 17.30 24.00 22.00 12.00 19.00 15.00 12.58 7.00 9.60 TOC Elevation (ft, MSL) 49.580 lote: These POC designated wells are for Sector 2 only - the first sector to be activated. 62.10 52.44 60.13 61.18 52.68 62.40 54.88 52.68 51.62 58.84 43.87 61.87 59.17 56.60 Ground Elev (ft, MSL) 59.249 58.008 52.375 49.938 48.386 55.958 41.345 50.039 56.096 55.456 41.411 60.197 59.131 47.380 59.787 49.78 Total Depth (ft,bgs) 50.00 33.00 42.00 33.00 42.00 37.00 47.00 42.00 37.00 39.00 38.00 17.00 29.00 33.00 48.00 43.00 MW-9R MW-10 MW-13 MW-15 MW-16 MW-18 MW-11 MW-12 MW-14 MW-24 8-MW 34 MW-9 Monitor Well # MW-3 **MW-5** 9-WW MW-17 **MW-2** MW-4 MW-7 MW-1

Ground Water Monitor Well #1 Measured Total Depth is 41.67 ft from top of PVC All Measures from Top of PVC Well Pipe Elevation** Top PVC 61.867 Feet, MSL

Elevation	Topino		
<u>Date</u>	Depth to Water feet	Elevation of water feet,MSL	Comments
03-29-91	35.6	26.27	
07-30-91	34.5	27.37	
08-08-91	34.69	27.18	
THE PROPERTY OF THE PARTY.	36.88	24.99	
04-14-92	30.02	31.85	
08-11-92	30.6	31.27	
09-28-92	28.61	33.26	
04-05-93	31.4	30.47	
03-14-94	29.02	32.85	
05-10-95	29	32.87	
07-11-96	29.85	32.02	
12-23-96	30.53	31.34	
03-20-97	27.79	34.08	
06-25-97	27.67	34.2	
08-04-97	22.94	38.93	
08-18-97	35.64	26.23	
09-02-97		33.59	
09-15-97	28.28 28.39	33.48	
09-29-97	28.57	33.3	
10-16-97 10-28-97	27.5	34.37	
11-10-97	27.1	34.77	
11-24-97	26.69	35.17	
12-08-97	26.36	35.5	
12-22-97	26.19	35.67	
01-05-98	26.05	35.81 35.98	
01-20-98	25.88 25.92	35.94	
02-02-98	25.92	36.19	
02-18-98 05-18-98	25.21	36.65	
06-16-98	25.54	36.32	
		Ot to Continue	

^{*} City of Kingsville was responsible for the measurements during this period. (used plopper)

^{**} All top of PVC casing elevation have been corrected to McCumber elevation survey of 07-29-97.

Ground Water Monitor Well #3 Measured Total Depth is 37.75 ft from top of PVC All Measures from Top of PVC Well Pipe Elevation** Top PVC 59.173 Feet, MSL

<u>Date</u>	Depth to Water feet	Elevation of water feet	Comments
03-29-91	25.59	33.58	
07-30-91	26.69	32.48	
08-08-91	26.86	32.31	
04-14-92	26.75	32.42	
08-11-92	25.54	33.63	
09-28-92	25.7	33.47	
	27.02	32.15	
04-05-93	26	33.17	
03-14-94	22.98	36.19	
05-10-95	10 may 10 m. 600 m.	37.17	
07-11-96	22	33.14	
12-23-96	26.03		
03-20-97	27.08	32.09	
06-25-97	22.11	37.06	
08-04-97	22.83	36.34	
08-18-97	23.26	35.91	
09-02-97	23.63	35.54	
09-15-97	23.79	35.38	
09-29-97	23.9	35.27	
10-16-97	22.31	36.86	
10-28-97	21.89	37.28	
11-10-97	21.2	37.97	
11-24-97	20.6	38.57	
12-08-97	20.36	38.81	
12-22-97	20.48	38.69	
01-05-98	20.65	38.52	
01-20-98	20.73	- 38.44	
02-02-98	21	38.17	
02-22-98	20.43	38.74	00
05-18-98	21.04	38.13	
06-16-98	21.58	37.59	le for denth

^{*}The City of Kingsville (COK) was responsible for depth measurements during this period. (used plopper)

^{**} All top of PVC casing elevations have been corrected to McCumber elevation survey of 07-29-97.

Ground Water Monitor Well #4 Measured Total Depth is 40.32 ft from top of PVC All Measures from Top of PVC Well Pipe Elevation** Top PVC 60.125 Feet, MSL

<u>Date</u>	Depth to Water feet	Elevation of water feet***	Comments
03-29-91	23.98	35.15	
07-30-91	23.77	35.36	
08-08-91	24.56	34.57	
04-14-92	27.39	31.74	
08-11-92	26.79	32.34	
09-28-92	30.4	28.73	
04-05-93	30.11	29.02	
03-14-94	28	31.13	
	25.02	34.11	
05-10-95	26.13	33	
07-11-96	26.32	32.81	
12-23-96		31.8	
03-20-97	27.33	36.85	
06-25-97	22.28	35.89	
08-04-97	24.24	35.37	
08-18-97	24.76	35.09	
09-02-97	25.04	36.29	
09-15-97	23.84	35.53	
09-29-97	24.6 23.16	36.97	
10-16-97	21.81	38.32	
10-28-97	22.19	37.94	
11-10-97	20.65	39.47	
11-24-97	20.52	39.60	
12-08-97	20.73	39.39	
12-22-97 01-05-98	20.99	39.13	
01-05-98	21.24	38.88	
02-02-98	21.52	38.60	
02-02-98	20.72	39.40	
05-18-98	21.96	38.16	
06-16-98	22.69	37.43	le for donth

^{*}The City of Kingsville (COK) was responsible for depth measurements during this period. (used plopper)

^{**} All top of PVC casing elevations have been corrected to McCumber elevation survey of 07-29-97.

^{***} One foot has been subtracted from the calculated water depth for MW #4, due to the addition of a 12.00" extension to the top of the well casing between the time of measurement of depth to water and the time of the McCumber elevation survey.

Ground Water Monitor Well #6 Measured Total Depth is 39.15 ft from top of PVC All Measures from Top of PVC Well Pipe Elevation** Top PVC 56.604 Feet, MSL

		100	28
<u>Date</u>	Depth to Water feet	Elevation of water feet	Comments
03-29-91	21.35	35.25	
	22.02	34.58	
07-30-91	21.44	35.16	
08-08-91	21.92	34.68	5
04-14-92		31.35	
08-11-92	25.25		
09-28-92	27	29.6	
04-05-93	27.11	29.49	
03-14-94	25.25	31.35	
05-10-95	Not	measured	
07-11-96	26.29	30.31	
12-23-96	28.19	28.41	
03-20-97	28.06	28.54	
06-25-97	Not	measured	
08-04-97	23.31	33.29	
08-18-97	24.01	32.59	
09-02-97	24.53	32.07	
09-15-97	24.69	31.91	
09-29-97	24.48	32.12	
10-16-97	17.74	38.86	
10-28-97	17.59	39.01	
11-10-97	18.3	38.3	
11-24-97	18.23	38.37	
12-08-97	18.35	38.25	
12-22-97	19.11	37.49 . 37.18	
01-05-98	19.42	37.18	
01-20-98	19.55	37.49	
02-02-98	19.11 18.64	37.96	÷
02-18-98 05-18-98	19.30	37.30	
06-16-98	20.38	36.22	
			la for donth

^{*}The City of Kingsville (COK) was responsible for depth measurements during this period. (used plopper)

^{**} All top of PVC casing elevations have been corrected to McCumber elevation survey of 07-29-97.

Ground Water Monitor Well #8 Measured Total Depth is 43.65 ft from top of PVC All Measures from Top of PVC Well Pipe Elevation** Top PVC 61.178 Feet, MSL

<u>Date</u>	Depth to Water feet	Elevation of water feet	Comments
03-29-91	Not	Drill'd	
07-30-91	27.67	33.51	
08-08-91	27.5	33.68	
	26.77	34.41	
04-14-92	27.52	33.66	
08-11-92	28.3	32.88	
09-28-92	- Device it	32.01	
04-05-93	29.17	33.08	
03-14-94	28.1		
05-10-95	28.46	32.72	
07-11-96	29.4	31.78	
12-23-96	30.38	30.8	
03-20-97	30.22	30.96	
06-25-97	Not	Measured	
08-04-97	27.37	33.81	
08-18-97	35.36	25.82	
09-02-97	35.76	25.42	
09-15-97	28.42	32.76	
09-29-97	28.14	33.04	
10-16-97	22.07	39.11	
10-28-97	22.74	38.44	
11-10-97	22.73	38.45	
11-24-97	23.06	38.11	
12-08-97	23.83	37.34	
12-22-97	24.38	36.79	
01-05-98	24.72	36.45	
01-20-98	24.91	36.26	
02-02-98	24.72	36.45	
02-18-98	23.14	38.03	
05-18-98	25.19	35.98	
06-16-98	25.89	35. <u>28</u>	- for donth

^{*}The City of Kingsville (COK) was responsible for depth measurements during this period. (used plopper)

^{**} All top of PVC casing elevations have been corrected to McCumber elevation survey of 07-29-97.

Ground Water Monitor Well #9R Measured Total Depth is 18.29 ft from top of PVC All Measures from Top of PVC Well Pipe Elevation** Top PVC 44.849 Feet, MSL

<u>Date</u>	Depth to Water feet	Elevation of water feet	Comments
03-29-91	Not	Drill'd	
07-30-91	Not	Drill'd	
08-08-91	Not	Drill'd	
04-14-92	Not	Drill'd	
08-11-92	Not	Drill'd	
09-28-92	Not	Drill'd	
04-05-93	Not	Drill'd	
03-14-94	Not	Drill'd	
05-14-95	Not	Drill'd	
07-11-96	12.57	32.28	
12-23-96	14.02	30.83	
03-20-97	13.76	31.09	
	Not	Measured	
06-25 - 97 08-04 - 97	10.49	34.36	
08-04-97	10.56	34.29	
09-02-97	10.45	34.4	
09-15-97	10.43	34.42	
09-29-97	9.85	35	
10-16-97	9.85	35	
10-28-97	9.85	35	
11-10-97	9.85	35	6
11-24-97	6.10	38.74	
12-08-97	6.35	38.49	
12-22-97	6.60	38.24	
01-05-98	6.93	37.91	
01-20-98	7.35	37.49 38.60	
02-02-98	6.24	38.61	
02-18-98	6.23		
05-18-98 06-16-98	7.93 8.65	36.91 36.19	
00-10-90	0.00	30.19	corrected to M

^{**} All top of PVC casing elevations have been corrected to McCumber elevation survey of 07-29-97.

Ground Water Monitor #10 Measured Total Depth is 31.48 ft from top of PVC All Measures from Top of PVC Well Pipe Elevation*** Top PVC 52.684 Feet, MSL

	<u>Date</u>	Depth to Water feet	Elevation of water feet	Comments
	03-29-91	Not	_ Drill'd	
	07-30-91	Not	Drill'd	
	08-08-91	Not	Drill'd	
	04-14-92	18.49	34.19	
	08-11-92	16.59	36.09	
	09-28-92	18.9	33.78	
	04-05-93	17.76	34.92	
*	03-14-94	17.5	35.18	
*	05-14-95	19.02	33.66	
*	07-11-96	19.36	33.32	
	12-23-96	20.91	31.77	
	03-20-97	21.33	31.35	
	06-25-97	17.35	35.33	
	08-04-97	18.16	34.52	
	08-18-97	18.16	34.52	
	09-02-97	18.31	34.37	
	09-15-97	18.32	34.36	
	09-29-97	18.26	34.42	
	10-16-97	16.56	36.12	
	10-28-97	15.58	37.1	
	11-10-97	15.35	37.33	
	11-24-97	15.01	37.67	
	12-08-97	15.06	37.62	
	12-22-97	15.19	37.49	
	01-05-98	15.24	37.44	
	01-20-98	15.25	37.43	19
	02-02-98	15.23	37.45	
	02-18-98	14.70	37.98	
	05-18-98 06-16-98	15.18 15.58	37.50 37.10	
			ible	o for denth

^{*}The City of Kingsville (COK) was responsible for depth measurements during this period. (used plopper)

Revision: 1 - November 2018

^{**} Due to surface water infiltration, a riser was installed and a taller casing protector was added. Three (3) foot was added to the "Top of PVC" datum point.

^{***} All top of PVC casings have been corrected to McCumber elevation survey of 07-29-97.

Ground Water Monitor Well #11 Measured Total Depth is 35.21 ft from top of PVC All Measures from Top of PVC Well Pipe Elevation** Top PVC 62.401 Feet, MSL

Date Depth Elevation Communication of water feet O3-29-91 Not Drill'd Not Drill'd	ments
03-29-91	
Deille	
07-30-91 Not Drill'd	
08-08-91 Not Drill'd	
04-14-92 Not Drill'd	
08-11-92 Not Drill'd	
09-28-92 Not Drill'd	
03-20-02	
04-03-33	
03-14-04	
05-10-95	
07-11-90	
12-23-90	
03-20-97	
06-25-97	
00-04-37	
00-10-97	
09-02-97	
09-10-97	
09-23-31	
10-10-97	
10-10-97	
11-10-97	
11-24-37	
12-00-37	
12-22-31	
01-00-30	
01-20-98 23.22 39.18 02-02-98 23.02 39.38	
02-18-98 22.22 40.18	
05-18-98 24.02 38.38	
06-16-98 24.90 37.50	1 4- 1/10

^{**} All top of PVC casing elevations have been corrected to McCumber elevation survey of 07-29-97.

Ground Water Monitor Well #12 Elevation** Top PVC 54.879 Feet, MSL

<u>Date</u>	Depth to Water feet	Elevation of water feet	Comments
03-29-91	Not	Drill'd	
07-30-91	Not	Drill'd	
08-08-91	Not	Drill'd	
04-14-92	Not	Drill'd	
08-11-92	Not	Drill'd	
09-28-92	Not	Drill'd	
04-05-93	Not	Drill'd	
03-14-94	Not	Drill'd	
05-10-95	Not	Drill'd	
07-11-96	Not	Drill'd	
12-23-96	Not	Drill'd	
03-20-97	Not	Drill'd	
06-25-97	Not	Drill'd	
08-04-97	20.97	33.91	
08-18-97	21.42	33.46	
09-02-97	21.82	33.06	
09-15-97	22.01	32.87	
09-29-97	22.09	32.79	
10-16-97	19.58	35.3	
10-28-97	19.61	35.27	
11-10-97	19.34	35.54	
11-24-97	18.65	36.22	
12-08-97	18.51	36.36	
12-22-97	18.54	36.33	
01-05-98	18.51	36.36	
01-20-98	18.49	36.38	
02-02-98	18.42	36.45	
02-18-98	17.81	37.06	
05-18-98	18.09	36.78	
06-16-98	18.82	36.05	heen corrected

^{**} All top of PVC casing elevations have been corrected to McCumber elevation survey of 07-29-97.

Ground Water Monitor Well #13 Elevation** Top PVC 62.096 Feet, MSL

<u>Date</u>	Depth to Water feet	Elevation of water feet	Comments
03-29-91	Not	Drill'd	
07-30-91	Not	Drill'd	
08-08-91	Not	Drill'd	
04-14-92	Not	Drill'd	
08-11-92	Not	Drill'd	
09-28-92	Not	Drill'd	
04-05-93	Not	Drill'd	
03-14-94	Not	Drill'd	
05-14-94	Not	Drill'd	
07-11-96	Not	Drill'd	
12-23-96	Not	Drill'd	
4-200 OLD 100 CONTROL	Not	Drill'd	
03-20-97	Not	Drill'd	
06-25-97	1000000000000000000000000000000000000	33.24	
08-04-97	28.86	32.95	
08-18-97	29.15	32.94	
09-02-97	29.16 29.33	32.77	
09-15-97	29.33	32.84	
09-29-97	28.53	33.57	
10-16-97	27.55	34.55	
10-28-98 11-10-97	27.12	34.98	
11-10-97	26.68	35.41	
12-08-97	26.49	35.60	
12-00-97	26.61	35.48	
01-05-98	26.71	35.38	
01-20-98	26.81	35.28	
02-02-98	27.17	34.92	
02-18-98	26.62	35.47	
05-18-98	26.62	35.47	
06-16-98	27.10	34.99	

^{**} All top of PVC casing elevations have been corrected to McCumber elevation survey of 07-29-97.

Ground Water Monitor Well #14
Elevation** Top PVC 52.677 Feet, MSL

<u>Date</u>	Depth to Water feet	Elevation of water feet	Comments
	1001		
03-29-91	Not	Drill'd	
07-30-91	Not	Drill'd	
08-08-91	Not	Drill'd	
04-14-92	Not	Drill'd	
08-11-92	Not	Drill'd	
09-28-92	Not	Drill'd	
	Not	Drill'd	
04-05-93	Not	Drill'd	
03-14-94	Not	Drill'd	
05-10-95	77.031/207	Drill'd	×
07-11-96	Not	Drill'd	
12-23-96	Not		
03-20-97	Not	Drill'd	
06-25-97	Not	Drill'd	
08-04-97	25.65	27.03	
08-18-97	25.88	26.8	
09-02-97	26.05	26.63	
09-15-97	25.95	26.73	
09-29-97	25.77	26.91	
10-16-97	25.46	27.22	
10-28-97	25.08	27.6	
11-10-97	24.66	28.02	
11-24-97	24.25	28.42	
12-08-97	23.89	28.78	
12-22-97	23.64	29.03	
01-05-98	23.63	29.04	
01-20-98	23.37	29.30	
02-02-98	23.51	29.16	
02-18-98	23.10	29.57	
05-18-98	22.52	30.15	
06-16-98	22.67	30.00	

^{**} All top of PVC casing elevations have been corrected to McCumber elevation survey of 07-29-97.

Ground Water Monitor Well #15 Elevation** Top PVC 51.624 Feet, MSL

*!	Date	Depth	Elevation	Comments
		to Water	of water	
		<u>feet</u>	<u>feet</u>	
	03-29-91	Not	Drill'd	
	07-30-91	Not	Drill'd	
	08-08-91	Not	Drill'd	
	04-14-92	Not	Drill'd	
	08-11-92	Not	Drill'd	
	09-28-92	Not	Drill'd	
	04-05-93	Not	Drill'd	
	03-14-94	Not	Drill'd	
	05-14-94	Not	Drill'd	
	07-11-96	Not	Drill'd	
	12-23-96	Not	Drill'd	
		Not	Drill'd	
	03-20-97	Not	Drill'd	
	06-25-97 08-04-97	17.47	34.15	
	08-04-97	18.17	33.45	
	09-02-97	18.47	33.15	
	09-15-97	18.68	32.94	
	09-29-97	18.65	32.97	
	10-16-97	10.19	41.43	
	10-28-97	10.16	41.46	
	11-10-97	8.14	43.48	
	11-24-97	8.19	43.43	
	12-08-97	7.62	44.00	
	12-22-97	9.05	42.57	
	01-05-98	9.89	41.73	
	01-20-98	10.54	41.08	
	02-02-98	9.54	42.08	
	02-18-98	8.91	42.91	
	05-18-98	11.98	39.64	
	06-16-98	13.16	38.46	- 12 VV V

^{**} All top of PVC casing elevations have been corrected to McCumber elevation survey of 07-29-97.

Ground Water Monitor Well #16 Elevation** Top PVC 58.839 Feet, MSL

<u>Date</u>	Depth to Water feet	Elevation of water feet	Comments
03-29-91	Not	Drill'd	
07-30-91	Not	Drill'd	
08-08-91	Not	Drill'd	
Acres Carron Common Com	Not	Drill'd	
04-14-92	Not	Drill'd	
08-11-92		Drill'd	
09-28-92	Not	Drill'd	
04-05-93	Not		
03-14-94	Not	Drill'd	
05-10-95	Not	Drill'd	
07-11-96	Not	Drill'd	
12-23-96	Not	Drill'd	
03-20-97	Not	Drill'd	
06-25-97	Not	Drill'd	
08-04-97	24.21	34.63	
08-18-97	24.63	34.21	
09-02-97	24.94	33.9	
09-15-97	24.95	33.89	
09-29-97	24.81	34.03	
10-16-97	23.32	35.52	(8)
10-28-97	22.75	36.09	
11-10-97	22.46	36.38	
11-24-97	21.94	36.89	
12-08-97	21.70	37.13	
12-22-97	21.71	37.12	
01-05-98	21.66	37.17	
01-20-98	21.67	37.16	
02-02-98	21.74	37.09	
02-18-98	21.28	37.55	
05-18-98	21.62	37.21	
06-16-98	22.27	36.56	corrected to Mo

^{**} All top of PVC casing elevations have been corrected to McCumber elevation survey of 07-29-97.

Ground Water Monitor Well #17
Elevation** Top PVC 43.868 Feet, MSL

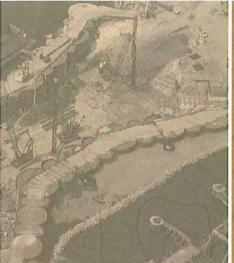
<u>Date</u>	Depth to Water feet	Elevation of water feet	Comments
03-29-91	Not	Drill'd	
07-30-91	Not	Drill'd	
08-08-91	Not	Drill'd	
04-14-92	Not	Drill'd	
08-11-92	Not	Drill'd	
09-28-92	Not	Drill'd	
04-05-93	Not	Drill'd	
03-14-94	Not	Drill'd	
05-14-94	Not	Drill'd	
07-11-96	Not	Drill'd	
12-23-96	Not	Drill'd	
	Not	Drill'd	
03-20-97		Drill'd	
06-25-97	Not	34.54	
08-04-97	9.33	34.18	
08-18-97	9.69	33.95	
09-02-97	9.92	34.19	
09-15-97	9.68 8.99	34.88	
09-29-97	4.28	39.59	
10-16-97	4.44	39.43	
10-28-97 11-10-97	3.64	40.23	
11-10-97	4.01	39.85	
12-08-97	4.45	39.41	
12-08-97	4.91	38.95	
01-05-98	5.58	38.28	
01-20-98	6.13	37.73	
02-02-98	3.82	40.04	
02-02-98	4.37	39.49	
05-18-98	6.40	37.46	
06-16-98	7.40	36.46	

^{**} All top of PVC casing elevations have been corrected to McCumber elevation survey of 07-29-97.

Ground Water Monitor Well #18
Elevation** Top PVC 52.438 Feet, MSL

- Development Company	Carrier 100 Sec 570-500		
<u>Date</u>	Depth to Water feet	Elevation of water feet	Comments
03-29-91	Not	Drill'd	
07-30-91	Not	Drill'd	
08-08-91	Not	Drill'd	
04-14-92	Not	Drill'd	
08-11-92	Not	Drill'd	
09-28-92	Not	Drill'd	
04-05-93	Not	Drill'd	
03-14-94	Not	Drill'd	
	Not	Drill'd	
05-10-95	Not	Drill'd	
07-11-96		Drill'd	
12-23-96	Not		
03-20-97	Not	Drill'd	
06-25-97	Not	Drill'd	
08-04-97	18.61	33.83	
08-18-97	18.47	33.97	
09-02-97	18.92	33.52	
09-15-97	18.78	33.66	
09-29-97	18.71	33.73	
10-16-97	16.65	35.79	
10-28-97	15.8	36.64	
11-10-97	15.14	37.3	
11-24-97	14.62	37.81	
12-08-97	14.25	38.18	
12-22-97	14.48	37.95	
01-05-98	14.67	37.76	
01-20-98	14.88	37.55	
02-02-98	15.16	37.27	
02-18-98 05-18-98	14.23 15.09	38:20 37.34	
06-16-98	15.09	36.51	
00-10-90	10.02	30.01	

^{**} All top of PVC casing elevations have been corrected to McCumber elevation survey of 07-29-97.



Tolunay-Wong Engineers, Inc.

GEOTECHNICAL ENGINEERING STUDY CITY OF KINGSVILLE MUNICIPAL SOLID WASTE LANDFILL EXPANSION KINGSVILLE, TEXAS

Prepared for:

Naismith/Hanson Corpus Christi, Texas

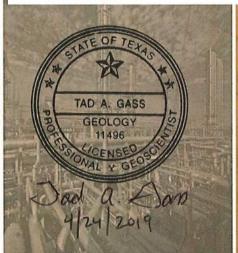
Prepared by:

Tolunay-Wong Engineers, Inc. 826 South Padre Island Drive Corpus Christi, Texas 78416

August 30, 2018

Project No. 16.53.042 / Report No. 12788R1

For Permitting Purposes Only. Applies to boring logs in Appendix B of Tolunay-Wong Engineers, Inc. Geotechnical Engineering Study, City of Kingsville Municipal Solid Waste Landfill Expansion, Kingsville, Texas – Report No. 12788R1, sealed by Don R. Rokohl, P.E. on 8-30-18 altered to provide text showing surface elevations, the elevations of all contacts between soil and rock layers, and unit identifiers in the soil boring logs. No information or data was altered or changed from the original report other than the addition of text showing these elevations and unit identifiers in Appendix B.



GEOTECHNICAL ENGINEERING, DEEP FOUNDATIONS TESTING, ENVIRONMENTAL SERVICES, CONSTRUCTION MATERIALS TESTING

1-888-887-9932 WWW.TWEINC.COM

PROJEC	LOG OF BOTE CLIEN		IG B			ring, lı	nc.					
	Municipal Solid Waste Landfill Aerial Expansion			J		Ű,						
DEPTH (ft) SAMPLE TYPE SYMBOLUSCS	COORDINATES: N 27° 26' 44.0" W 97° 49' 23.1" SURFACE ELEVATION: 45.99' AMSL DRILLING METHOD: Dry Augered: 0-ft. to 82.5-ft. Wash Bored: to	(P) POCKET PEN (tsf) (T) TORVANE (psf)	STD. PENETRATION TEST (blows/ft)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	-AILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
	MATERIAL DESCRIPTION	©,F	S		ă				₹			
0 -	Dense to very dense tan and gray CLAYEY SAND (SC) with gypsum crystals		11/6" 23/6" 50/5"	16		42	17				37	
- 5 -	-color changes to tan with ferrous staining		34/6" 50/3"									
- 10 -	-with sand partings		13/6" 50/3"									
- 15 -			7/6" 12/6" 20/6"	35							33	
	-color changes to reddish tan and light gray		6/6" 15/6" 20/6"									
20 -	Very stiff to hard reddish tan and light gray FAT CLAY (CH) with gypsum crystals LIGHT OLIVE GREEN TO GRAY CLAY		10/6" 17/6" 26/6"									
- 25 -	-color changes to reddish tan and tan		10/6" 18/6" 30/6"	25		50	28				92	
30	-color changes to tan and reddish brown		8/6" 11/6" 16/6"									
- 35 -	-color changes to tan and gray		8/6" 12/6" 18/6"									
DATE BOI	RING COMPLETED: 07/23/2016 was a J. Gonzalez	during out	as encou drilling op n of 10'-6 I with cen	eratic	ns. A	fter a 1 mpletion	0 to 1	15-minu	ıte wa	iting p	eriod,	water
1.1.00201	TOLUNAY-WONG	ENG	INEERS	S. INC	D					Pag	e1 of	3

PROJEC	Municipal Solid Waste Landfill	ORIN NT: N	IG B laismith	-30 Eng	inee	ring, lı	nc.					
DEPTH (ft) SAMPLE TYPE SYMBOLUSCS	Aerial Expansion COORDINATES: N 27° 26' 44.0" W 97° 49' 23.1" SURFACE ELEVATION: 45.99' AMSL DRILLING METHOD: Dry Augered: 0-ft. to 82.5-ft. Wash Bored: to	(P) POCKET PEN (tsf) (T) TORVANE (psf)	STD. PENETRATION TEST (blows/ft)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
- 35 -	Very stiff to hard reddish tan and tan FAT CLAY (CH)											
	with gypsum crystals and ferrous stains LIGHT OLIVE GREEN TO GRAY CLAY	,	10/6" 17/6" 21/6"	30							90	
40 -	-color changes to tan and reddish brown		9/6" 14/6" 21/6"									
45			13/6" 19/6" 29/6"									
- 50	-becomes sandy 48' to 52'		8/6" 11/6" 13/6"	30							70	
	-color changes to tan and becomes slickensided	(P) 4.50+		23	100	71	51				87	
- 55 -		(P) 4.50+										
- 60		(P) 4.50+										
- 65 -	-becomes sandy and color changes to tan and gray	(P) 4.50+		26	97	54	30	1.75	3		69	
70	-color changes to tan and reddish brown with trace calcareous nodules	(P) 3.00										
DATE BOR	RING COMPLETED: 07/23/2016 was a J. Gonzalez	water wa e during d at a depth backfilled	drilling op n of 10'-6	eratic	ns. A he co	fter a 1	0 to 1	15-minu	ıte wa	iting p	eriod,	water
NOOLOT	TOLUNAY-WONG	ENGI	NEERS	s. INC	D	-				Pag	e2 of	3

PROJECT: City of Kingsville Municipal Solid Aerial Expansion	Waste Landfill	BORIN ENT: N	IG B Naismith	3-31 Eng	ineer	ring, lı	nc.					
SURFACE ELEVATION DRILLING METHOD: Dry Auge Wash Bo	97° 49' 24.3" I: 58.37' AMSL ered: 0-ft. to 68-ft. ered: to	(P) POCKET PEN (tsf) (T) TORVANE (psf)	STD. PENETRATION TEST (blows/ft)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	-AILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
MATER	AL DESCRIPTION	<u> </u>	S		□				Ā			
	y dense gray CLAYEY SAND (S BODY	1	4/6" 5/6" 7/6"									
	ules and sand pockets		10/6" 22/6" 18/6" 4/6"	11							46	
- 5 -			5/6" 6/6"	''							40	
			6/6" 8/6" 6/6"									
-10 -with cemented sand	layers		8/6" 12/6" 8/6" 27/6"	27							22	
-color changes to tan			29/6" 29/6" 18/6" 32/6"									
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	43.87' AMS		39/6"									
-15 - X Yery dense tan POO (SP-SC) and sand pa	RLY GRADED SAND with CLAY rtings BODY IV		36/6" 50/5" 12/6" 50/5"	15							9	
			45/6" 50/5" 35/6"									
- 20 -			50/4" 17/6" 26/6"									
	34.87' AMS	SL	50/5" 17/6" 38/6" 38/6"									
CLAY (CL-ML) with s	light gray SANDY LEAN SILTY and partings		13/6" 20/6" 31/6" 23/6" 34/6" 50/4" 12/6" 17/6" 50/5"	26		29	7				66	
-color changes to red stains	dish tan and tan with ferrous		13/6" 32/6" 50/5" 7/6" 36/6" 39/6" 10/6" 21/6" 36/6" 10/6"	25							62	
35			18/6" 35/6"									
COMPLETION DEPTH: DATE BORING STARTED: DATE BORING COMPLETED: LOGGER: PROJECT NO.:	07/21/2016 wa	ee water wa de during of s at a dept s backfilled	drilling op h of 21'-6	eratic 5". At t	ns. A	fter a 1 mpletio	0 to 1	15-minu	ıte wa	iting p	eriod,	water
	TOLUNAY-WONG	ENO.	INEERS	S INIZ	,	-				Pag	e1 o	f 2

PRO	OJ	IEC ⁻	Municipal Solid Waste Landfill Aerial Expansion	ORIN NT: N	IG B laismith	-31 Eng	inee	ring, lı	nc.					
DEPTH (ft)	SAMPLE TYPE	SYMBOL/USCS	COORDINATES: N 27° 26' 50.1" W 97° 49' 24.3" SURFACE ELEVATION: 58.37' AMSL DRILLING METHOD: Dry Augered: 0-ft. to 68-ft. Wash Bored: to	(P) POCKET PEN (tsf) (T) TORVANE (psf)	STD. PENETRATION TEST (blows/ft)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	-AILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
	_	Λ.	MATERIAL DESCRIPTION	€ [™]	S		□				₹			
35	X		Hard reddish tan and tan SANDY LEAN CLAY (CL) with ferrous stains and laminated sands		17/6" 25/6" 35/6" 17/6" 13/6" 19/6" 7/6"									
40 -	$\frac{\lambda}{2}$		18.87' AMSL Very stiff to hard reddish tan and tan FAT CLAY with		16/6" 17/6" 3/6"	 								
+0	X X		SAND (CH) and ferrous stains LIGHT OLIVE GREEN TO GRAY CLAY		7/6" 10/6" 9/6" 20/6" 27/6" 5/6" 14/6"	37		59	36				76	
45 -	X		-with trace gypsum crystals and ferrous stains		17/6" 10/6" 18/6" 21/6" 18/6" 23/6" 30/6" 6/6" 20/6"									
50	X		-with calcareous nodules and ferrous stains	(P) 4.50+	21/6" 9/6" 17/6" 19/6" 9/6" 18/6" 23/6" 11/6" 23/6" 26/6"	30	91	83	50	4.14	2		83	
55 -				(P) 4.50+										
60 -				(P) 4.50+		34	87			2.88	2		83	
			-with trace gypsum crystals and ferrous stains	(P) 4.50+ (P) 4.50+										
65 -				(P) 4.50+										
			-9.63' AMSL	(P) 4.50+										
70 -			Bottom @ 68'											
DAT DAT	Ē	BOR	ING COMPLETED: 07/21/2016 was a	water wa e during d at a depth backfilled	Irilling op of 21'-6	eratio ". At t	ns. A he co	fter a 1 mpletio	0 to 1	15-minu	ıte wa	iting p e ope	eriod	, water e-hole

PR	O	JEC1	Municipal Solid Waste Landfill Aerial Expansion	NT: N	laismith	Eng	inee	ring, l	nc.					
DEPTH (ft)	SAMPLE TYPE	SYMBOL/USCS	COORDINATES: N 27° 26' 49.7" W 97° 49' 17.0" SURFACE ELEVATION: 48.46' AMSL DRILLING METHOD: Dry Augered: 0-ft. to 82.5-ft. Wash Bored: to	(P) POCKET PEN (tsf) (T) TORVANE (psf)	STD. PENETRATION TEST (blows/ft)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	-AILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
		٨	MATERIAL DESCRIPTION	(E)	S						₹			
35 -			Medium dense to dense reddish tan and gray CLAYEY SAND (SC) with gypsum crystals 12.46' AMSL/Very stiff to hard tan FAT CLAY with SAND (CH), slickensided, with calcareous nodules	(P) 4.50+		29	89						79	
40 -			LIGHT OLIVE GREEN TO GRAY CLAY -color changes to tan and reddish brown with gypsum		8/6"									
45 -	X		crystals and ferrous stains -color changes to tan, gray, and reddish brown	(P) 4.50+	12/6" 15/6"									
50 -			-color changes to tan, gray, and reddish brown	(, , , , , , , , , , , , , , , , , , ,	4/6" 9/6" 10/6"	30		73	51				82	
55 -			-color changes to tan and gray	(P) 4.50+ (P) 4.50+										
65 -			-color changes to tan, red, and brown	(P) 4.50+ (P) 4.00		26	94			0.61	2		81	
			-color changes to tan and gray	(P) 4.50+										
70 -		AV.	3 3 4											
DA ⁻	TE TE	BOR	ING COMPLETED: 07/28/2016 was a	e during d at a depth backfilled	Irilling op n of 14'-7	eratic ". At t nent-b	ons. A he co pentor	fter a 1 mpletionite gro	10 to 1 on of tout.	15-minu the bori	ute wa	iting p e ope	eriod,	, water

PR	.О.	JECT	City of Kingsville CLIEN Municipal Solid Waste Landfill Aerial Expansion	ORIN	IG B laismith	3-32 Eng	inee	ring, lı	nc.					
DEPTH (ft)	SAMPLE TYPE	SYMBOL/USCS	COORDINATES: N 27° 26' 49.7" W 97° 49' 17.0" SURFACE ELEVATION: 48.46' AMSL DRILLING METHOD: Dry Augered: 0-ft. to 82.5-ft. Wash Bored: to	(P) POCKET PEN (tsf) (T) TORVANE (psf)	STD. PENETRATION TEST (blows/ft)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
		٨	MATERIAL DESCRIPTION	(F)	ST						₹			
- 70 -			Very stiff to hard tan and gray FAT CLAY with SAND (CH), slickensided with gypsum crystals and calcareous nodules LIGHT OLIVE GREEN TO GRAY CLAY -24.54' AMSL											
- 75 -			Medium dense to dense tan CLAYEY SAND (SC) with calcareous nodules	(P) 0.75		21		24	8				24	
	X		-with gypsum crystals and ferrous stains		5/6" 10/6" 13/6"									
- 80 -	X		-34.04' AMSL Bottom @ 82.5'		13/6" 20/6" 20/6"									
- 85 -														
- 90 -														
- 95 -														
-100-														
-105-														
DA ¹	TE TE	BOR	ING COMPLETED: 07/28/2016 was a	during out a depth	es encou drilling op n of 14'-7 with cer	eratio	ns. A he co	fter a 1 mpletio	0 to 1	15-minເ	ıte wa	iting p e ope	eriod, n bore	water e-hole
			 TOLUNAY-WONG	ENGI	NEERS	S, IN(D					Pag	e3 o	f 3

PROJEC	T: City of Kingsville CLIEN Municipal Solid Waste Landfill Aerial Expansion		IG B laismith			ring, lı	nc.					
DEPTH (ft) SAMPLE TYPE SYMBOLUSCS	COORDINATES: N 27° 26' 55.9" W 97° 49' 11.3" SURFACE ELEVATION: 64.51' AMSL DRILLING METHOD: Dry Augered: 0-ft. to 86-ft. Wash Bored: to	(P) POCKET PEN (tsf) (T) TORVANE (psf)	STD. PENETRATION TEST (blows/ft)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pdf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
	MATERIAL DESCRIPTION	(a) E	ST						Ε			
- 0 -	Medium dense to very dense tan CLAYEY SAND (SC) with gypsum crystals BODY I		2/6" 7/6" 9/6"									
- 5 -	-color changes to dark gray and gray with trace gravel		7/6" 11/6" 9/6"	16							47	
- 10 -	-color changes to tan and light gray sand partings		27/6" 50/6"									
15 - 222	-color changes to tan and white with trace caliche		50/5"									
1333	48.01' AMSL		47/01	44		05					40	
A WEST	Dense to very dense tan and white POORLY GRADED SAND with SILT (SP-SM), and trace caliche		17/6" 48/6" 50/3"	11		35	8				12	
- 20 -	BODY II											
20			17/6" 21/6" 27/6"									
- 25 - 135 (1) 135 (1) 135 (1) 135 (1) 135 (1) 135 (1) 135 (1) 135 (1)	-color changes to light gray and tan with gypsum crystals and ferrous stains		15/6" 17/6" 32/6"									
	₹ 36.01' AMSL Medium dense to dense gray and white CLAYEY SAND		14/6"	42							20	
- 30	(SC) with gypsum crystals		22/6" 26/6"									
35 -	-color changes to tan		13/6" 21/6" 22/6"									
'											<u> </u>	
DATE BOR	RING COMPLETED: 08/05/2016 was a	during of the deptile	as encour drilling op h of 28'-2 I with cen	eratio	ns. A he co	fter a 1 mpletic	0 to 1	15-minu	ıte wa	iting p e opei	eriod,	water e-hole
	TOLUNAY-WONG	ENG	INEERS	S. INC	D					9		

PR	O.	JEC1	Municipal Solid Waste Landfill Aerial Expansion	ORIN IT: N	IG B	3-33 Eng	inee	ring, l	nc.					
DEPTH (ft)	SAMPLE TYPE	SYMBOL/USCS	COORDINATES: N 27° 26' 55.9" W 97° 49' 11.3" SURFACE ELEVATION: 64.51' AMSL DRILLING METHOD: Dry Augered: 0-ft. to 86-ft. Wash Bored: to	(P) POCKET PEN (tsf) (T) TORVANE (psf)	STD. PENETRATION TEST (blows/ft)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	-AILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
	H	l l	MATERIAL DESCRIPTION	<u> </u>	·ω						12			
35 -			Medium dense to dense reddish tan CLAYEY SAND (SC) with gypsum crystals and ferrous stains		6/6" 9/6" 12/6"									
40 -	X		-color changes to tan and reddish tan		8/6" 16/6" 18/6"									
	L		20.01' AMSL											
45 -	X		Stiff to very stiff reddish tan LEAN CLAY with SAND (CL), slickensided, with ferrous stains SANDY SILTY CLAY BED		9/6" 12/6" 18/6"	29		43	24				79	
50 -	X		-color changes to reddish tan and tan with gypsum crystals		5/6" 6/6" 9/6"									
			12.51' AMSL											
			Stiff to very stiff LEAN CLAY (CL), slickensided, with ferrous stains SANDY SILTY CLAY BED	(P) 2.00		40	79			1.06	3		96	
55 -			-color changes to reddish brown and tan with gypsum crystals	(P) 3.50										
60 -				(P) 4.00		34	87							
			-0.51' AMSL	(D) 4 50 :		00	40	0.4	00	0.57			0.5	
65 -			Very stiff to hard tan FAT CLAY (CH), slickensided, with gypsum crystals and ferrous stains	(r) 4.5U+		32	42	64	33	2.57	2		95	
			LIGHT OLIVE GREEN TO GRAY CLAY											
70 -	X		-color changes to tan and reddish brown		7/6" 12/6" 14/6"									
DA DA	TE TE GG	BOR	ING COMPLETED: 08/05/2016 was a J. Gonzalez	water wa during d t a depth ackfilled	Irilling op of 28'-2	eratio	ns. A he co	fter a 1	10 to 1 on of t	15-minເ	ıte wa	iting p e ope	eriod,	, wate e-hole

PR	О.	JEC1	LOG OF B CLIEN		IG B			ring, lı	nc.					
			Municipal Solid Waste Landfill Aerial Expansion			J		0,						
DEPTH (ft)	SAMPLE TYPE	SYMBOL/USCS	COORDINATES: N 27° 26' 55.9" W 97° 49' 11.3" SURFACE ELEVATION: 64.51' AMSL DRILLING METHOD: Dry Augered: 0-ft. to 86-ft. Wash Bored: to	(P) POCKET PEN (tsf) (T) TORVANE (psf)	STD. PENETRATION TEST (blows/ft)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	-AILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
		N.	MATERIAL DESCRIPTION	(a)	ST						₹			
- 70 -			Very stiff to hard tan and reddish brown FAT CLAY (CH), slickensided, with gypsum crystals and ferrous stains LIGHT OLIVE GREEN TO GRAY CLAY -color changes to tan and light gray	(P) 4.50+										
- 75 -	X		-with layers of calcareous nodules		9/6" 10/6" 21/6"									
			17 101 13 707											
- 80 -			-15.49' AMSL Very stiff to hard tan FAT CLAY with SAND (CH) with	(P) 4.50+		18	106			3.57	3		77	
			gypsum crystals and ferrous stains LIGHT OLIVE GREEN TO GRAY CLAY											
- 85 -			-color changes to tan and white -21.49' AMSL	(P) 4.50+										
		<i>≥2.%</i>	Bottom @ 86'											
- 90 -														
- 95 -														
-100-														
-105-														
DA DA LO	TE TE GG	BOR	ING COMPLETED: 08/05/2016 was a J. Gonzalez	e during o	as encour drilling op n of 28'-2 with cen	eratio ". At t	ns. A he co	fter a 1	0 to 1	15-minu	ıte wa	iting p e opei	eriod, n bore	water -hole
			 TOLUNAY-WONG	ENGI	NEERS	S, INC	D					Pag	e3 of	3

PROJEC	T: City of Kingsville CLIEN Municipal Solid Waste Landfill Aerial Expansion	ORIN NT: N	IG B laismith	8-34 n Eng	inee	ring, l	nc.					
DEPTH (ft) SAMPLE TYPE SYMBOLUSCS	COORDINATES: N 27° 26' 43.4" W 97° 49' 11.4" SURFACE ELEVATION: 61.14' AMSL DRILLING METHOD: Dry Augered: 0 ft. to 30 ft. Wash Bored: 30 ft. to 43 ft.	(P) POCKET PEN (tsf) (T) TORVANE (psf)	STD. PENETRATION TEST (blows/ft)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	-AILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
	MATERIAL DESCRIPTION	<u> </u>	ω						[₩			
0 -	Medium dense dark gray, gray, and light gray CLAYEY SAND (SC) with trace of organics	(P) 4.50+	2/6" 5/6" 6/6"	15	112			2.53	6		42	
2222	57.14' AMSL Very stiff to hard gray and light gray SANDY LEAN	(P) 4.50+		15	115	21	7				59	
5 -	SILTY CLAY (CL-ML) with calcareous nodules	(D) 4 50			444			0.40			00	
	-color changes to light gray	(P) 4.50+		14	114			6.13	4		62	
10	-color changes to light gray and tan		4/6" 12/6" 16/6"									
	-color changes to white and light gray		11/6" 18/6" 16/6"									
	-becomes stiff		5/6" 6/6" 8/6"									
15 -	46.64' AMSL Medium dense to dense white and light gray SILTY	,	4/6" 6/6"	17		38	7				31	
	SAND (SM) with calcareous nodules BODY II		8/6" 4/6"									
	-color changes to light gray and tan with ferrous stains		10/6" 19/6"									
$ \boxtimes$			23/6" 50/5"									
20 -			23/6" 50/4"									
	-color changes to light gray		27/6" 35/6" 50/4"	22							25	
25 -			5/6" 37/6" 45/6"									
			20/6" 39/6" 37/6"									
	-becomes medium dense		8/6" 12/6" 9/6"	26		39	2				28	
30	"		4/6" 12/6" 10/6"	33							39	
			5/6" 6/6" 10/6"									
35	-color changes to tan and marine green		3/6"									
COMPLET DATE BOF	RING COMPLETED: 06/22/2016	water wa e during c at a depth backfilled	drilling op n of 28'-4	eratic l". At t	ns. A he co	fter a 1	0 to 1	າ5-minເ	ıte wa	iting p e opei	eriod, n bore	water -hole
PROJECT	NO.: J. Garcia was I 16.53.042 TOLUNAY-WONG	backfilled		nent-k	entor	nite gro	out.		J,	•	e1 of	

PR	Ю.	JEC	City of Kingsville CLIEN Municipal Solid Waste Landfill Aerial Expansion	ORIN	IG B laismith	-34 Eng	 inee	ring, lı	nc.					
DEPTH (ft)	SAMPLE TYPE	SYMBOL/USCS	COORDINATES: N 27° 26' 43.4" W 97° 49' 11.4" SURFACE ELEVATION: 61.14' AMSL DRILLING METHOD: Dry Augered: 0 ft. to 30 ft. Wash Bored: 30 ft. to 43 ft. MATERIAL DESCRIPTION	(P) POCKET PEN (tsf) (T) TORVANE (psf)	STD. PENETRATION TEST (blows/ft)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
- 35 -		A		A)							ш			
	X		Medium dense tan and marine green SILTY SAND (SM) with sand lenses and trace organics25.14' AMS/THAIR HARD THAIR HARD TO THE BEAN CLAY (CL)	(P) 4.50+	8/6" 13/6"									
			SANDY SILTY CLAY BED	(P) 4.50+		30	91	40	17	0.93	1		91	
- 40 -				(P) 4.50+										
			18.14' AMSL	(P) 4.50+										
			Bottom @ 43'											
- 45 -														
	-													
- 50 -														
- 55 -														
- 60 -														
- 65 -														
- 70 -	L													
DA DA LO	TE TE GG	BOR BOR ER:	ING COMPLETED: 06/22/2016 was a	e during o	s encoundrilling open of 28'-4'	eratio '. At t	ns. A he co	fter a 1 mpletion	0 to 1	15-minu	ıte wa	iting p	eriod,	water
	ΟJ	ECT	NO 10.33.042					o gro				Pag	e2 of	f 2
			TOLUNAY-WONG	ENGI	NEERS	, INC	D							

PROJE	ECT	: City of Kingsville CLIEN Municipal Solid Waste Landfill Aerial Expansion	ORIN IT: N	IG B laismith	-35 Eng	inee	ring, lı	nc.					
DEPTH (ft) SAMPLE TYPE	nscs	COORDINATES: N 27° 26' 50.5" W 97° 48' 57.2" SURFACE ELEVATION: 64.50' AMSL DRILLING METHOD: Dry Augered: 0-ft. to 72.5-ft. Wash Bored: to	(P) POCKET PEN (tsf) (T) TORVANE (psf)	STD. PENETRATION TEST (blows/ft)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	-AILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
		MATERIAL DESCRIPTION	ق ق	·ν						₽.			
0 -	XXX XXX XXX XXX XXX XXX XXX XXX XXX XX	Medium dense tan and brown CLAYEY SAND (SC) with trace caliche		5/6" 8/6" 7/6"									
- 5 -	200 200 200 200 200 200 200 200 200 200	-color changes to reddish brown with ferrous stains		5/6" 8/6" 5/6"	12		31	17				38	
	7.7.7 7.7.7 7.7.7	56.50' AMSL	(5)		ļ.,								
- 10 -		Very stiff to hard reddish tan SANDY LEAN CLAY (CL) with gypsum crystals	(P) 4.50+		14	117			2.22	3		52	
- 15 -		-color changes to reddish tan and tan with ferrous stains		5/6" 10/6" 12/6"									
		-color changes to reddish tan	(P) 4.50+		17	109	42	25					
- 20 -		-color changes to reddish tan and tan	(P) 4.50+										
		40.50' AMSL											
- 25 -	222 223 223 223 223 223 223 223 223 223	Medium dense to dense reddish tan and tan CLAYEY SAND (SC) with gypsum crystals and ferrous stains BODY III	(P) 4.50+		17	104			1.29	3		40	
30	***************************************	-color changes to reddish tan		4/6" 7/6" 9/6"									
- 35 -	Z Z Z Z Z Z Z Z Z Z Z Z Z Z Z Z Z Z Z	<u>7</u>		8/6" 13/6" 20/6"									
COMPL DATE B	BORII	NG COMPLETED: 07/29/2016 was a	water wa e during c at a depth packfilled	drilling op n of 30'-9	eratio	ns. A he co	fter a 1 mpletio	0 to 1	15-minເ	ıte wa	iting p	eriod,	water
		TOLUNAY-WONG	ENGI	NEERS	S, INC	D					Pag	e1 o	f 3

PRO	ЭJ	JEC1	City of Kingsville CLIEN Municipal Solid Waste Landfill Aerial Expansion	ORIN IT: N	IG B laismith	3-35 Eng	inee	ring, l	nc.					
DEPTH (ft)	SAMPLE TYPE	SYMBOL/USCS	COORDINATES: N 27° 26' 50.5" W 97° 48' 57.2" SURFACE ELEVATION: 64.50' AMSL DRILLING METHOD: Dry Augered: 0-ft. to 72.5-ft. Wash Bored: to	(P) POCKET PEN (tsf) (T) TORVANE (psf)	STD. PENETRATION TEST (blows/ft)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	-AILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
	4	N	MATERIAL DESCRIPTION	©	LS						¥			
35 -			28.00' AMSL Medium dense to dense reddish tan and tan CLAYEY SAND (SC) with gypsum crystals and ferrous stains											
	X		Hard tan and light gray FAT CLAY with SAND (CH), gypsum crystals, and ferrous stains LIGHT OLIVE GREEN TO GRAY CLAY		17/6" 26/6" 30/6"	25		109	72				77	
40 -	X		-color changes to tan and reddish brown		8/6" 15/6" 24/6"									
45 -	\checkmark		-with sand partings		10/6" 16/6"									
	\triangle		16.00' AMSL		16/6"									
50	X		Stiff to hard reddish brown and tan FAT CLAY (CH) with gypsum crystals and ferrous stains LIGHT OLIVE GREEN TO GRAY CLAY		4/6" 7/6" 10/6"	34							96	
			-becomes slickensided with sand layers	(P) 2.00										
55 -	X		-color changes to tan		4/6" 7/6" 10/6"									
60 -				(P) 3.75	10/0	33	89	90	67	3.88	4		89	
65 -				(P) 4.25										
			-color changes to tan and reddish brown	(P) 4.50+										
70		-												
DAT	E	BOR BOR	ING COMPLETED: 07/29/2016 was a	water wa during c at a depth ackfilled	drilling op n of 30'-9	eratio	ns. A he co	fter a 1 mpletio	10 to 1 on of t	15-minu	ıte wa	iting p e ope	eriod, n bore	water e-hole
			 TOLUNAY-WONG	ENGI	NEERS	S, INC	D					Pag	e2 of	13

PROJEC	T: City of Kingsville CLIEN Municipal Solid Waste Landfill Aerial Expansion	ORIN NT: N	IG B laismith	-36 Eng	inee	ring, lı	nc.					
DEPTH (ft) SAMPLE TYPE SYMBOL/USCS	COORDINATES: N 27° 26' 56.8"	(P) POCKET PEN (tsf) (T) TORVANE (psf)	STD. PENETRATION TEST (blows/ft)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	-AILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
	MATERIAL DESCRIPTION	(a) (b)	ST		ă				₹			
0 -	Loose to medium dense dark gray and gray CLAYEY SAND (SC) BODY I											
- 5 -	-with calcareous nodules		18/6" 20/6" 21/6"	10							36	
	-color changes to light gray and tan		4/6" 5/6" 5/6"									
- 10 -	-color changes to tan		4/6" 5/6" 6/6"	12		47	28				44	
- 15 -			2/6" 4/6" 6/6"									
- 20	-color changes to light gray with ferrous stains		4/6" 10/6" 14/6"									
	-becomes very dense and color changes to light gray and tan		15/6" 24/6" 50/6"	25							32	
- 25 -			12/6" 14/6" 15/6"									
- 30 -	-becomes dense		5/6" 17/6" 27/6"									
35			4/6"									
COMPLET DATE BOR	J. Garcia was a	water wa e during d at a depth backfilled	drilling op n of 18'-3	eratio	ns. A he co	fter a 1 mpletic	0 to 1	15-minu	ıte wa	iting p e ope	eriod,	water -hole
	TOLUNAY-WONG	ENG	NEERS	S. INC). <u> </u>					. ∽9		

PRO	0.	JEC ⁻	City of Kingsville CLIEN Municipal Solid Waste Landfill		IG B			ring, lı	nc.					
			Aerial Expansion											
DEPTH (ft)	SAMPLE TYPE	SYMBOL/USCS	COORDINATES: N 27° 26' 56.8" W 97° 49' 04.9" SURFACE ELEVATION: 59.13' AMSL DRILLING METHOD: Dry Augered: 0-ft. to 22-ft. Wash Bored: 22-ft. to 68-ft.	(P) POCKET PEN (tsf) (T) TORVANE (psf)	STD. PENETRATION TEST (blows/ft)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	-AILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
		_	MATERIAL DESCRIPTION	€ _C	S						₹			
- 35	X		Medium dense light gray and tan CLAYEY SAND (SC) BODY I		7/6" 8/6"									
40	X		-with sand seams, calcareous nodules, and ferrous staining		6/6" 10/6" 13/6"	21		47	30				35	
	X	********	-color changes to reddish brown and light gray		4/6" 8/6" 10/6"									
45 -			13.13' AMSL											
			Stiff to very stiff reddish brown and light gray FAT CLAY (CH), slickensided, with ferrous staining	(P) 4.50+										
			LIGHT OLIVE GREEN TO GRAY CLAY											
- 50 -	X		-with sand seams and calcareous nodules		4/6" 6/6" 8/6"	42							96	
- 55 -	X		-color changes to light gray with sand layers		11/6" 12/6" 14/6"									
- 60	X		-becomes hard		11/6" 21/6" 26/6"	37		70	44				94	
- 65 -	X				7/6" 8/6" 9/6"									
- 65 -	X		-color changes to brown yellow, reddish brown, and light gray -8.87' AMSL Bottom @ 68'		7/6" 10/6" 10/6"									
\vdash			DOLLOHI @ 00											
DAT DAT LOG	E	BOR BOR	ING COMPLETED: 06/24/2016 was a	during out a depthematical	as encoun drilling open of 18'-3' with cem	eratio '. At t ent-b	ons. A he co pentor	fter a 1 mpletio	0 to 1	15-minu	ıte wa	iting p e opei	eriod,	water e-hole

PROJE	CT: City of Kingsville CLIEN Municipal Solid Waste Landfill Aerial Expansion	ORIN	IG B laismith	3 -37 Eng	inee	ring, lı	nc.					
SAMPLE TYPE	COORDINATES: N 27° 26' 57.1" W 97° 49' 17.6" SURFACE ELEVATION: 45.52' AMSL DRILLING METHOD: Dry Augered: 0-ft. to 12-ft. Wash Bored: 12-ft. to 48-ft.	(P) POCKET PEN (tsf) (T) TORVANE (psf)	STD. PENETRATION TEST (blows/ft)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	-AILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
	MATERIAL DESCRIPTION	(P)	<u> </u>		Δ				₹			
- 0 -	Very dense light gray and tan SILTY SAND (SM)											
	BODY II -with ferrous staining		6/6" 16/6" 50/5"									
- 5 -												
			11/6" 50/5"	20		33	9				20	
- 10 -	-with calcareous nodules		23/6" 37/6" 50/6"									
	\\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\											
- 15 -	Very stiff to hard tan and light tan SANDY LEAN SILTY CLAY (CL-ML) SANDY SILTY CLAY BED		6/6" 7/6" 10/6"	31							52	
20	-color changes to tan and light gray with ferrous staining		9/6" 17/6" 27/6"									
			7/6" 12/6" 13/6"									
- 25 -	19.02' AMSL											
	Stiff to very stiff reddish brown and light gray FAT CLAY (CH) with calcareous nodules and ferrous staining LIGHT OLIVE GREEN TO GRAY CLAY		4/6" 5/6" 9/6"	33		56	39				99	
- 30 -	-color changes to light gray with sand layers		5/6" 7/6" 12/6"									
			F/0"								00	
35			5/6"	34							86	
DATE B	ORING COMPLETED: 06/25/2016 was a	during of table a	as encou drilling op n of 9'-3" I with cer	eratio	ns. A e con	fter a 1	0 to 1	15-minເ	ıte wa	iting p	eriod,	water
	TOLUNAY-WONG	ENG	INEERS	S, INC	D					Pag	e1 o	f 2

PR	.O.	JEC	LOG OF BO City of Kingsville CLIEN Municipal Solid Waste Landfill Aerial Expansion	ORIN	IG B Naismith	-37 Eng	inee	ring, lı	nc.					
DEPTH (ft)	SAMPLE TYPE	SYMBOL/USCS	COORDINATES: N 27° 26' 57.1" W 97° 49' 17.6" SURFACE ELEVATION: 45.52' AMSL DRILLING METHOD: Dry Augered: 0-ft. to 12-ft. Wash Bored: 12-ft. to 48-ft.	(P) POCKET PEN (tsf) (T) TORVANE (psf)	STD. PENETRATION TEST (blows/ft)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
		٨	MATERIAL DESCRIPTION	(P)	S						₹			
- 35 -	X		Stiff to very stiff light gray and brownish tan FAT CLAY (CH) with sand seams, calcareous nodules, and ferrous staining LIGHT OLIVE GREEN TO GRAY CLAY		7/6" 12/6"									
- 40 -	X				4/6" 5/6" 7/6"									
- 45 -	X		-color changes to light gray and reddish brown		6/6" 6/6" 9/6"									
	X		-color changes to light gray -2.48' AMSL Bottom @ 48'		4/6" 5/6" 9/6"	35		80	51				86	
- 50 -														
- 55 -														
- 60 -														
- 65 -														
- 70 -														
DA ⁻	TE TE	BOR	ING COMPLETED: 06/25/2016 was a	during o	as encoundrilling op h of 9'-3". I with cem	eratic At th	ns. A e con	fter a 1 opletion	0 to 1	15-minເ	ıte wa	iting p	eriod,	water
	JUI		TOLUNAY-WONG	ENGI	INEERS	, INC	D	-				Pag	e2 o	f 2

PRC	ЭJ	IEC ⁻	City of Kingsville CLIEN Municipal Solid Waste Landfill Aerial Expansion	ORIN NT: N	IG B laismith	-38 Eng	inee	ring, I	nc.					
DEPTH (ft)	SAIMPLE ITPE	SYMBOL/USCS	COORDINATES: N 27° 27′ 03.76″	(P) POCKET PEN (tsf) (T) TORVANE (psf)	STD. PENETRATION TEST (blows/ft)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	-AILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
35		<u> </u>	MATERIAL DESCRIPTION	<u>B</u> , 0	ν \ 8/6"						10			
			Very stiff to hard reddish brown and light gray SANDY FAT CLAY (CH) with sand seams and layers	(P) 4.50+	10/6"									
			3.64' AMSL Stiff to hard light gray FAT CLAY (CH), slickensided, with calcareous nodules and ferrous stains	(P) 4.50+		42	78	100	72	2.95	2		93	
40 -			-color changes to reddish brown and light gray	(P) 4.50+										
			LIGHT OLIVE GREEN TO GRAY CLAY	(P) 4.50+										
45 -			-color changes to tannish brown and light gray with trace organics	(P) 4.50+										
			-color changes to light gray	(P) 4.50+	5/6" 6/6" 8/6"	30	91			2.14	3		87	
50					6/6" 7/6" 7/6" 4/6" 5/6" 8/6"									
55 -			-color changes to tannish brown and light gray		5/6" 7/6" 9/6"									
			-color changes to light gray -16.36' AMSL		6/6" 7/6" 9/6"									
			Bottom @ 58'											
60 -														
65 -														
70 -														
DATE	E E	BOR BOR	ING COMPLETED: 06/23/2016 was a	e during o	drilling op n of 5'-5".	eration At th	ns. A e con	fter a 1	10 to 1	15-minເ	ıte wa	iting p	eriod,	water
PRO.	JĒ	ECT			with cem			Ū				Pag	je2 o	f 2
			TOLUNAY-WONG	ENGI	NEERS	, INC). <u> </u>							

PROJE	CT: City of Kingsville CLIEN Municipal Solid Waste Landfill Aerial Expansion	ORIN NT: N	IG B laismith	-39 Eng	inee	ring, lı	nc.					
DEPTH (ft) SAMPLE TYPE	COORDINATES: N 27° 27' 01.3"	(P) POCKET PEN (tsf) (T) TORVANE (psf)	STD. PENETRATION TEST (blows/ft)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	-AILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
	MATERIAL DESCRIPTION	<u>6</u> ,0	·ν						₽.			
0 -	Medium dense to dense tan and light gray CLAYEY SAND FILL with trace gravel BODY I		8/6" 9/6" 6/6"	18							33	
	-color changes to brown 55.76' AMSL		40/6" 27/6" 19/6"									
5 -	Medium dense to dense brown and reddish brown CLAYEY SAND (SC) BODY I	,	6/6" 7/6" 8/6"									
	-color changes to tan and gray with calcareous nodules		4/6" 5/6" 6/6"									
			5/6" 6/6" 8/6"	11		36	20				49	
10	-color changes to tan and light gray		4/6" 6/6" 7/6"									
	-color changes to light gray		7/6" 8/6"									
15 - \(\)	-color changes to light gray and tan with ferrous stains		11/6" 6/6" 12/6"									
	-color changes to light gray		19/6" 11/6" 19/6"									
	41.76' AMSL Stiff to hard light gray SANDY LEAN CLAY (CL) with	,	22/6" 3/6" 4/6" 5/6"	19							65	
20	calcareous nodules and ferrous stains		6/6"									
			9/6" 13/6" 8/6"									
) 25	-color changes to light tan and light gray	(P) 4.50+	11/6" 20/6"									
25 -	color changes to light gray	(P) 4.00										
	<u>¥</u>		7/6"									
30	-color changes to light gray and tan	(P) 4.50+	11/6" 13/6"	19	102			1.14	7		50	
			12/6" 16/6"									
35			20/6" 8/6"									
COMPLI DATE B	DRING COMPLETED: 06/24/2016 was a	water wa e during d at a depth packfilled	drilling op n of 26'-6	eratio	ns. A he co	fter a 1 mpletio	0 to 1	15-minu	ıte wa	iting p e opei	eriod, n bore	water e-hole
	TOLUNAY-WONG	ENGI	NEERS	SINIC						Pag	e1 o	12

PROJEC	T: City of Kingsville CLIEN Municipal Solid Waste Landfill Aerial Expansion		IG B			ring, lı	nc.					
DEPTH (ft) SAMPLE TYPE SYMBOLUSCS	COORDINATES: N 27° 27' 01.3" W 97° 48' 57.3" SURFACE ELEVATION: 60.26' AMSL DRILLING METHOD: Dry Augered: 0 ft. to 26 ft. Wash Bored: 26 ft. to 68 ft. MATERIAL DESCRIPTION	(P) POCKET PEN (tsf) (T) TORVANE (psf)	STD. PENETRATION TEST (blows/ft)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
35	Stiff to hard light gray and tan SANDY LEAN CLAY (CL))	12/6" 16/6"									
	with ferrous stains 23.76' AMSL Medium dense to dense light gray CLAYEY SAND (SC) with ferrous stains BODY III	,	7/6" 8/6" 11/6"									
40			11/6" 12/6" 7/6" 10/6" 13/6"	25		69	51				45	
	15.76' AMSL		13/6" 19/6" 21/6"									
- 45 -	Dense light gray POORLY GRADED SAND with CLAY (SP- SC)		12/6" 21/6" 20/6" 11/6" 16/6"									
- 50 -	12.26' AMSL Hard reddish brown and light gray FAT CLAY with SAND (CH) LIGHT OLIVE GREEN TO GRAY CLAY	(P) 4.50+ (P) 4.50+	16/6"	28	93			0.85	1		72	
	-becomes slickensided with calcareous nodules	(P) 4.50+										
- 55 -	-with ferrous stains	(P) 4.50+ (P) 4.50+										
- 60 -		(P) 4.50+ (P) 4.50+										
	-becomes stiff		7/6" 7/6" 7/6"									
- 65 -	-6.24' AMSL		6/6"	20	102	61	45	1.91	5		46	
	Medium dense light gray CLAYEY SAND (SC) with calcareous nodules and ferrous stains -7.74' AMSL Bottom @ 68'	,	10/6" 13/6"		102		70	1.51			70	
DATE BOR	RING COMPLETED: 06/24/2016 was a J. Garcia	e during dat a depth	s encoun Irilling ope n of 26'-6" with cem	eratic	ns. A he co	fter a 1 mpletio	0 to 1	15-minu	ıte wa	iting p e oper	eriod,	water -hole
	TOLUNAY-WONG	ENGI	NEERS	. INC	D					ıay	5∠ 0	_

PROJE	CT: City of Kingsville CLIE Municipal Solid Waste Landfill Aerial Expansion	BORIN INT: N	IG B Naismith	-40 Eng	ineei	ring, l	nc.					
SAMPLE TYPE	COORDINATES: N 27° 27' 09.97" W 97° 49' 11.18" SURFACE ELEVATION: 52.31' AMSL DRILLING METHOD: Dry Augered: 0 ft. to 22 ft. Wash Bored: 22 ft. to 33.75 ft.	(P) POCKET PEN (tsf) (T) TORVANE (psf)	STD. PENETRATION TEST (blows/ft)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	-AILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
	MATERIAL DESCRIPTION	(E)	S		ă				ΕĀ			
0 -	Loose to very dense light gray and gray SILTY SAND (SM) with trace caliche BODY II		4/6" 4/6" 6/6"									
	-color changes to light gray and tan with ferrous stains		5/6" 7/6" 11/6"	16		35	10				31	
5 -	color changes to light grov with colorrous podulos		7/6" 17/6" 17/6" 12/6"									
	-color changes to light gray with calcareous nodules -color changes to light gray and white		21/6" 34/6" 12/6"	18							34	
10 -	-color changes to white		27/6" 50/3" 15/6" 50/3"									
	-color changes to light gray and white		25/6" 50/4"									
	37.81' AMS		7/6"	22		70	41				80	
15 -	Hard light gray FAT CLAY with SAND (CH), calcareou nodules, and ferrous stains	S	26/6" 50/5"	22		70	41				80	
			5/6" 17/6" 28/6"									
	_		10/6" 30/6" 35/6"									
20	⇒ 31.81' AMSI Hard light gray SANDY FAT CLAY (CH) with	_	9/6"	31							59	
	calcareous nodules and ferrous stains		25/6" 35/6"									
			16/6" 32/6" 50/5"									
25 -	25.81' AMS	L	16/6" 31/6" 50/5"				00				40	
	Dense to very dense light gray CLAYEY SAND (SC) with calcareous nodules		8/6" 18/6" 27/6" 6/6"	30		53	32				49	
30	53 23 23 23 23 23 23 23 23 23 23 23 23 23		18/6" 50/6" 6/6"									
	31 32 33 33 31		20/6" 50/5"									
	18.81' AMS	L	3/6" 40/6" \ 50/3"	16							30	
- 35 -	DOMOIT & 33.5											
DATE B	ORING COMPLETED: 06/22/2016 was	de during of at a deption backfilled	drilling op h of 19'. <i>A</i>	eration At the ment-b	ons. A comp pentor	fter a 1 detion nite gro	10 to of the out.	15-minu boring	ıte wa	iting p pen b	eriod,	, water ole

PROJEC1	Municipal Solid Waste Landfill	ORIN	IG B laismith	- 41 Eng	ineeı	ring, lı	nc.					
DEPTH (ft) SAMPLE TYPE SYMBOL/USCS	Aerial Expansion COORDINATES: N 27° 27' 09.8"	(P) POCKET PEN (tsf) (T) TORVANE (psf)	STD. PENETRATION TEST (blows/ft)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
- 0	MATERIAL DESCRIPTION	<u>(i)</u>	S						7			
	Loose to medium dense gray CLAYEY SAND (SC) with calcareous nodules BODY I		4/6" 5/6" 5/6"	8							35	
- 5 -	-color changes to light gray		4/6" 5/6" 6/6"									
(222) (222) (222) (222)	41.70' AMSL											
	Stiff to very stiff gray SANDY FAT CLAY (CH)		5/6" 8/6"	20		78	52				64	
10	LIGHT OLIVE GREEN TO GRAY CLAY		11/6"									
- 15 -	-becomes hard and color changes to brown with interbedded sand seams		9/6" 17/6" 25/6"									
	-color changes to brown and tan		7/6" 12/6" 14/6"									
20 -	-color changes to tan with sand layers		3/6" 4/6" 6/6"	36							64	
25 -	-color changes to brown with sand partings		5/6" 4/6" 6/6"									
30	-color changes to brown and tan		6/6" 7/6" 8/6"	31		52	30				51	
35 -			4/6" 6/6" 6/6"									
DATE BOR	ING COMPLETED: 07/20/2016 was a	during out a depth	s encour drilling op n of 19'-3	eratio	ns. A he co	fter a 1 mpletio	0 to 1	15-minu	ite wa	iting p	eriod,	water
rkujeu i	NO.: 16.53.042 Was L		NEERS			Ü				Pag	e1 o	f 2

PR	OJ	JECT	City of Kingsville CLIEN Municipal Solid Waste Landfill	ORIN IT: N	IG B	- 41 Eng	inee	ring, lı	nc.					
			Aerial Expansion											
DEPTH (ft)	SAMPLE TYPE	SYMBOL/USCS	COORDINATES: N 27° 27' 09.8"	(P) POCKET PEN (tsf) (T) TORVANE (psf)	STD. PENETRATION TEST (blows/ft)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
	_		MATERIAL DESCRIPTION	@	S						₹			
- 35 -			14.20' AMSL Stiff to very stiff gray SANDY FAT CLAY (CH)											
			Very stiff brown FAT CLAY with SAND (CH)	(P) 3.25		27	92						77	
			LIGHT OLIVE GREEN TO GRAY CLAY											
- 40 -			-color changes to brown and tan		6/6" 13/6"									
	Ă		G		13/6" 11/6"									
- 45 -	X				4/6" 9/6" 14/6"									
- 50	X				6/6" 8/6" 9/6"	35		97	75				84	
	X		-color changes to brown and gray		7/6" 9/6" 12/6"									
- 55 -														
			-color changes to gray	(P) 4.50+										
- 60 -														
				(P) 3.50										
			-12.30' AMSL			-								
			Bottom @ 62.5'											
- 65 -														
- 70 -														
DAT DAT LOG	E G	BOR BOR ER:	M. Anderson was a	water wa during d at a depth backfilled	Irilling op n of 19'-3	eratic	ns. A he co	fter a 1 mpletio	0 to 1	15-minເ	ite wa	iting p	eriod,	water
PRC)JE	ECTI	NO.: 16.53.042 was t	ackilleu	with CEI	nent-L	r o nilOl	iile gil	out.			Pag	e2 of	2
			TOLUNAY-WONG	ENGI	NEERS	S. INC	D							



Tolunay-Wong Engineers, Inc.

GEOTECHNICAL ENGINEERING STUDY CITY OF KINGSVILLE MUNICIPAL SOLID WASTE LANDFILL EXPANSION KINGSVILLE, TEXAS

Prepared for:

Naismith/Hanson Corpus Christi, Texas

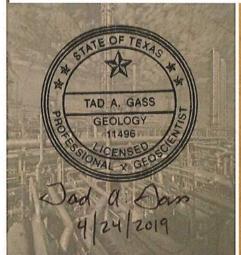
Prepared by:

Tolunay-Wong Engineers, Inc. 826 South Padre Island Drive Corpus Christi, Texas 78416

August 30, 2018

Project No. 16.53.042 / Report No. 12788R1

For Permitting Purposes Only. Applies to boring logs in Appendix B of Tolunay-Wong Engineers, Inc. Geotechnical Engineering Study, City of Kingsville Municipal Solid Waste Landfill Expansion, Kingsville, Texas – Report No. 12788R1, sealed by Don R. Rokohl, P.E. on 8-30-18 altered to provide text showing surface elevations, the elevations of all contacts between soil and rock layers, and unit identifiers in the soil boring logs. No information or data was altered or changed from the original report other than the addition of text showing these elevations and unit identifiers in Appendix B.



GEOTECHNICAL ENGINEERING, DEEP FOUNDATIONS TESTING, ENVIRONMENTAL SERVICES, CONSTRUCTION MATERIALS TESTING 1-888-887-9932 WWW.TWEINC.COM

PRO	ΟJ	EC1	Municipal Solid Waste Landfill	ORIN	IG B laismith	3-30 n Eng	inee	ring, I	nc.					
DEPTH (ft)	SAMPLE TYPE	SYMBOL/USCS	Aerial Expansion COORDINATES: N 27° 26' 44.0" W 97° 49' 23.1" SURFACE ELEVATION: 45.99' AMSL DRILLING METHOD: Dry Augered: 0-ft. to 82.5-ft. Wash Bored: to	(P) POCKET PEN (tsf) (T) TORVANE (psf)	STD. PENETRATION TEST (blows/ft)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
- 0 -	1		MATERIAL DESCRIPTION	ق	Ś						14			
			Dense to very dense tan and gray CLAYEY SAND (SC) with gypsum crystals		11/6" 23/6" 50/5"	16		42	17				37	
- 5 -2			-color changes to tan with ferrous staining		34/6" 50/3"									
- 10 -	X		-with sand partings		13/6" 50/3"									
- 15 -	XXXXXXXX		-		7/6" 12/6" 20/6"	35							33	
	X		-color changes to reddish tan and light gray		6/6" 15/6" 20/6"									
- 20 -	X		Very stiff to hard reddish tan and light gray FAT CLAY (CH) with gypsum crystals LIGHT OLIVE GREEN TO GRAY CLAY		10/6" 17/6" 26/6"									
- 25 -			-color changes to reddish tan and tan		10/6" 18/6" 30/6"	25		50	28				92	
30			-color changes to tan and reddish brown		8/6" 11/6" 16/6"									
			-color changes to tan and gray		8/6" 12/6" 18/6"									
DAT	E E	BOR BOR	ING COMPLETED: 07/23/2016 was a	during of the during of the depth of the dep	as encou drilling op n of 10'-6 I with cer	erations". At the ment-b	ons. A he co pentor	fter a 1 mpletionite gro	10 to 10 of to 10 out.	15-minu the bori	ite wa ng, th	iting p e ope	eriod,	water e-hole

PRO	JEC ⁻	T: City of Kingsville CLIE Municipal Solid Waste Landfill Aerial Expansion		IG B laismith			ring, lı	nc.					
DEPTH (ft)	SYMBOL/USCS	COORDINATES: N 27° 26' 44.0"	(P) POCKET PEN (tsf) (T) TORVANE (psf)	STD. PENETRATION TEST (blows/ft)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	-AILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
	N	MATERIAL DESCRIPTION	(E)	S						₹			
35 -		Very stiff to hard reddish tan and tan FAT CLAY (CH) with gypsum crystals and ferrous stains LIGHT OLIVE GREEN TO GRAY CLAY		10/6" 17/6" 21/6"	30							90	
- 40 -		-color changes to tan and reddish brown		9/6" 14/6" 21/6"									
- 45 -				13/6" 19/6" 29/6"									
50		-becomes sandy 48' to 52'		8/6" 11/6" 13/6"	30							70	
- 55 -		-color changes to tan and becomes slickensided	(P) 4.50+		23	100	71	51				87	
			(P) 4.50+										
- 60 -			(P) 4.50+										
- 65 -		-becomes sandy and color changes to tan and gray	(P) 4.50+		26	97	54	30	1.75	3		69	
- 70 -		-color changes to tan and reddish brown with trace calcareous nodules	(P) 3.00										
DATE	BOR BOR SER:	ING COMPLETED: 07/23/2016 was J. Gonzalez	water wa e during o at a depth backfilled	Irilling op n of 10'-6	eratic 5". At t	ns. A he co	fter a 1	0 to	15-minu	ıte wa	iting p e ope	eriod, n bore	water -hole
		 TOLUNAY-WONG	FNGI	NEERS	s. INC) .					Pag	e2 of	3

PRO	JEC ⁻	City of Kingsville CLIEN Municipal Solid Waste Landfill		IG B laismith			ring, lı	nc.					
DEPTH (ft) SAMPLE TYPE	SYMBOLUSCS	Aerial Expansion COORDINATES: N 27° 26' 50.1"	(P) POCKET PEN (tsf) (T) TORVANE (psf)	STD. PENETRATION TEST (blows/ft)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
		MATERIAL DESCRIPTION	(a) (b)	S		□				Ā			
- 0 -		Medium dense to very dense gray CLAYEY SAND (SC) BODY I -with calcareous nodules and sand pockets		4/6" 5/6" 7/6"									
- 5 -		50.00.000 00.00		22/6" 18/6" 4/6"	11							46	
\ \ \ \ \	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX			5/6" 6/6" 5/6" 6/6"									
				8/6" 6/6" 8/6"									
10		-with cemented sand layers		8/6" 8/6" 27/6" 29/6"	27							22	
		-color changes to tan		18/6" 32/6" 39/6"									
- 15 -		Very dense tan POORLY GRADED SAND with CLAY (SP-SC) and sand partings BODY IV		36/6" 50/5" 12/6" 50/5"	15							9	
20				45/6" 50/5" 35/6" 50/4"									
X		¥ ¥ 34.87' AMSL		17/6" 26/6" 50/5" 17/6" 38/6" 38/6"									
- 25		Hard reddish tan and light gray SANDY LEAN SILTY CLAY (CL-ML) with sand partings		13/6" 20/6" 31/6" 23/6" 34/6" 50/4" 12/6" 17/6" 50/5"	26		29	7				66	
30		-color changes to reddish tan and tan with ferrous stains		13/6" 32/6" 50/5" 7/6" 36/6" 39/6" 10/6" 21/6" 36/6"	25							62	
35				10/6" 18/6" 35/6"									
DATE DATE LOGG	BOR BOR ER:	ING COMPLETED: 07/21/2016 was a J. Gonzalez	during out	as encour drilling op n of 21'-6 I with cen	eratio ". At t	ns. A he co	fter a 1 mpletio	0 to 1	15-minu	ıte wa	iting p	eriod,	water
PROJ	ECT	NO.: 16.53.042 Was b		INEERS			o gro				Pag	e1 of	2

PROJEC	Municipal Solid Waste Landfill		IG B laismith			ring, lı	nc.					
DEPTH (ft) SAMPLE TYPE SYMBOL/USCS	Aerial Expansion COORDINATES: N 27° 26' 50.1" W 97° 49' 24.3" SURFACE ELEVATION: 58.37' AMSL DRILLING METHOD: Dry Augered: 0-ft. to 68-ft. Wash Bored: to MATERIAL DESCRIPTION	(P) POCKET PEN (tsf) (T) TORVANE (psf)	STD. PENETRATION TEST (blows/ft)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
- 35	Hard reddish tan and tan SANDY LEAN CLAY (CL) with ferrous stains and laminated sands		17/6" 25/6" 35/6" 17/6" 13/6" 19/6"									
- 40 -	18.87' AMSL Very stiff to hard reddish tan and tan FAT CLAY with SAND (CH) and ferrous stains LIGHT OLIVE GREEN TO GRAY CLAY	,	16/6" 17/6" 3/6" 7/6" 10/6" 9/6" 20/6" 27/6" 5/6" 14/6"	37		59	36				76	
- 45 -	-with trace gypsum crystals and ferrous stains		14/6" 17/6" 10/6" 18/6" 21/6" 23/6" 30/6" 6/6" 20/6"	30							83	
- 50	-with calcareous nodules and ferrous stains	(P) 4.50+ (P) 4.50+	9/6" 17/6" 19/6" 9/6" 18/6" 23/6" 11/6" 23/6" 26/6"	32	91	83	50	4.14	2		87	
- 60 -	-with trace gypsum crystals and ferrous stains	(P) 4.50+ (P) 4.50+ (P) 4.50+		34	87			2.88	2		83	
- 65 -	-9.63' AMSL Bottom @ 68'	(P) 4.50+										
DATE BOR	RING COMPLETED: 07/21/2016 was a J. Gonzalez	water wa e during d at a depth packfilled	Irilling op n of 21'-6	eratio ". At t	ns. A he co	fter a 1 mpletic	0 to 1	15-minu	ıte wa	iting p e opei	eriod,	water e-hole

PR	О.	JECT	City of Kingsville CLIEN Municipal Solid Waste Landfill Aerial Expansion		IG B			ring, lı	nc.					
DEPTH (ft)	SAMPLE TYPE	SYMBOL/USCS	COORDINATES: N 27° 26' 49.7"	(P) POCKET PEN (tsf) (T) TORVANE (psf)	STD. PENETRATION TEST (blows/ft)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	-AILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
- 35 -			MATERIAL DESCRIPTION	<u> </u>	· v						12			
- 35			Medium dense to dense reddish tan and gray CLAYEY SAND (SC) with gypsum crystals 12.46' AMSL/Very stiff to hard tan FAT CLAY with SAND (CH), slickensided, with calcareous nodules LIGHT OLIVE GREEN TO GRAY CLAY	(P) 4.50+		29	89						79	
- 40 -	X		-color changes to tan and reddish brown with gypsum crystals and ferrous stains		8/6" 12/6" 15/6"									
- 45 -			-color changes to tan, gray, and reddish brown	(P) 4.50+										
- 50 -	X		-color changes to tan and reddish brown		4/6" 9/6" 10/6"	30		73	51				82	
- 55 -			-color changes to tan and gray	(P) 4.50+ (P) 4.50+										
- 60 -				(P) 4.50+		26	94			0.61	2		81	
- 65 -			-color changes to tan, red, and brown	(P) 4.00										
- 70 -			-color changes to tan and gray	(P) 4.50+										
DA DA LO	TE TE GG	BOR	ING COMPLETED: 07/28/2016 was a J. Gonzalez	water wa e during d at a depth backfilled	Irilling op n of 14'-7	eratio	ns. A he co	fter a 1 mpletio	0 to 1	15-minເ	ıte wa	iting p e opei	eriod, n bore	water e-hole
			 TOLUNAY-WONG	ENGI	NEERS	S. INC	D					Pag	e2 of	3

PR	0.	JEC ⁻		ORIN	IG B	3-32 Eng	inee	ring, lı	nc.					
			Municipal Solid Waste Landfill Aerial Expansion											
DЕРТН (ft)	SAMPLE TYPE	SYMBOL/USCS	COORDINATES: N 27° 26' 49.7" W 97° 49' 17.0" SURFACE ELEVATION: 48.46' AMSL DRILLING METHOD: Dry Augered: 0-ft. to 82.5-ft. Wash Bored: to	(P) POCKET PEN (tsf) (T) TORVANE (psf)	STD. PENETRATION TEST (blows/ft)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	-AILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
	L	0,	MATERIAL DESCRIPTION	(P)	STI		占				Ā			
- 70 -			Very stiff to hard tan and gray FAT CLAY with SAND (CH), slickensided with gypsum crystals and calcareous nodules LIGHT OLIVE GREEN TO GRAY CLAY -24.54' AMSL	,										
- 75 -			Medium dense to dense tan CLAYEY SAND (SC) with calcareous nodules	(P) 0.75		21		24	8				24	
			-with gypsum crystals and ferrous stains		5/6" 10/6" 13/6"									
- 80 -	X		-34.04' AMSL Bottom @ 82.5'		13/6" 20/6" 20/6"									
- 85 -			2 0											
- 90 -														
- 95 -														
-100-														
-105-	1													
DA DA LO	TE TE GG	BOR	ING COMPLETED: 07/28/2016 was a	e during o	as encour drilling op n of 14'-7 with cen	eratio	ns. A he co	fter a 1 mpletio	0 to 1	15-minu	ıte wa	iting p	eriod,	water
	-50		TOLUNAY-WONG	ENG	NEERS	S, INO	D	-				Pag	e3 of	f 3

PRC	DJEC	T: City of Kingsville CLIEN Municipal Solid Waste Landfill Aerial Expansion	ORIN IT: N	IG B laismith	-33 Eng	inee	ring, li	nc.					
DEPTH (ft)	SYMBOL/USCS	COORDINATES: N 27° 26' 55.9" W 97° 49' 11.3" SURFACE ELEVATION: 64.51' AMSL DRILLING METHOD: Dry Augered: 0-ft. to 86-ft. Wash Bored: to	(P) POCKET PEN (tsf) (T) TORVANE (psf)	STD. PENETRATION TEST (blows/ft)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	-AILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
	-	MATERIAL DESCRIPTION	(P)	S						₹			
0 -		Medium dense to very dense tan CLAYEY SAND (SC) with gypsum crystals BODY I		2/6" 7/6" 9/6"									
- 5 -		-color changes to dark gray and gray with trace gravel		7/6" 11/6" 9/6"	16							47	
- 10 -		-color changes to tan and light gray sand partings		27/6" 50/6"									
- 15 -		-color changes to tan and white with trace caliche		50/5"									
	222	48.01' AMSL											
	PARTY PATTY PATTY PATTY PATTY PATTY PATTY PATTY PATTY PATTY PATTY	Dense to very dense tan and white POORLY GRADED SAND with SILT (SP-SM), and trace caliche BODY II		17/6" 48/6" 50/3"	11		35	8				12	
20 -	17811 17811 17811 17811 17811 17811 17811			17/6" 21/6" 27/6"									
- 25 -		-color changes to light gray and tan with gypsum crystals and ferrous stains		15/6" 17/6" 32/6"									
30		Medium dense to dense gray and white CLAYEY SAND (SC) with gypsum crystals		14/6" 22/6" 26/6"	42							20	
- 35 -		-color changes to tan		13/6" 21/6" 22/6"									
COM	E BOI E BOI	RING COMPLETED: 08/05/2016 was a	during o t a depth ackfilled	as encour drilling op n of 28'-2 I with cen	eration ". At the nent-b	ns. A he co entor	fter a 1 mpletionite gro	10 to 1 on of tout.	15-minu the bori	ıte wa	iting p e ope	eriod,	water e-hole

PRO	JEC	Municipal Solid Waste Landfill		IG B laismith			ring, lı	nc.					
DEPTH (ft)	SYMBOLUSCS	Aerial Expansion COORDINATES: N 27° 26' 55.9" W 97° 49' 11.3" SURFACE ELEVATION: 64.51' AMSL DRILLING METHOD: Dry Augered: 0-ft. to 86-ft. Wash Bored: to MATERIAL DESCRIPTION	(P) POCKET PEN (tsf) (T) TORVANE (psf)	STD. PENETRATION TEST (blows/ft)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
- 35 -		Medium dense to dense reddish tan CLAYEY SAND (SC) with gypsum crystals and ferrous stains		6/6" 9/6"									
- 40 -	**************************************	-color changes to tan and reddish tan		8/6" 16/6" 18/6"									
- 45 -		20.01' AMSL Stiff to very stiff reddish tan LEAN CLAY with SAND (CL), slickensided, with ferrous stains SANDY SILTY CLAY BED		9/6" 12/6" 18/6"	29		43	24				79	
- 50		-color changes to reddish tan and tan with gypsum crystals		5/6" 6/6" 9/6"									
		12.51' AMSL	(D) 0 00		10	70			1.00				
		Stiff to very stiff LEAN CLAY (CL), slickensided, with ferrous stains SANDY SILTY CLAY BED	(P) 2.00		40	79			1.06	3		96	
- 55 -		-color changes to reddish brown and tan with gypsum crystals	(P) 3.50										
- 60 -			(P) 4.00		34	87							
		-0.51' AMSL											
- 65 -		Very stiff to hard tan FAT CLAY (CH), slickensided, with gypsum crystals and ferrous stains LIGHT OLIVE GREEN TO GRAY CLAY	(P) 4.50+		32	42	64	33	2.57	2		95	
70		-color changes to tan and reddish brown		7/6" 12/6" 14/6"									
COM	E BO E BO GER:	RING COMPLETED: 08/05/2016 was a	during data depthetackfilled	Irilling op n of 28'-2	eratio ". At t nent-b	ns. A he co entor	fter a 1 mpletio	0 to 1	15-minu	ıte wa	iting p e opei	eriod,	water -hole

PR	O.	JECT	City of Kingsville CLIEN Municipal Solid Waste Landfill Aerial Expansion	ORIN	IG B laismith	-33 Eng	inee	ring, lı	nc.					
DEPTH (ft)	SAMPLE TYPE	SYMBOL/USCS	COORDINATES: N 27° 26' 55.9"	(P) POCKET PEN (tsf) (T) TORVANE (psf)	STD. PENETRATION TEST (blows/ft)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
- 70 -			Very stiff to hard tan and reddish brown FAT CLAY (CH), slickensided, with gypsum crystals and ferrous stains LIGHT OLIVE GREEN TO GRAY CLAY											
- 75 -	X		-color changes to tan and light gray -with layers of calcareous nodules		9/6" 10/6" 21/6"									
- 80 -			-15.49' AMSL Very stiff to hard tan FAT CLAY with SAND (CH) with gypsum crystals and ferrous stains LIGHT OLIVE GREEN TO GRAY CLAY	(P) 4.50+		18	106			3.57	3		77	
- 85 -			-color changes to tan and white -21.49' AMSL Bottom @ 86'	(P) 4.50+										
- 90 -														
- 95 -														
-100-														
			ON DEPTH: 86 ft REMARKS: Free											
DA	TΕ	BOR BOR ER: ECT I	ING COMPLETED: 08/05/2016 was a	at a depth backfilled	drilling op n of 28'-2 with cen	". At t nent-b	he co centoi	mpletion nite gro	on of tout.	the bori		e opei		-hole

PROJ	ECT	Municipal Solid Waste Landfill Aerial Expansion	ORIN NT: N	IG B	8-34 n Eng	inee	ring, I	nc.					
DEPTH (ft) SAMPLE TYPE	SYMBOL/USCS	COORDINATES: N 27° 26' 43.4" W 97° 49' 11.4" SURFACE ELEVATION: 61.14' AMSL DRILLING METHOD: Dry Augered: 0 ft. to 30 ft. Wash Bored: 30 ft. to 43 ft.	(P) POCKET PEN (tsf) (T) TORVANE (psf)	STD. PENETRATION TEST (blows/ft)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	-AILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
		MATERIAL DESCRIPTION	(a) (b)	S						₹			
0 -		Medium dense dark gray, gray, and light gray CLAYEY SAND (SC) with trace of organics	(P) 4.50+	2/6" 5/6" 6/6"	15	112			2.53	6		42	
		57.14' AMSL Very stiff to hard gray and light gray SANDY LEAN	(P) 4.50+		15	115	21	7				59	
5 -		SILTY CLAY (CL-ML) with calcareous nodules	(, , ,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,										
		color changes to light gray	(P) 4.50+		14	114			6.13	4		62	
		-color changes to light gray		4/01									
10		-color changes to light gray and tan -color changes to white and light gray		4/6" 12/6" 16/6" 11/6"									
$\exists X$		ooo ondriges to write and light gray		18/6" 16/6"									
$-\!$		-becomes stiff		5/6" 6/6" 8/6"									
15 -		46.64' AMSL Medium dense to dense white and light gray SILTY	,	4/6" 6/6"	17		38	7				31	
$-\square$		SAND (SM) with calcareous nodules BODY II		8/6" 4/6"									
		-color changes to light gray and tan with ferrous stains		10/6" 19/6"									
$-\!$				23/6" 50/5"									
20 -				23/6"									
				50/4"									
		-color changes to light gray		27/6" 35/6" 50/4"	22							25	
25 -				5/6" 37/6" 45/6"									
		-		20/6" 39/6" 37/6" 8/6"	26		39	2				28	
30	-	-becomes medium dense		12/6" 9/6" 4/6"	33		00					39	
				12/6" 10/6"									
				5/6" 6/6" 10/6"									
35	IVI	-color changes to tan and marine green		3/6"									
DATE I	BORI BORI	NG COMPLETED: 06/22/2016 was a	water wa e during d at a depth backfilled	Irilling op n of 28'-4	oeratio I". At t	ns. A he co	fter a 1	0 to 1	າ5-minເ	ute wa	iiting p e ope	eriod	, wate e-hole

PR	OJ	JEC ⁻	City of Kingsville CLIEN Municipal Solid Waste Landfill Aerial Expansion	ORIN	IG B laismith	-34 Eng	inee	ring, lı	nc.					
DEPTH (ft)	SAMPLE TYPE	SYMBOLUSCS	COORDINATES: N 27° 26' 43.4" W 97° 49' 11.4" SURFACE ELEVATION: 61.14' AMSL DRILLING METHOD: Dry Augered: 0 ft. to 30 ft. Wash Bored: 30 ft. to 43 ft. MATERIAL DESCRIPTION	(P) POCKET PEN (tsf) (T) TORVANE (psf)	STD. PENETRATION TEST (blows/ft)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
- 35 -			Medium dense tan and marine green SILTY SAND		8/6"									
			\(\sigma\) with sand lenses and trace organics25.14' AMS/\(\sigma\) Hard tan and light gray LEAN CLAY (CL) SANDY SILTY CLAY BED	(P) 4.50+ (P) 4.50+		30	91	40	17	0.93	1		91	
- 40 -				(P) 4.50+										
			18.14' AMSL	(P) 4.50+										
- 45 -			Bottom @ 43'											
- 50 -														
- 55 -														
- 60 -														
- 65 -														
- 70 -														
DA1	ΓE	BOR	ING COMPLETED: 06/22/2016 was a	e during o	as encoundrilling open of 28'-4'	eratic ". At t	ns. A he co	fter a 1 mpletio	0 to 1	15-minu	ıte wa	iting p	eriod,	water
PRO	JJE	ECI	NO.: 16.53.042 Was t		INEERS							Pag	e2 of	f 2

PROJEC	T: City of Kingsville CLIEN Municipal Solid Waste Landfill Aerial Expansion	ORIN NT: N	IG B laismith	-35 Eng	inee	ring, I	nc.					
DEPTH (ft) SAMPLE TYPE SYMBOL/USCS	COORDINATES: N 27° 26' 50.5" W 97° 48' 57.2" SURFACE ELEVATION: 64.50' AMSL DRILLING METHOD: Dry Augered: 0-ft. to 72.5-ft. Wash Bored: to	(P) POCKET PEN (tsf) (T) TORVANE (psf)	STD. PENETRATION TEST (blows/ft)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	-AILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
	MATERIAL DESCRIPTION	<u>6</u> ,0	·ν		۵				12			
0 -	Medium dense tan and brown CLAYEY SAND (SC) with trace caliche		5/6" 8/6" 7/6"									
5 -	-color changes to reddish brown with ferrous stains		5/6" 8/6" 5/6"	12		31	17				38	
2222 2222 2222	56.50' AMSL	,										
10	Very stiff to hard reddish tan SANDY LEAN CLAY (CL) with gypsum crystals	(P) 4.50+		14	117			2.22	3		52	
	-color changes to reddish tan and tan with ferrous stains		5/6" 10/6" 12/6"									
15 -	-color changes to reddish tan	(P) 4.50+		17	109	42	25					
20	-color changes to reddish tan and tan	(P) 4.50+										
	40.50' AMCI											
25 -	40.50' AMSL Medium dense to dense reddish tan and tan CLAYEY SAND (SC) with gypsum crystals and ferrous stains BODY III	(P) 4.50+		17	104			1.29	3		40	
30	-color changes to reddish tan		4/6" 7/6" 9/6"									
	= □		8/6" 13/6" 20/6"									
DATE BOR	ING COMPLETED: 07/29/2016 was a	water wa e during c at a depth packfilled	drilling op n of 30'-9	eratio	ns. A he co	fter a 1	10 to 1 on of t	15-minເ	ıte wa	iting p e opei	eriod,	water e-hole
	TOLUNAY-WONG	ENGI	NEERS	S. INC	D					. ug	,5 , 0	. •

PRO	JEC ⁻	T: City of Kingsville CLIEN Municipal Solid Waste Landfill Aerial Expansion	ORIN	IG B laismith	3-35 Eng	inee	ring, l	nc.					
DEPTH (ft)	SYMBOL/USCS	COORDINATES: N 27° 26' 50.5" W 97° 48' 57.2" SURFACE ELEVATION: 64.50' AMSL DRILLING METHOD: Dry Augered: 0-ft. to 72.5-ft. Wash Bored: to	(P) POCKET PEN (tsf) (T) TORVANE (psf)	STD. PENETRATION TEST (blows/ft)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	-AILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
	 N	MATERIAL DESCRIPTION 28.00' AMSL	(F)	ω'						₽.			
35 -	222 2222 2222	Medium dense to dense reddish tan and tan CLAYEY SAND (SC) with gypsum crystals and ferrous stains											
		Hard tan and light gray FAT CLAY with SAND (CH), gypsum crystals, and ferrous stains LIGHT OLIVE GREEN TO GRAY CLAY		17/6" 26/6" 30/6"	25		109	72				77	
40 -		-color changes to tan and reddish brown		8/6" 15/6" 24/6"									
		-with sand partings		10/6"									
45 -		-with sand partings		16/6" 16/6"									
50		Stiff to hard reddish brown and tan FAT CLAY (CH) with gypsum crystals and ferrous stains LIGHT OLIVE GREEN TO GRAY CLAY	1	4/6" 7/6" 10/6"	34							96	
		-becomes slickensided with sand layers	(P) 2.00										
55 -		-color changes to tan		4/6" 7/6" 10/6"									
60			(P) 3.75	10/0	33	89	90	67	3.88	4		89	
65 -			(P) 4.25										
		-color changes to tan and reddish brown	(P) 4.50+										
70													
DATE	BOR	ING COMPLETED: 07/29/2016 was a	water wa during o at a depth backfilled	drilling op n of 30'-9	eratio	ns. A he co	fter a 1 mpletio	10 to 1 on of t	15-minu	ıte wa	iting p e opei	eriod, n bore	water -hole
		 TOLUNAY-WONG	ENGI	NEERS	S. INC)					Pag	e2 of	3

PROJEC	T: City of Kingsville CLIEN Municipal Solid Waste Landfill Aerial Expansion	ORIN	IG B laismith	3-36 Eng	ineei	ring, lı	nc.					
DEPTH (ft) SAMPLE TYPE SYMBOL/USCS	COORDINATES: N 27° 26' 56.8" W 97° 49' 04.9" SURFACE ELEVATION: 59.13' AMSL DRILLING METHOD: Dry Augered: 0-ft. to 22-ft. Wash Bored: 22-ft. to 68-ft.	(P) POCKET PEN (tsf) (T) TORVANE (psf)	STD. PENETRATION TEST (blows/ft)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
	MATERIAL DESCRIPTION	(F)	ST						Æ	_		
0 - 222	Loose to medium dense dark gray and gray CLAYEY SAND (SC) BODY I											
	-with calcareous nodules		18/6" 20/6" 21/6"	10							36	
5 - 222			4/6"									
	-color changes to light gray and tan		5/6" 5/6"									
10 -	-color changes to tan		4/6" 5/6" 6/6"	12		47	28				44	
15 - \(\)			2/6" 4/6"									
/ Vez.	▼		6/6"									
20	-color changes to light gray with ferrous stains		4/6" 10/6" 14/6"									
	-becomes very dense and color changes to light gray and tan		15/6" 24/6" 50/6"	25							32	
25 -			12/6" 14/6"									
			15/6"									
30 -	-becomes dense		5/6" 17/6" 27/6"									
35			4/6"									
COMPLET DATE BO	RING COMPLETED: 06/24/2016 was a	water water water during of the depth of the	drilling op n of 18'-3	eratio ". At t	ns. A he co	fter a 1 mpletio	0 to 1	15-minu	ıte wa	iting p	eriod,	water
PROJECT	NO.: 16.53.042 Was t		NEERS			Ü				Pag	e1 of	f 2

PRO	JEC ⁻			IG B			ring, lı	nc.					
		Municipal Solid Waste Landfill Aerial Expansion											
DEPTH (ft)	SYMBOL/USCS	COORDINATES: N 27° 26' 56.8" W 97° 49' 04.9" SURFACE ELEVATION: 59.13' AMSL DRILLING METHOD: Dry Augered: 0-ft. to 22-ft. Wash Bored: 22-ft. to 68-ft. MATERIAL DESCRIPTION	(P) POCKET PEN (tsf) (T) TORVANE (psf)	STD. PENETRATION TEST (blows/ft)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
35	A 200	Madisus dans links supposed to CLAVEV CAND (CC)		7/6" [
	(N)	Medium dense light gray and tan CLAYEY SAND (SC) BODY I		7/6" 8/6"									
40		-with sand seams, calcareous nodules, and ferrous staining		6/6" 10/6" 13/6"	21		47	30				35	
	33333333333333333333333333333333333333	-color changes to reddish brown and light gray		4/6" 8/6" 10/6"									
- 45 -	222	13.13' AMSL											
		Stiff to very stiff reddish brown and light gray FAT CLAY (CH), slickensided, with ferrous staining LIGHT OLIVE GREEN TO GRAY CLAY	(P) 4.50+										
- 50 -		-with sand seams and calcareous nodules		4/6" 6/6" 8/6"	42							96	
- 55 -		-color changes to light gray with sand layers		11/6" 12/6" 14/6"									
- 60		-becomes hard		11/6" 21/6" 26/6"	37		70	44				94	
- 65 -				7/6" 8/6" 9/6"									
000		-color changes to brown yellow, reddish brown, and light gray -8.87' AMSL		7/6" 10/6" 10/6"									
70		Bottom @ 68'											
DATE DATE LOG(BOR BOR	ING COMPLETED: 06/24/2016 was a	e during o at a depth backfilled	as encoun drilling open of 18'-3' with cem	eratio '. At t ent-b	ons. A he co pentor	fter a 1 mpletio	0 to 1	15-minu	ıte wa	iting p e opei	eriod,	water e-hole

MATERIAL DESCRIPTION Wery dense light gray and tan SILTY SAND (SM) BODY II -with ferrous staining -with refrous staining -with calcareous nodules -with calcareous nodules 31.02' AMSL Very stiff to hard tan and light tan SANDY LEAN SILTY CLAY (CL-ML) SANDY SILTY CLAY BED -color changes to tan and light gray with ferrous staining -color changes to tan and light gray with ferrous staining LIGHT OLIVE GREEN TO GRAY CLAY -color changes to light gray with sand layers -color changes to light gray with sand layers -ser - ser - se	PROJEC	LOG OF BOTE CLIEN City of Kingsville CLIEN Municipal Solid Waste Landfill Aerial Expansion	ORIN IT: N	IG B laismith	3-37 Eng	ineei	ring, li	nc.					
Very dense light gray and tan SILTY SAND (SM) BODY II -with ferrous staining -staining -staining -with calcareous nodules -to-lo-lo-lo-lo-lo-lo-lo-lo-lo-lo-lo-lo-lo	DEPTH (ft) SAMPLE TYPE SYMBOL/USCS	W 97° 49' 17.6" SURFACE ELEVATION: 45.52' AMSL DRILLING METHOD: Dry Augered: 0-ft. to 12-ft. Wash Bored: 12-ft. to 48-ft.) POCKET PEN (tsf) (T) TORVANE (psf)	TD. PENETRATION TEST (blows/ft)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	AILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
-with ferrous staining -with ferrous staining -with ferrous staining -with calcareous nodules -with calcareous nodules	- 0 -		A)	os .						ш.			
-with ferrous staining -s - 6 - 110													
with calcareous nodules 31.02' AMSL Very stiff to hard tan and light tan SANDY LEAN SILTY CLAY BED -tolor changes to tan and light gray with ferrous staining -color changes to tan and light gray with ferrous staining -tolor changes to tan and light gray FAT CLAY (CH) with calcareous nodules and ferrous staining LIGHT OLIVE GREEN TO GRAY CLAY -color changes to light gray with sand layers -tolor changes to light gray with sand light tan SANDY Lean Sandy Sandy Sandy Sandy Sandy Sandy S		-with ferrous staining 6/6" 16/6" 50/5"											
-with calcareous nodules -with calcareous nodules 31.02' AMSL Very stiff to hard tan and light tan SANDY LEAN SILTY CLAY (CL-ML) SANDY SILTY CLAY BED -color changes to tan and light gray with ferrous staining -color changes to tan and light gray with ferrous staining 19.02' AMSL Stiff to very stiff reddish brown and light gray FAT CLAY (CH) with calcareous nodules and ferrous staining LIGHT OLIVE GREEN TO GRAY CLAY -color changes to light gray with sand layers Stiff to very stiff reddish brown and light gray FAT CLAY (CH) with calcareous nodules and ferrous staining LIGHT OLIVE GREEN TO GRAY CLAY -color changes to light gray with sand layers Stiff to very stiff reddish brown and light gray FAT CLAY (CH) with calcareous nodules and ferrous staining LIGHT OLIVE GREEN TO GRAY CLAY -color changes to light gray with sand layers Stiff to very stiff reddish brown and light gray FAT CLAY (CH) with calcareous nodules and ferrous staining LIGHT OLIVE GREEN TO GRAY CLAY -color changes to light gray with sand layers Stiff to very stiff reddish brown and light gray FAT CLAY (She the program that the part of					20		33	9				20	
31.02' AMSL Very stiff to hard tan and light tan SANDY SLTY CLAY BED CLAY (CL-ML) SANDY SLTY CLAY BED -color changes to tan and light gray with ferrous staining -color changes to tan and light gray with ferrous staining 19.02' AMSL 7/6' 12/6' 13.06' 31 Stiff to very stiff reddish brown and light gray FAT CLAY (CH) with calcareous nodules and ferrous staining LIGHT OLIVE GREEN TO GRAY CLAY -color changes to light gray with sand layers 5/6' 7/6' 12/6' 33 56 39 99 COMPLETION DEPTH: A8 ft DATE BORING STARTED: 06/24/2016 06/24/2016 06/25/2016	- 10 -	-with calcareous nodules		23/6"									
Very stiff to hard tan and light tan SANDY LEAN SILTY CLAY BED -color changes to tan and light gray with ferrous staining -color changes to tan and light gray with ferrous staining -color changes to tan and light gray with ferrous staining -20 Stiff to very stiff reddish brown and light gray FAT CLAY 12/6* (CH) with calcareous nodules and ferrous staining LIGHT OLIVE GREEN TO GRAY CLAY -color changes to light gray with sand layers -color changes to tan and light gray with ferrous staining -color changes to tan and light gray with ferrous staining -color changes to tan and light gray with ferrous staining -color changes to tan and light gray with ferrous staining -color changes to tan and light gray with ferr		√ 7		37/6" 50/6"									
-color changes to tan and light gray with ferrous staining -color changes to tan and light gray with ferrous staining -color changes to tan and light gray with ferrous staining -color changes to tan and light gray with ferrous staining -color changes to tan and light gray with ferrous staining -color changes to light gray with sand layers -color changes to tan and light gray with ferrous staining gray and gray difference with processing gray and gray gray gray gray gray gray gray gray	15 -			6/6"	31							52	
27/6° 27/6° 27/6° 27/6° 27/6° 12/6° 13/6° 12/6° 13/6° 25- Stiff to very stiff reddish brown and light gray FAT CLAY (CH) with calcareous nodules and ferrous staining LIGHT OLIVE GREEN TO GRAY CLAY -color changes to light gray with sand layers COMPLETION DEPTH: DATE BORING STARTED: 06/24/2016 06/24/2016 06/25/2016 REMARKS: Free water was encounterd at an approximate depth of 15' below existing grade during drilling operations. After a 10 to 15-minute waiting period, wate was at a depth of 0/3° at the completions of the boring the poper bors bytes at a depth of 0/3° at the completion of the boring the poper bors bytes.		0. 13. (0. 10.)		10/6"									
Stiff to very stiff reddish brown and light gray FAT CLAY (CH) with calcareous nodules and ferrous staining LIGHT OLIVE GREEN TO GRAY CLAY -30color changes to light gray with sand layers COMPLETION DEPTH: DATE BORING STARTED: 06/24/2016 06/25/2016 19.02' AMSL 4/6" 5/6" 9/6" 33 56 39 99 COMPLETION DEPTH: 48 ft 06/24/2016 06/25/2016 REMARKS: Free water was encounterd at an approximate depth of 15' below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 0'.3" At the completion of the point the open beyond the open below below the complete of the prior of the open below to the open below below the open below to the open below the open be	- 20	-color changes to tan and light gray with ferrous staining		9/6" 17/6" 27/6"									
Stiff to very stiff reddish brown and light gray FAT CLAY (CH) with calcareous nodules and ferrous staining LIGHT OLIVE GREEN TO GRAY CLAY -30 - color changes to light gray with sand layers Solution of the prince the open byre-bole was at a depth of 92. At the completions. After a 10 to 15-minut was at a depth of 92. At the completions. After a 10 to 15-minut was at a depth of 92. At the completions. After a 10 to 15-minut was at a depth of 92. At the completions of the boring the open byre-bole was at a depth of 92. At the completion of the boring the open byre-bole was at a depth of 92. At the completion of the boring the open byre-bole was at a depth of 92. At the completion of the boring the open byre-bole was at a depth of 92. At the completion of the boring the open byre-bole was at a depth of 92. At the completion of the boring the open byre-bole was at a depth of 92. At the completion of the boring the open byre-bole was at a depth of 92. At the completion of the boring the open byre-bole was at a depth of 92. At the completion of the boring the open byre-bole was at a depth of 92. At the completion of the boring the open byre-bole was at a depth of 92. At the completion of the boring the open byre-bole was at a depth of 92. At the completion of the boring the open byre-bole was at a depth of 92. At the completion of the boring the open byre-bole was at a depth of 92. At the completion of the boring the open byre-bole was at a depth of 92. At the completion of the boring the open byre-bole was at a depth of 92. At the completion of the boring the open byre-bole was at a depth of 92. At the completion of the boring the part of 92. At the completion of the boring the part of 92. At the completion of 92. At th				7/6" 12/6" 13/6"									
Stiff to very stiff reddish brown and light gray FAT CLAY (CH) with calcareous nodules and ferrous staining LIGHT OLIVE GREEN TO GRAY CLAY -30 -color changes to light gray with sand layers 5/6" 12/6" 33 56 39 99 99 COMPLETION DEPTH: DATE BORING STARTED: DATE BORING COMPLETED: 06/24/2016 DATE BORING COMPLETED: 06/25/2016 8EMARKS: Free water was encounterd at an approximate depth of 15' below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 9/3". At the completion of the horizon, the open bere-hole.	- 25 -	19 02' AMSI											
-color changes to light gray with sand layers -color changes to light g		Stiff to very stiff reddish brown and light gray FAT CLAY (CH) with calcareous nodules and ferrous staining		4/6" 5/6" 9/6"	33		56	39				99	
COMPLETION DEPTH: DATE BORING STARTED: DATE BORING COMPLETED: 06/24/2016 06/25/2016 06/25/2016 REMARKS: Free water was encounterd at an approximate depth of 15' below existing grade during drilling operations. After a 10 to 15-minute waiting period, water was at a depth of 9'-3". At the completion of the boring the open bore-hole.	30 -	-color changes to light gray with sand layers		5/6" 7/6" 12/6"									
DATE BORING STARTED: 06/24/2016 grade during drilling operations. After a 10 to 15-minute waiting period, wate DATE BORING COMPLETED: 06/25/2016 was at a depth of 9/3" At the completion of the boring, the open bore-hole	35			5/6"	34							86	
L DDO LECT NO . 46.53.043 Was dacklined with cement-denionite drout.	DATE BOR DATE BOR	ING STARTED: 06/24/2016 grade ING COMPLETED: 06/25/2016 was a	during out	drilling op n of 9'-3"	eratio . At the	ns. A e com	fter a 1	0 to 1	15-minu	ıte wa	iting p	eriod,	water
PROJECT NO.: 16.53.042 was backlined with certific production by the property of 2 TOLUNAY-WONG ENGINEERS, INC	PROJECT										Pag	e1 o	f 2

PR	PROJECT: City of Kingsville CLIENT: Naismith Engineering, Inc. Municipal Solid Waste Landfill													
	ñ	g	Aerial Expansion COORDINATES: N 27° 26' 57.1" W 97° 49' 17.6"	v (tsf) psf)	t)		노			√E sf)	(%) 7	(isi	00	φ.
DЕРТН (ft)	SAMPLE TYPE	SYMBOL/USCS	SURFACE ELEVATION: 45.52' AMSL DRILLING METHOD: Dry Augered: 0-ft. to 12-ft. Wash Bored: 12-ft. to 48-ft.	(P) POCKET PEN (tsf) (T) TORVANE (psf)	STD. PENETRATION TEST (blows/ft)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
	S	Ś	MATERIAL DESCRIPTION	(P)	STD		DR			ა დ	FAIL	- H	Δ.	0 "
- 35 -	X		Stiff to very stiff light gray and brownish tan FAT CLAY (CH) with sand seams, calcareous nodules, and ferrous staining LIGHT OLIVE GREEN TO GRAY CLAY		7/6" 12/6"									
- 40	X		4/6" 5/6" 7/6"											
40														
	-color changes to light gray and reddish brown 6/6" 6/6" 9/6"													
- 45 -			-color changes to light gray		4/6"	35		80	51				86	
	Д		-2.48' AMSL Bottom @ 48'		4/6" 5/6" 9/6"									
- 50 -														
- 55 -														
- 60 -														
- 65 -														
- 70 -														
DA1	TE TE	BOR	ING COMPLETED: 06/25/2016 was a	during out	drilling ope n of 9'-3".	eratic At th	ns. A e con	fter a 1 opletion	0 to	15-minu	ıte wa	iting p	eriod,	water
		ĒĊŤ			l with cem			nite gro	out.			Pag	e2 of	f2

PRC)JI	ECT	T: City of Kingsville CLIEN Municipal Solid Waste Landfill Aerial Expansion	ORIN NT: N	IG B laismith	-38 Eng	inee	ring, I	nc.					
DEPTH (ft)	SAINIPLE IT PE	SYMBOL/USCS	COORDINATES: N 27° 27' 03.76"	(P) POCKET PEN (tsf) (T) TORVANE (psf)	STD. PENETRATION TEST (blows/ft)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	-AILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
35	1		Very stiff to hard reddish brown and light gray SANDY	<u>g</u> , -	8/6" 10/6"						<u> </u>			
			FAT CLAY (CH) with sand seams and layers 3.64' AMSL	(P) 4.50+	10/6									
			Stiff to hard light gray FAT CLAY (CH), slickensided, with calcareous nodules and ferrous stains	(P) 4.50+		42	78	100	72	2.95	2		93	
- 40 -			-color changes to reddish brown and light gray LIGHT OLIVE GREEN TO GRAY CLAY	(P) 4.50+										
				(P) 4.50+										
- 45 -			-color changes to tannish brown and light gray with trace organics	(P) 4.50+										
			-color changes to light gray		5/6" 6/6"									
				(P) 4.50+	8/6"	30	91			2.14	3		87	
50					6/6" 7/6" 7/6"									
					4/6" 5/6" 8/6"									
- 55 -			-color changes to tannish brown and light gray		5/6" 7/6" 9/6"									
_			-color changes to light gray -16.36' AMSL		6/6" 7/6" 9/6"									
	Ĭ		Bottom @ 58'		3/0									
- 60 -														
- 65 -														
- 70 - - COM			ON DEDTIL				_4 -		.:	. al c = 4		h.'		
DATE	E E	3OR 3OR	ING COMPLETED: 06/23/2016 was a	e during o	drilling op n of 5'-5".	eratic At th	ns. A e con	fter a 1	10 to 1 n of th	15-minເ	ıte wa	iting p	eriod,	water
PRO.	ĴΈ	ĊŤ I	NO.: 16.53.042 was t		with cerr			Ū				Pag	e2 o	f 2

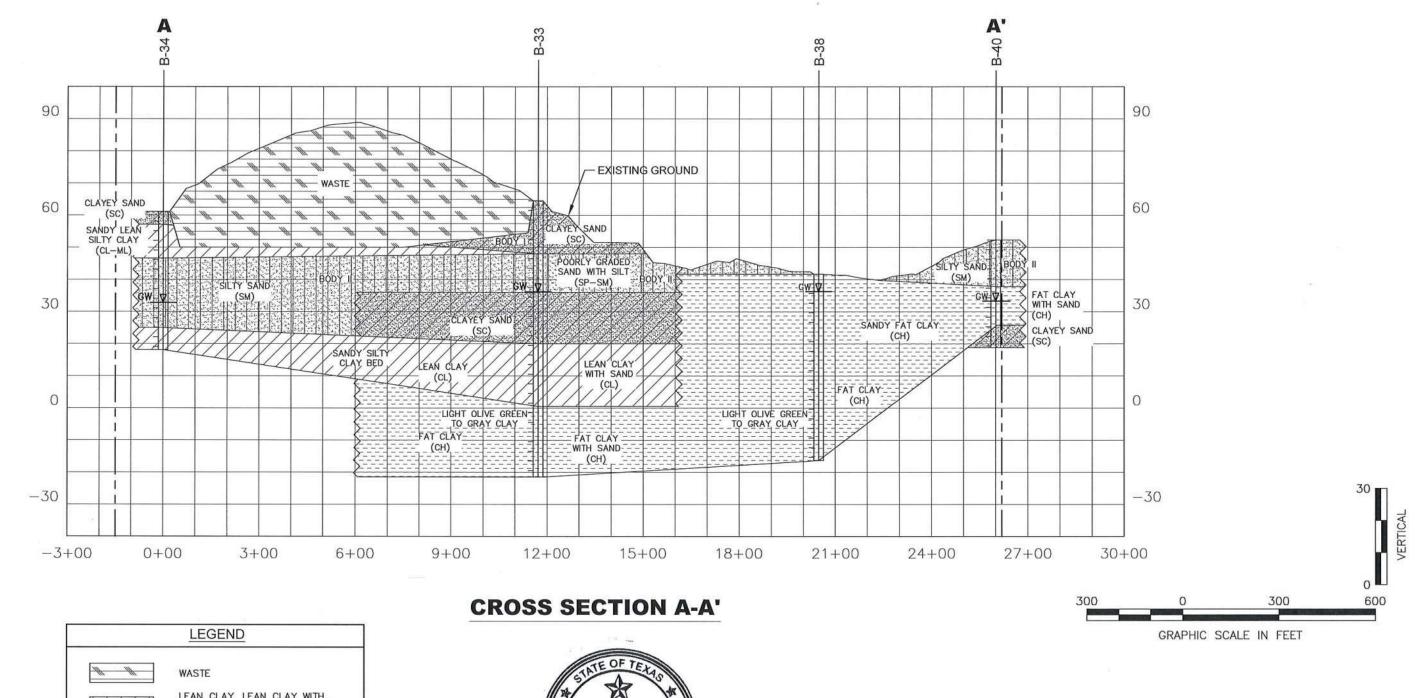
PROJE	CT: City of Kingsville CLIEN Municipal Solid Waste Landfill Aerial Expansion	ORIN NT: N	IG B laismith	-39 Eng	inee	ring, lı	nc.					
SAMPLE TYPE	COORDINATES: N 27° 27' 01.3" W 97° 48' 57.3" SURFACE ELEVATION: 60.26' AMSL DRILLING METHOD: Dry Augered: 0 ft. to 26 ft. Wash Bored: 26 ft. to 68 ft.	(P) POCKET PEN (tsf) (T) TORVANE (psf)	STD. PENETRATION TEST (blows/ft)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
_	MATERIAL DESCRIPTION	(E)	<u> </u>	-	Δ				₹			
0 -	Medium dense to dense tan and light gray CLAYEY SAND FILL with trace gravel BODY I		8/6" 9/6" 6/6"	18							33	
	-color changes to brown		40/6" 27/6" 19/6"									
5 - 22	55.76' AMSL Medium dense to dense brown and reddish brown CLAYEY SAND (SC) BODY I		6/6" 7/6"									
	CLAYEY SAND (SC) BODY I -color changes to tan and gray with calcareous nodules		8/6" 4/6" 5/6"									
			6/6" 5/6"	11		36	20				49	
10			6/6" 8/6" 4/6"									
	color changes to tan and light gray		6/6" 7/6"									
	-color changes to light gray		7/6" 8/6" 11/6"									
15 - 15	-color changes to light gray and tan with ferrous stains		6/6" 12/6" 19/6"									
	-color changes to light gray		11/6" 19/6"									
	41.76' AMSL Stiff to hard light gray SANDY LEAN CLAY (CL) with		22/6"	19							65	
20	calcareous nodules and ferrous stains		3/6" 4/6" 5/6"									
			9/6" 13/6"									
		(D) 4.50	8/6" 11/6" 20/6"									
25 -	-color changes to light tan and light gray	(P) 4.50+										
	卖color changes to light gray	(P) 4.00										
	무		7/6"									
30	-color changes to light gray and tan	(P) 4.50+	11/6" 13/6"	19	102			1.14	7		50	
			12/6" 16/6" 20/6"									
35			8/6"						_			
DATE BO	PRING COMPLETED: 06/24/2016 was a	water wa e during d at a depth backfilled	Irilling op n of 26'-6	eratio	ns. A he co	fter a 1 mpletic	0 to 1	15-minu	ıte wa	iting p e opei	eriod, n bore	water e-hole
	 TOLUNAY-WONG	ENGI	NEERS	S. INC)					Pag	e1 o	12

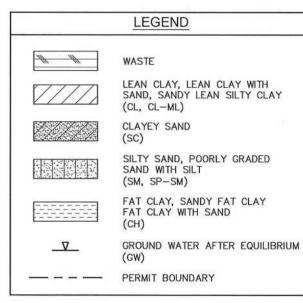
PRO	0.	JECT	City of Kingsville CLIEN Municipal Solid Waste Landfill Aerial Expansion	ORIN IT: N	IG B	-39 Eng	inee	ring, l	nc.					
DEPTH (ft)	SAMPLE TYPE	SYMBOL/USCS	COORDINATES: N 27° 27' 01.3" W 97° 48' 57.3" SURFACE ELEVATION: 60.26' AMSL DRILLING METHOD: Dry Augered: 0 ft. to 26 ft. Wash Bored: 26 ft. to 68 ft. MATERIAL DESCRIPTION	(P) POCKET PEN (tsf) (T) TORVANE (psf)	STD. PENETRATION TEST (blows/ft)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	-AILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
35					12/6" [ш			
	$\stackrel{\times}{\rightarrow}$		Stiff to hard light gray and tan SANDY LEAN CLAY (CL) with ferrous stains 23.76' AMSL		16/6" 7/6"									
	X		Medium dense to dense light gray CLAYEY SAND (SC) with ferrous stains BODY III		8/6" 11/6" 6/6"									
40	Å V				11/6" 12/6" 7/6"	25		69	51				45	
	$\frac{\Lambda}{}$				10/6" 13/6" 13/6"									
/	Д		15.76' AMSL		19/6" 21/6"									
- 45 -	X		Dense light gray POORLY GRADED SAND with CLAY (SP- SC)		12/6" 21/6" 20/6"									
	X		12.26' AMSL		11/6" 16/6" 16/6"									
			Hard reddish brown and light gray FAT CLAY with SAND (CH)	(P) 4.50+										
- 50 -			LIGHT OLIVE GREEN TO GRAY CLAY	(P) 4.50+		28	93			0.85	1		72	
			-becomes slickensided with calcareous nodules	(P) 4.50+										
- 55 -			-with ferrous stains	(P) 4.50+										
				(P) 4.50+										
				(P) 4.50+										
- 60 -				(P) 4.50+										
	X		-becomes stiff		7/6" 7/6" 7/6"									
- 65 -			C 24! AMCI											
	X		-6.24' AMSL Medium dense light gray CLAYEY SAND (SC) with calcareous nodules and ferrous stains -7.74' AMSL		6/6" 10/6" 13/6"	20	102	61	45	1.91	5		46	
- 70 -			Bottom @ 68'											
CON DAT DAT	Ē	BOR	ING COMPLETED: 06/24/2016 was a	during of at a depth backfilled	s encoun Irilling ope of 26'-6' with cem	eratio '. At t nent-b	ons. A he co pentor	fter a 1 mpletionite gro	10 to for of tout.	15-minu the bori	ıte wa	iting p e ope	eriod,	water -hole

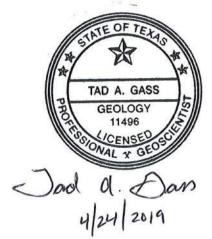
PROJEC [*]	City of Kingsville CLIEN Municipal Solid Waste Landfill Aerial Expansion	ORIN IT: N	IG B laismith	-40 Eng	ineei	ring, lı	nc.					
DEPTH (ft) SAMPLE TYPE SYMBOL/USCS	COORDINATES: N 27° 27' 09.97" W 97° 49' 11.18" SURFACE ELEVATION: 52.31' AMSL DRILLING METHOD: Dry Augered: 0 ft. to 22 ft. Wash Bored: 22 ft. to 33.75 ft.	(P) POCKET PEN (tsf) (T) TORVANE (psf)	STD. PENETRATION TEST (blows/ft)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	-AILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
	MATERIAL DESCRIPTION	(£)	ST		۵				₹			
0 -	Loose to very dense light gray and gray SILTY SAND (SM) with trace caliche BODY II		4/6" 4/6" 6/6"									
	-color changes to light gray and tan with ferrous stains		5/6" 7/6" 11/6"	16		35	10				31	
5 -	-color changes to light gray with calcareous nodules		7/6" 17/6" 17/6" 12/6"									
	-color changes to light gray and white		21/6" 34/6" 12/6"	18							34	
10 -	-color changes to white		27/6" 50/3" 15/6" 50/3"									
	-color changes to light gray and white		25/6" 50/4"									
15 - 🗸 📝	37.81' AMSL Hard light gray FAT CLAY with SAND (CH), calcareous		7/6"	22		70	41				80	
	nodules, and ferrous stains		26/6" 50/5"									
			5/6" 17/6" 28/6"									
	-		10/6" 30/6" 35/6"									
20	₩ 31.81' AMSL Hard light gray SANDY FAT CLAY (CH) with		9/6"	31							59	
	calcareous nodules and ferrous stains		25/6" 35/6"									
			16/6" 32/6" 50/5"									
25 -	25.81' AMSL		16/6" 31/6" 50/5"									
	Dense to very dense light gray CLAYEY SAND (SC) with calcareous nodules		8/6" 18/6" 27/6" 6/6"	30		53	32				49	
30 - 30			18/6" 50/6" 6/6"									
			20/6" 50/5"									
	18.81' AMSL		3/6" 40/6" \ 50/3"	16							30	
35 -	Bottom @ 33.5'											
DATE BOR	ING COMPLETED: 06/22/2016 was a	during of the during of the depth of the dep	as encour drilling op n of 19'. A with cen	eration At the nent-b	ns. A comp entor	fter a 1 detion nite gro	0 to 1 of the out.	15-minu boring	ıte wa	iting p pen b	eriod,	, water ole

COORDINATES: N 27° 27' 09.8"	PROJECT	Municipal Solid Waste Landfill	ORIN	IG B	- 41 Eng	ineeı	ring, lı	nc.					
Loose to medium dense gray CLAYEY SAND (SC) with BODY I calcareous nodules	DEPTH (ft) SAMPLE TYPE SYMBOL/USCS	W 97° 49' 17.4" SURFACE ELEVATION: 50.20' AMSL DRILLING METHOD: Dry Augered: 0-ft. to 62.5-ft. Wash Bored: to	y) POCKET PEN (tsf) (T) TORVANE (psf)	TD. PENETRATION TEST (blows/ft)	MOISTURE CONTENT (%)	ORY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	AILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
Loose to medium dense gray CLAYEY SAND (SC) with BODY I Sec. 8 8 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9	0		<u>B</u>	S						7.			
Stiff to very stiff gray SANDY FAT CLAY (CH) LIGHT OLIVE GREEN TO GRAY CLAY -becomes hard and color changes to brown with interbedded sand seams -becomes hard and color changes to brown with interbedded sand seams -color changes to brown and tan -color changes to brown with sand layers -color changes to brown with sand layers -color changes to brown with sand partings -color changes to brown and tan -color changes to brown with sand partings -color changes to brown with sand layers -color changes to bro				5/6"	8							35	
Stiff to very stiff gray SANDY FAT CLAY (CH) LIGHT OLIVE GREEN TO GRAY CLAY -becomes hard and color changes to brown with interbedded sand seams -color changes to brown and tan -color changes to tan with sand layers -color changes to tan with sand layers -color changes to brown with sand partings -color changes to brown with sand partings -color changes to brown and tan -color changes to brown with sand partings -color changes to brown and tan -color changes to brown with sand partings -color changes to brown and tan -color changes to brown and tan -color changes to brown with sand partings -color changes to brown with sand layers -color changes to brown	5 -	-color changes to light gray		5/6"									
Stiff to very stiff gray SANDY FAT CLAY (CH) LIGHT OLIVE GREEN TO GRAY CLAY		41 70' AMSI											
-color changes to brown with sand layers -color changes to brown with sand layers -color changes to brown with sand partings -color changes to brown and tan -color changes to brown with sand partings -color changes to brown wi				8/6"	20		78	52				64	
interbedded sand seams -color changes to brown and tan -color changes to tan with sand layers -color changes to tan with sand layers -color changes to brown with sand partings -color changes to brown with sand partings -color changes to brown and tan -color changes to brown with sand partings -color	10	LIGHT OLIVE GREEN TO GRAY CLAY		11/6"									
-color changes to tan with sand layers -color changes to tan with sand partings -color changes to brown with sand partings -color changes to brown and tan -color changes to brown with sand partings -color changes to	15 -			17/6"									
-color changes to tan with sand layers -color changes to tan with sand layers -color changes to brown with sand partings -color changes to brown with sand partings -color changes to brown and tan -color changes to brown with sand partings -color changes to brown with sand partings -color changes to brown and tan -color changes to brown with sand partings -color changes to brown and tan -color changes to brown and ta		-color changes to brown and tan		12/6"									
-color changes to brown and tan	20 -	-color changes to tan with sand layers		4/6"	36							64	
COMPLETION DEPTH: DATE BORING STARTED: DATE BORING COMPLETED: DATE B	25	-color changes to brown with sand partings		4/6"									
COMPLETION DEPTH: DATE BORING STARTED: DATE BORING COMPLETED: DOMPLETION DEPTH: DATE BORING COMPLETED: DOMPLETED: DOMPL	30	-color changes to brown and tan		7/6"	31		52	30				51	
DATE BORING STARTED: 07/20/2016 DATE BORING COMPLETED: 07/20/2016 LOGGER: M. Anderson PROJECT NO.: grade during drilling operations. After a 10 to 15-minute waiting period, water a depth of 19'-3". At the completion of the boring, the open bore-hole was backfilled with cement-bentonite grout.	35 -			6/6"									
Page1 of 2	DATE BOR DATE BOR	ING STARTED: 07/20/2016 grade ING COMPLETED: 07/20/2016 was a	during out a depth	drilling op n of 19'-3	eratio	ns. A he co	fter a 1 mpletio	0 to 1	15-minu	ite wa	iting p	eriod,	water
TOLUNAY-WONG ENGINEERS, INC.	PROJECT						Ü				Pag	e1 of	f 2

PR	O.	JECT		ORIN IT: N	IG B	- 41 Eng	inee	ring, lı	nc.					
			Municipal Solid Waste Landfill Aerial Expansion											
DEPTH (ft)	SAMPLE TYPE	SYMBOL/USCS	COORDINATES: N 27° 27' 09.8"	(P) POCKET PEN (tsf) (T) TORVANE (psf)	STD. PENETRATION TEST (blows/ft)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
		N	MATERIAL DESCRIPTION 14.20' AMSL	Ē.	<u></u> σ						7			
- 35 -			Stiff to very stiff gray SANDY FAT CLAY (CH)			L_								
			Very stiff brown FAT CLAY with SAND (CH) LIGHT OLIVE GREEN TO GRAY CLAY	(P) 3.25		27	92						77	
- 40 -	X		-color changes to brown and tan		6/6" 13/6" 11/6"									
- 45 -	X				4/6" 9/6" 14/6"									
- 50 -	X				6/6" 8/6" 9/6"	35		97	75				84	
- 55 -	X		-color changes to brown and gray		7/6" 9/6" 12/6"									
33			-color changes to gray	(P) 4.50+										
- 60 -			10.00(A.M.G.)	(P) 3.50										
			-12.30' AMSL Bottom @ 62.5'											
- 65 -														
- 70 -														
DA DA LO	TE TE GG	BOR	M. Anderson was a	water wa during d at a depth ackfilled	Irilling op n of 19'-3	eratic	ns. A he co	fter a 1 mpletio	0 to 1	15-minເ	ite wa	iting p e opei	eriod, n bore	water -hole
			TOLUNAY-WONG	ENGI	NEERS	S. INC	D					rag	e2 of	_







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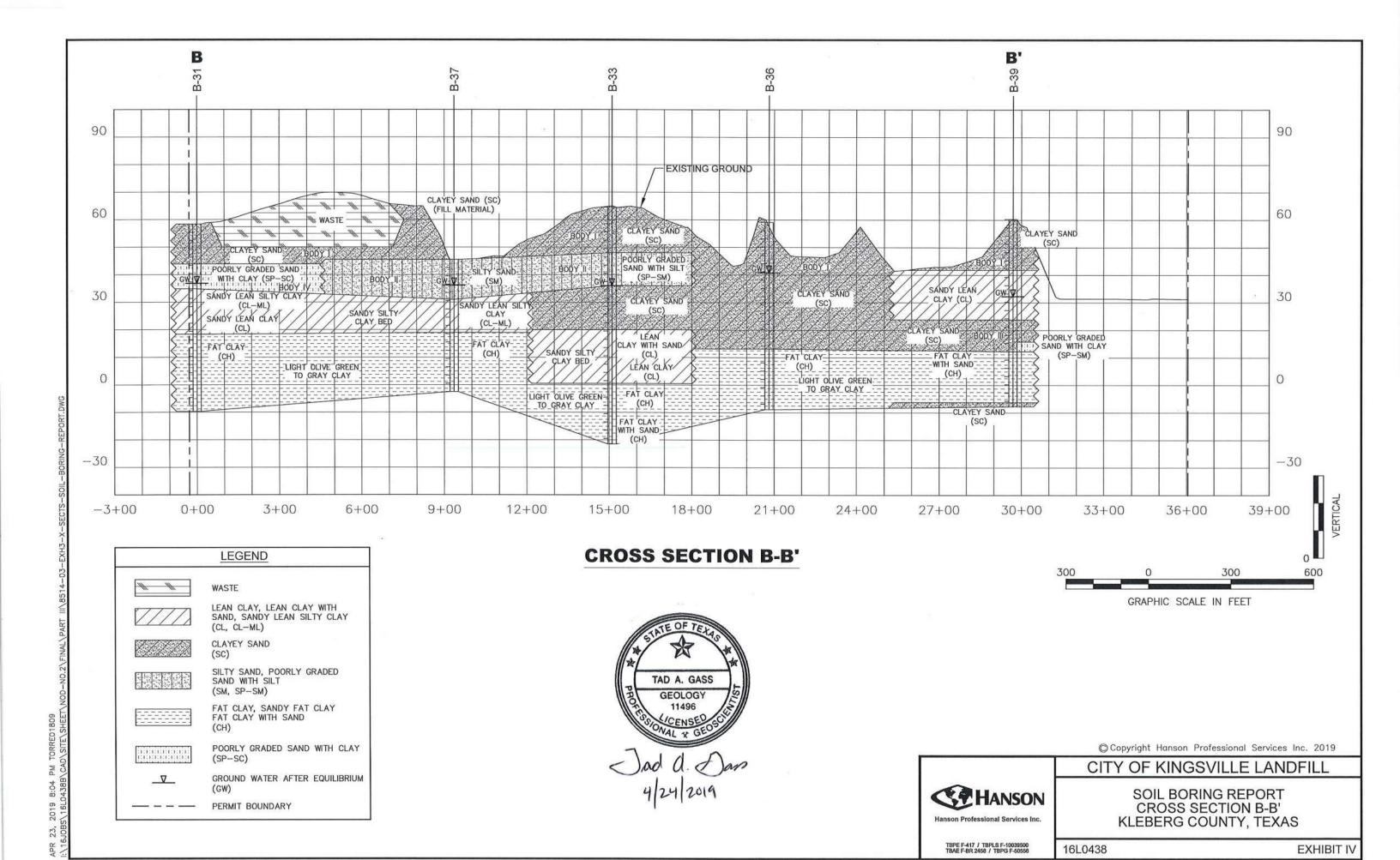
CITY OF KINGSVILLE LANDFILL

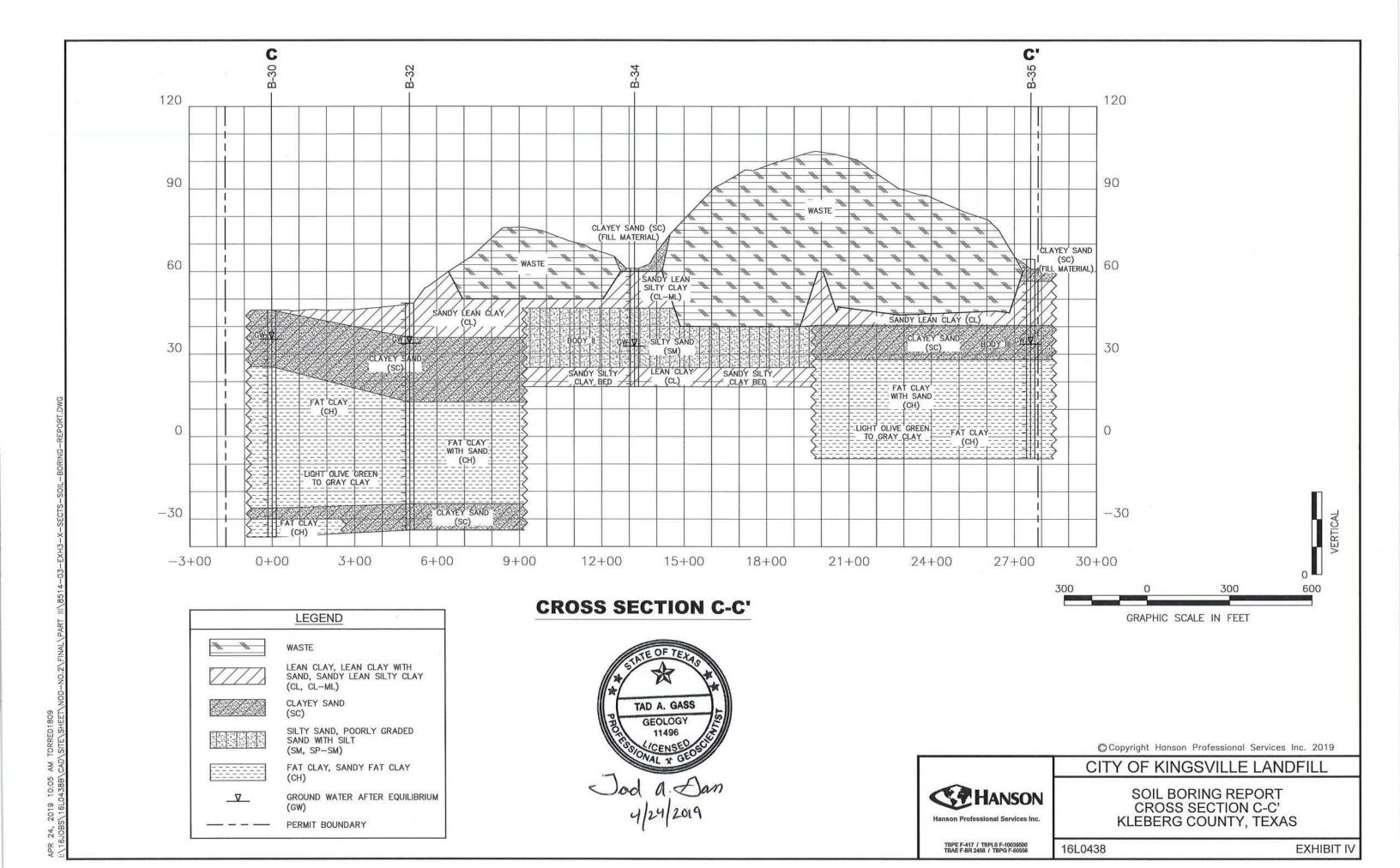
SOIL BORING REPORT CROSS SECTION A-A' KLEBERG COUNTY, TEXAS

TBPE F-417 / TBPLS F-10039500 TBAE F-BR 2458 / TBPG F-50556

16L0438

EXHIBIT IV





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CITY OF KINGSVILLE LANDFILL

SOIL BORING REPORT

CROSS SECTION D-D'

KLEBERG COUNTY, TEXAS

EXHIBIT IV

HANSON

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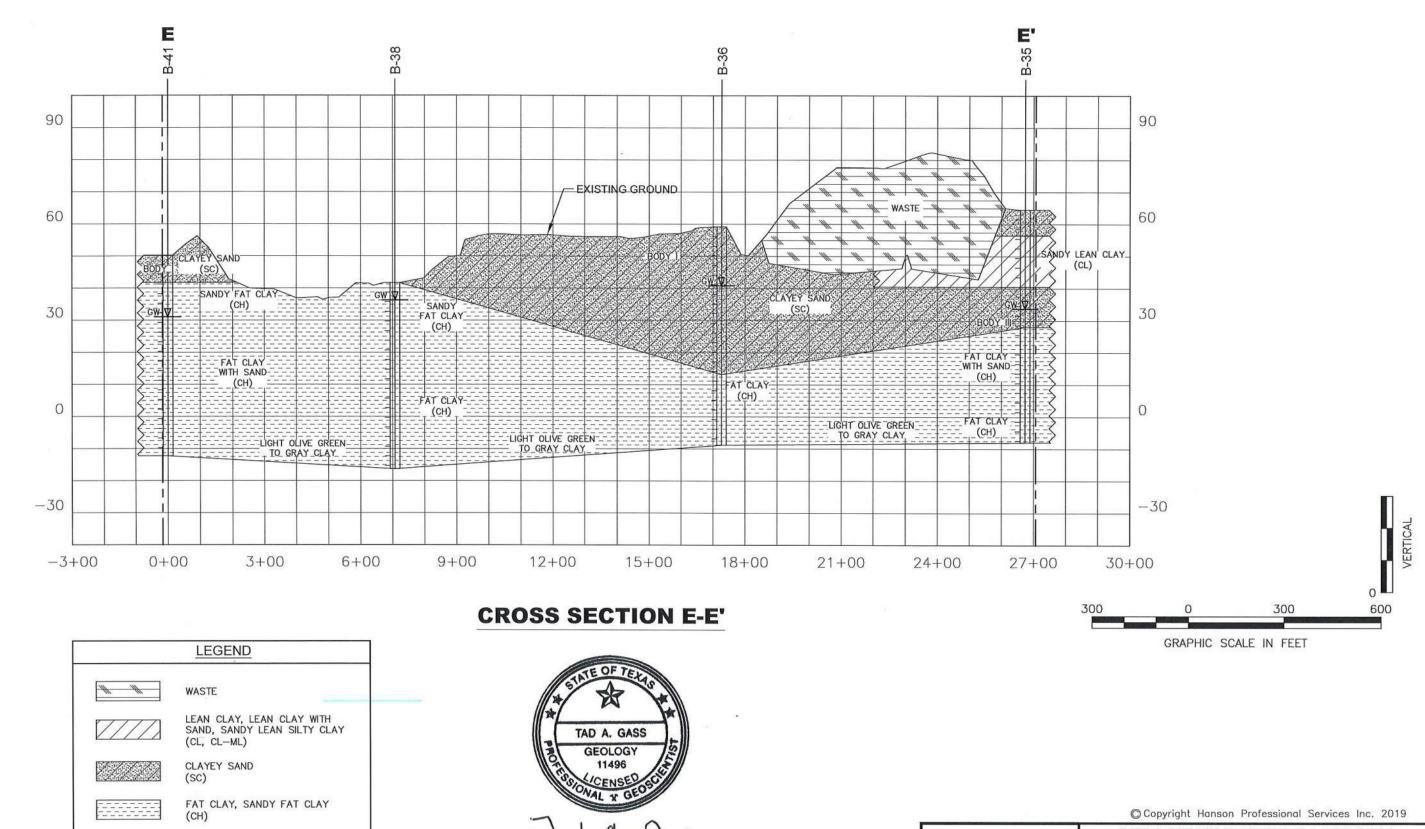
PERMIT BOUNDARY

(CH)

(GW)

FAT CLAY, SANDY FAT CLAY

GROUND WATER AFTER EQUILIBRIUM



GROUND WATER AFTER EQUILIBRIUM

PERMIT BOUNDARY

HANSON Hanson Professional Services Inc.

CITY OF KINGSVILLE LANDFILL

SOIL BORING REPORT **CROSS SECTION E-E'** KLEBERG COUNTY, TEXAS

TBPE F-417 / TBPLS F-10039500 TBAE F-BR 2458 / TBPG F-50558

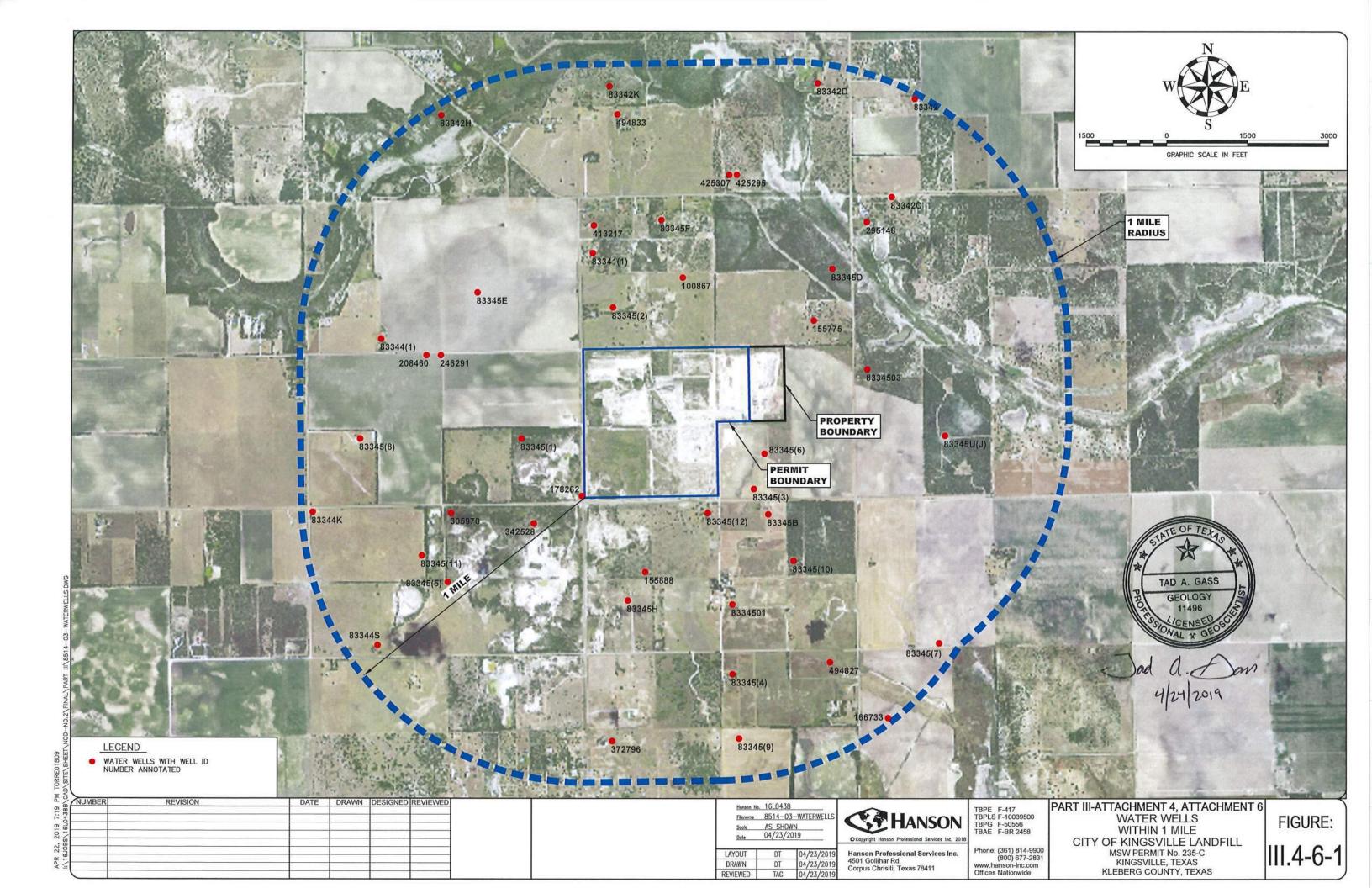
16L0438

EXHIBIT IV

CITY OF KINGSVILLE LANDFILL PART III, ATTACHMENT 4 ATTACHMENT 6

WATER WELL SURVEY DATA

Well ID	Figure 4.15 ID	Well Use	Aquifer	Well Depth (Ft.)	Approximate Distance from Site
	118410 1123 12	Well Obe	Wells Identified by FEE	tren Depth (1 ti)	Approximate Distance from Site
00 04 504	504		· ·	604	
83-34-501	501	Domestic	Evangeline Aquifer (Goliad Sand)		~0.6 Miles South
83-34-503	503	N/A	Aquifer Code Is Not Applicable to this Well	6131	~ 0.8 Miles Northeas
83-34-2C	2C	Domestic	*Evangeline Aquifer (Goliad Sand)	618	~0.9 Miles Northeas
83-34-2D	2D	Other	*Evangeline Aquifer (Goliad Sand)	556	~0.9 Miles Northeas
83-34-2H	2H	Domestic	*Evangeline Aquifer (Goliad Sand)	618	~0.9 Mile Northwes
83-34-2K	2K	Domestic	*Evangeline Aquifer (Goliad Sand)	591	~0.9 Miles Northwes
83-34-2K	2K	Domestic	*Evangeline Aquifer (Goliad Sand)	668	~0.9 Miles Northwes
83-34-4K	4K	Domestic	*Evangeline Aquifer (Goliad Sand)	692	~0.9 Miles Southwes
83-34-45	4S	Domestic	*Evangeline Aquifer (Goliad Sand)	640	~0.8 Miles Southwes
83-34-5B	5B	Domestic	*Evangeline Aquifer (Goliad Sand)	631	~0.4 Miles Southeas
83-34-5D	5D	Domestic	*Evangeline Aquifer (Goliad Sand)	642	~0.7 Miles Northeas
83-34-5E	5E	Domestic	*Evangeline Aquifer (Goliad Sand)	612	~0.5 Miles Northwes
83-34-5F	5F	Domestic	*Evangeline Aquifer (Goliad Sand)	727	~0.5 Miles North
83-34-5G	5G	Domestic	*Evangeline Aquifer (Goliad Sand)	763	~0.9 Miles Southwes
83-34-5H	5H	Domestic	*Evangeline Aquifer (Goliad Sand)	687	~0.5 Miles South
83-34-5U	5J	Domestic	*Evangeline Aquifer (Goliad Sand)	640	~ 0.7 Miles Northeas
83-34-1	1(1)	Irrigation	*Evangeline Aquifer (Goliad Sand)	642	~0.5 Miles Northwes
83-34-2	2(1)	Domestic	*Evangeline Aquifer (Goliad Sand)	540	~1.0 Miles Northeast
83-34-4	4(1)	Domestic	*Evangeline Aquifer (Goliad Sand)	630	~0.7 Miles Northwest
83-34-5	5(1)	Domestic	*Evangeline Aquifer (Goliad Sand)	573	~0.3 Miles Southwest
83-34-5	5(2)	Domestic	*Evangeline Aquifer (Goliad Sand)	630	~0.4 Miles Northwest
83-34-5	5(3)	Domestic	*Evangeline Aquifer (Goliad Sand)	662	~0.3 Miles Southeast
83-34-5	5(4)	Domestic	*Evangeline Aquifer (Goliad Sand)	652	~0.5 Miles Southeast
83-34-5	5(5)	Domestic	*Evangeline Aquifer (Goliad Sand)	661	~0.7 Miles Southwest
83-34-5	5(6)	Domestic	*Evangeline Aquifer (Goliad Sand)	729	~0.3 Miles East
83-34-5	5(7)	Supply	*Evangeline Aquifer (Goliad Sand)	720	~0.9 Miles Southeast
83-34-5	5(8)	Industrial	*Evangeline Aquifer (Goliad Sand)	801	~0.5 Miles West
83-34-5	5(9)	Domestic	*Evangeline Aquifer (Goliad Sand)	645	~0.8 Miles Southwest
83-34-5	5(10)	Domestic	*Evangeline Aquifer (Goliad Sand)	656	~0.5 Miles Southeast
83-34-5	5(11)	Domestic	*Evangeline Aquifer (Goliad Sand)	663	~0.7 Miles Southwest
83-34-5	5(12)	Domestic	*Evangeline Aquifer (Goliad Sand)	612	~0.3 Miles Southeast
	- (/		Additional Wells Identified by Hanson Profe	· ·	
Tracking #	Owner Well #	Well Hee	Aguifer	Well Depth (Ft.)	Approximate Distance from Site
155775	No Data	Domestic	*Evangeline Aquifer (Goliad Sand)	600	~0.7 Miles Northeast
100867	NOLLKINPER #2		*Evangeline Aquifer (Goliad Sand)	640	~0.6 Miles Northeast
425307	NOLLKINPER #2		*Evangeline Aquifer (Goliad Sand)	650	~0.9 Miles Northeast
425295	1	Domestic		650	
423293	FLAMINGO #1		*Evangeline Aquifer (Goliad Sand) *Evangeline Aquifer (Goliad Sand)	600	~0.9 Miles Northeast
-		<u> </u>			~1.0 Miles Southeast
372796	No Data	Domestic	*Evangeline Aquifor (Goliad Sand)		~1.0 Miles Southwest
155888	No Data	Industrial	*Evangeline Aquifor (Goliad Sand)	580	~0.5 Miles Southwest
305970	No Data	Industrial	*Evangeline Aquifer (Goliad Sand)	608	~0.8 Miles Southwest
342528	No Data	Domestic	*Evangeline Aquifer (Goliad Sand)	645	~0.5 Miles Southwest
178262	No Data	Domestic	*Evangeline Aquifer (Goliad Sand)	595	~0.2 Miles Southwest
208460	No Data	Domestic	*Evangeline Aquifer (Goliad Sand)	596	~0.8 Milles Northwes
246291	No Data	Domestic	*Evangeline Aquifer (Goliad Sand)	560	~0.8 Milles Northwes
413217	No Data	Domestic	*Evangeline Aquifer (Goliad Sand)	622	~0.8 Milles Northwes
295148	No Data	Domestic	*Evangeline Aquifer (Goliad Sand)	600	~0.5 Milles Northeas
8334503	No Data		Aquifer Code Is Not Applicable to this Well	6131	~0.3 Milles East
166733	No Data	Industrial	*Evangeline Aquifer (Goliad Sand)	612	~1.0 Miles Southeas
494833	No Data	Stock	*Evangeline Aquifer (Goliad Sand)	560	~0.9 Miles Northwest
8334501	No Data	Domestic	Evangeline Aquifer (Goliad Sand)	631	~0.4 Milles South
				C40	0.4 0 8 4 1 6 1
190906	No Data	Domestic	*Evangeline Aquifer (Goliad Sand)	648	~1.0 Miles Southwes



THE CITY OF KINGSVILLE LANDFILL TCEQ PERMIT MSW 235C

PERMIT AMENDMENT APPLICATION Volume 4 of 6



CITY OF KINGSVILLE, KLEBERG COUNTY, TEXAS

September 2018

Revision 1 – November 2018

Revision 2 – February 2019

Revision 3 – April 2019

Prepared by





TBPE F-417

HANSON PROJECT NO. 16L0438-0003

CITY OF KINGSVILLE LANDFILL PART III ATTACHMENT 5

ALTERNATIVE LINER AND OVERLINER
POINT OF COMPLIANCE DEMONSTRATIONS

ATTACHMENT 5

ALTERNATIVE LINER AND OVERLINER DESIGN AND POINT OF COMPLIANCE DEMONSTRATIONS



Submittal Date: September 2018 Revision 3 - April 2019

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- 1.2 Proposed Alternate Liner
- 1.3 Proposed Overliner System
- 1.4 Site Geology and Hydrogeology
- 1.5 Liner Quality Control Plan (LQCP)

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- 2.4 Slope Stability Analysis
- 2.5 Alternate Composite Final Cover Design Demonstration

3. MODEL INPUT PARAMETERS

4. POINT OF COMPLIANCE DEMONSTRATION RESULTS

APPENDIX A

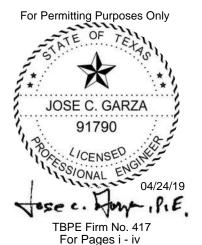
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- A.3 Permit Amendment Application MSW-235C Landfill Point of Compliance Locations
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- A.5. Permit Amendment Application MSW-235C Landfill Typical Profile-Interim Landfill with Alternative Liner
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Revision 3 - April 2019

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APPENDIX I

PRE-SUBTITLE D AREA (SECTOR 8A AND SECTOR 8B) FINAL COVER TEST DATA & PROPERTIES FIGURE

I.1 Pre-Subtitle D Area (Sector 8A and Sector 8B) Final Cover Test Data & Properties

Appendices C.7.1 through C.7.11. The upper clay (light olive green clay) is ubiquitous under the site with a minimum proven thickness of 38 feet thick, the Chicot Aquifer is approximately 220 feet below ground surface, and the Evangeline Aquifer is approximately 500 feet below ground surface. The light olive green clay layer serves as aquiclude between the uppermost acquifer below the landfill site and the Chicot acquifer. To provide a conservative assumption given the bottom of the landfill and the groundwater, the percolation through the alternate liner and overliner system was assumed to be conveyed directly to the upper strata and therefore travel time, dilution, and attenuation are not accounted for in this analysis for upper soils.

2.4 SLOPE STABILITY ANALYSIS

The alternative liner and overliner system were analyzed for slope stability by performing two dimensional, effective stress slope stability analyses for the final, closed geometry, using the computer program SLIDE. The slope stability calculations are presented in Part III Attachment 4, Appendix 2-Section 7 WASTE MASS STABILITY and Appendix F: Graphical Representation of Mass Stability Analyses Results.

2.5 ALTERNATE COMPOSITE FINAL COVER DESIGN DEMONSTRATION

The alternate composite final cover design demonstration will demonstrate that the use of a geosynthetic clay liner (GCL) will provide equivalent infiltration and protection from wind and water erosion as the conventional composite final cover defined in 30 TAC §330.457 (d)(1) & (d)(2). The design demonstration is shown in Appendix G.

4 POINT OF COMPLIANCE DEMONSTRATION RESULTS

The HELP and MULTIMED models were used to evaluate the proposed design of the alternative liner and overliner system by estimating constituent concentrations at the POC for the landfill cases discussed in Section 2.3. The percolation rates obtained from the HELP Model cases included in Appendix C.3 and Appendix C.4 were used as input for the MULTIMED model to determine the DAF. Conservatively, the constituent concentrations at the base of the landfill liner and at the POC were used to calculate the DAF.

A summary of the calculated DAF is presented below and in Appendix D.

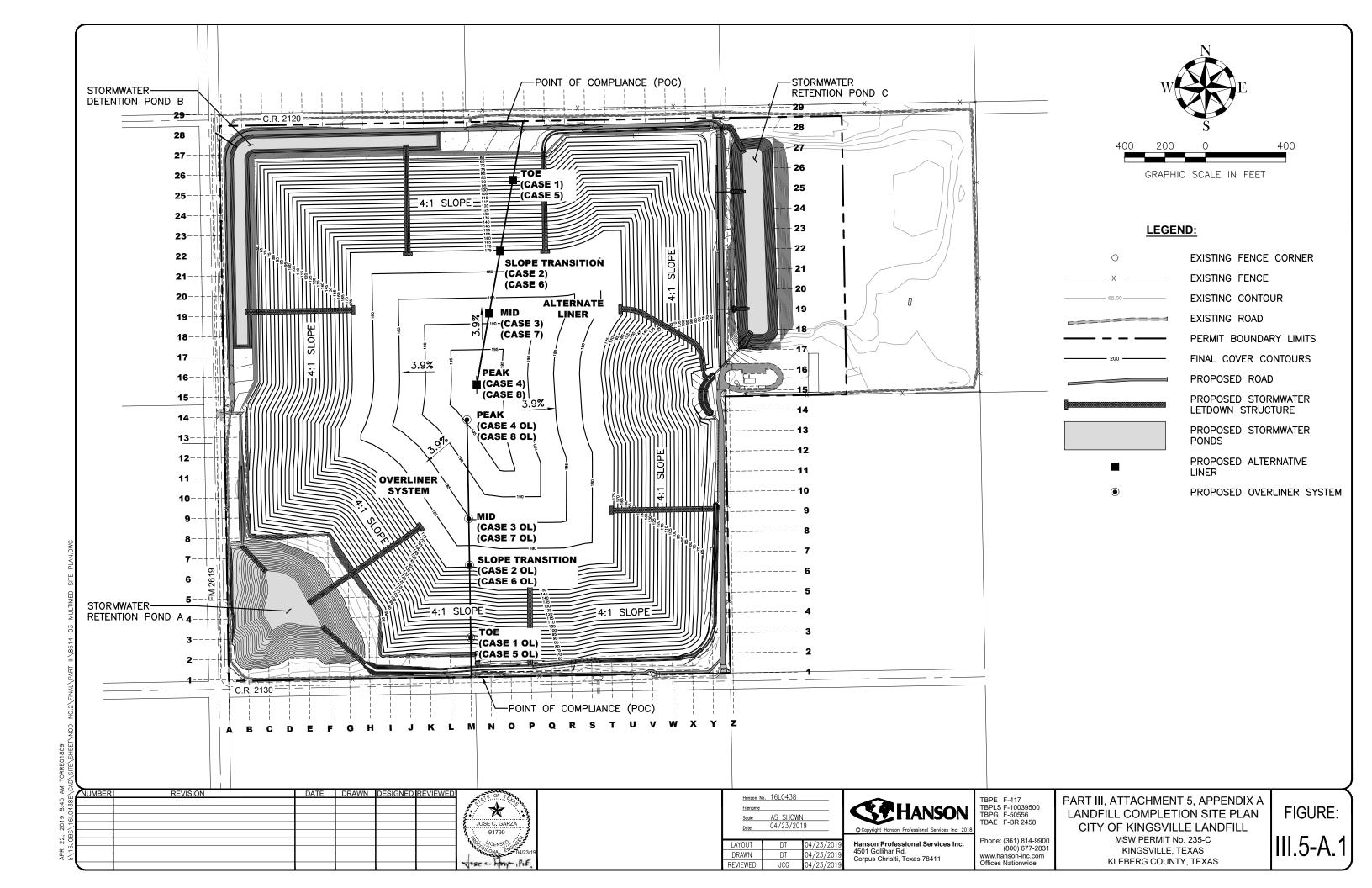
	Interim Case	
Location	DAF	Closed Case DAF
Alternative Liner Location 1	40,833	102,301
Alternative Liner Location 2	68,446	239,750
Alternative Liner Location 3	137,381	481,231
Alternative Liner Location 4	286,533	1,003,814

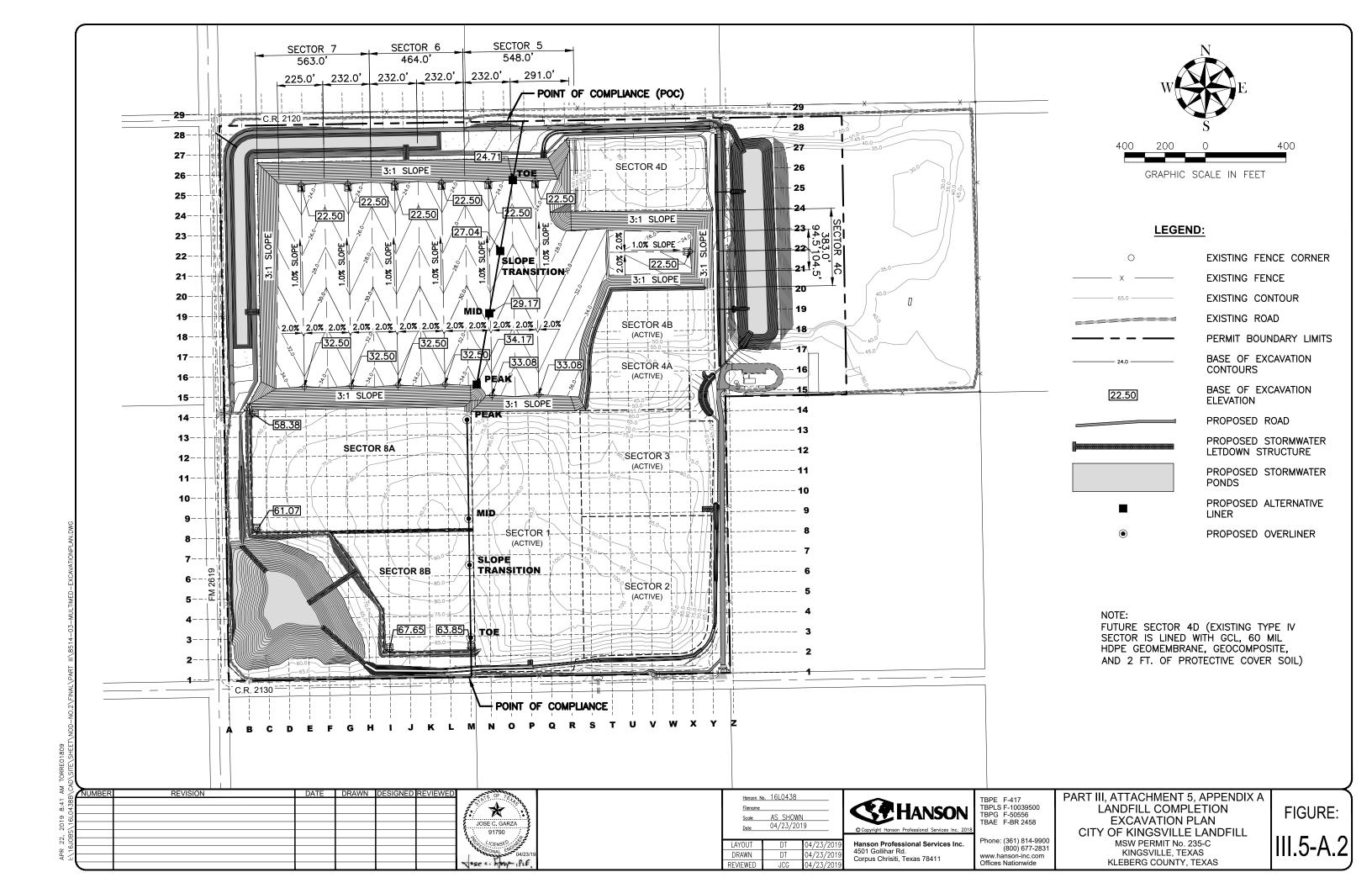
	Interim Case	
Location	DAF	Closed Case DAF
Overliner Location 1	18,797	65,833
Overliner Location 2	77,640	232,450
Overliner Location 3	158,253	473,934
Overliner Location 4	615,385	1,842,639

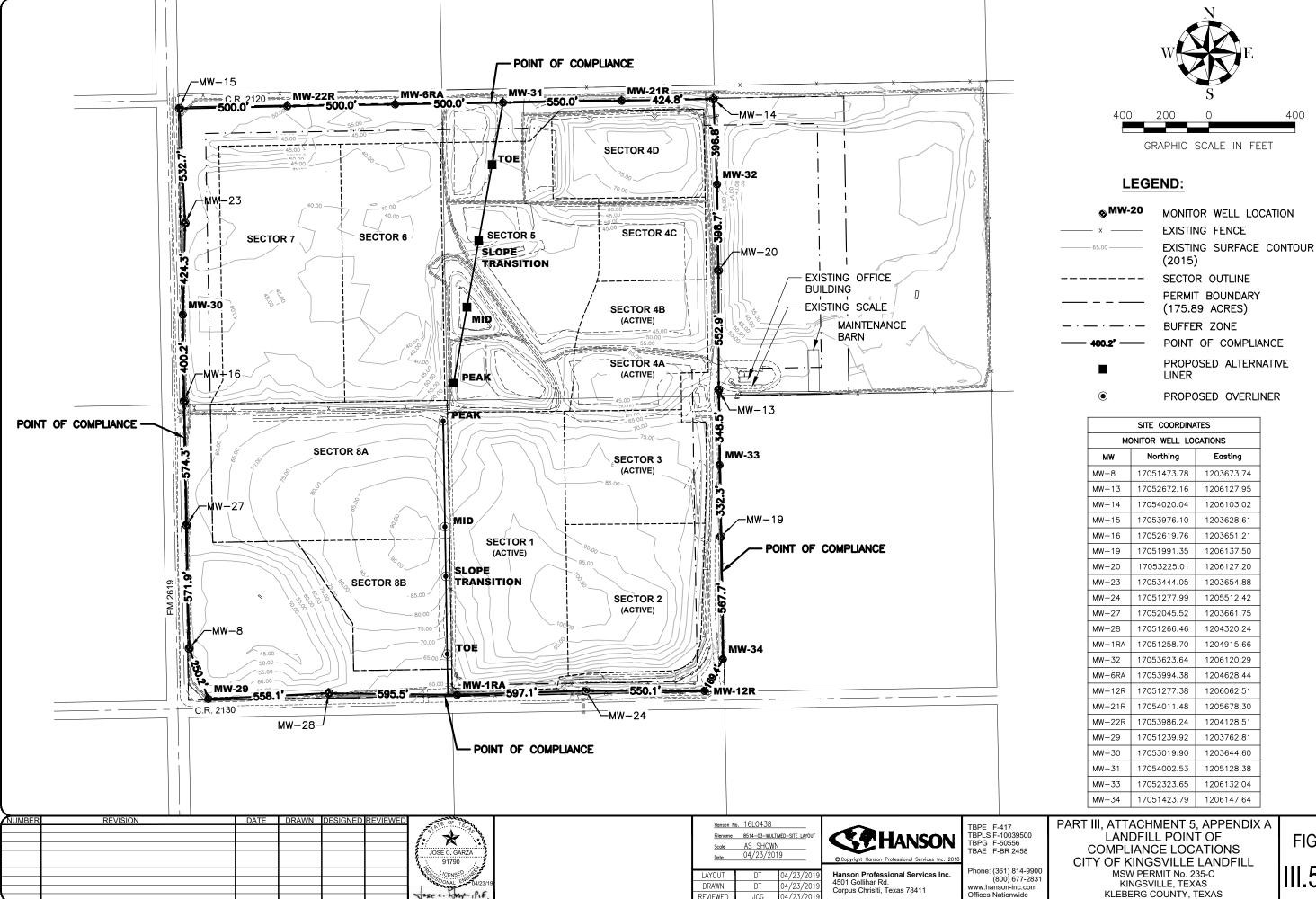
The results demonstrate that the proposed alternative liner design and overliner design meets or exceeds the requirements of Title 30 TAC §330.331(a)(1). The DAF calculated by the use of HELP and MULTIMED are well in excess of the 260 minimum criterion. The actual DAFs are expected to be substantially higher than the DAFs predicted by this modeling demonstration because the model input was conservatively estimated as discussed in previous sections of this report.

APPENDIX A POINT OF COMPLIANCE FIGURES





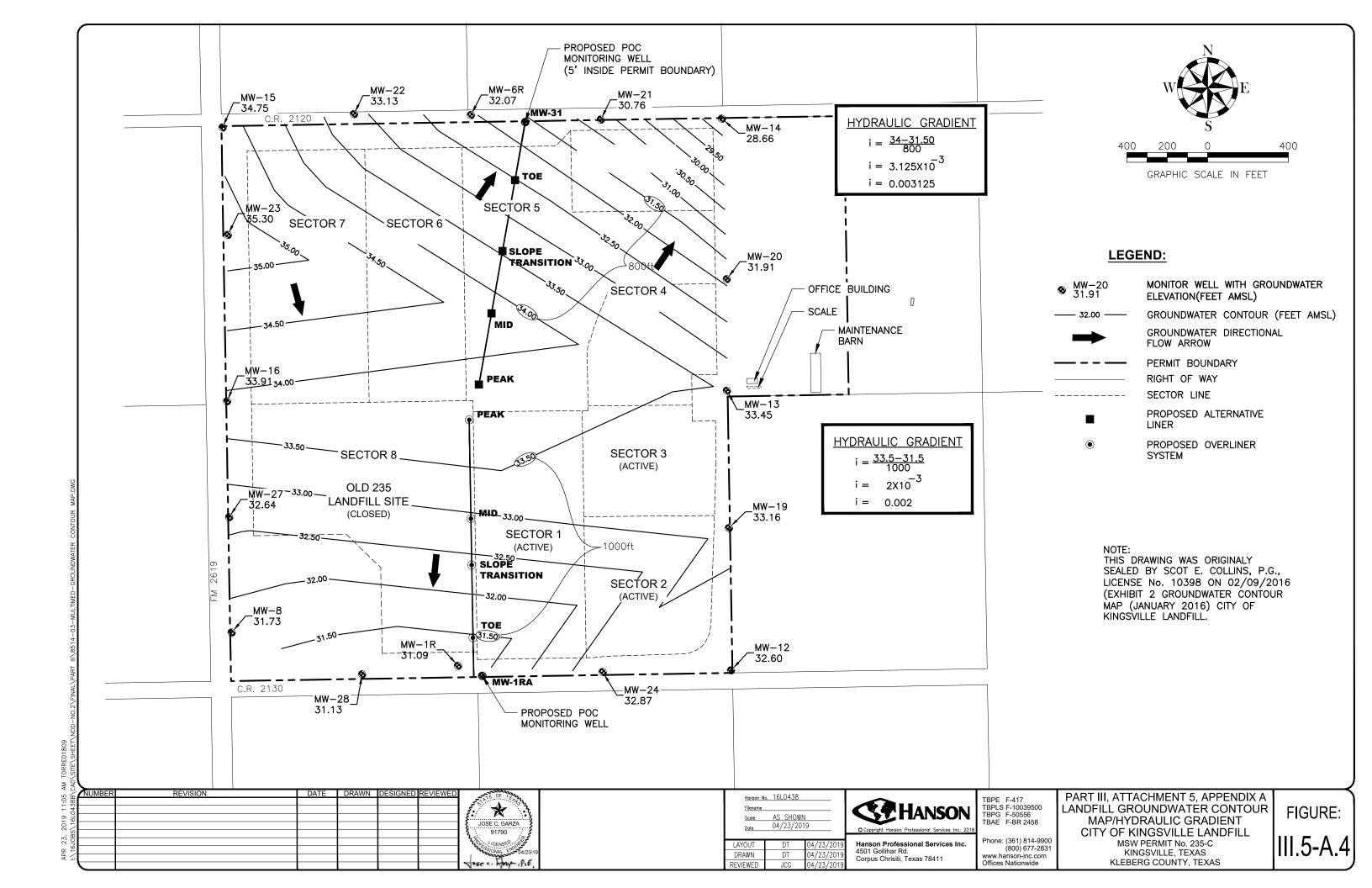


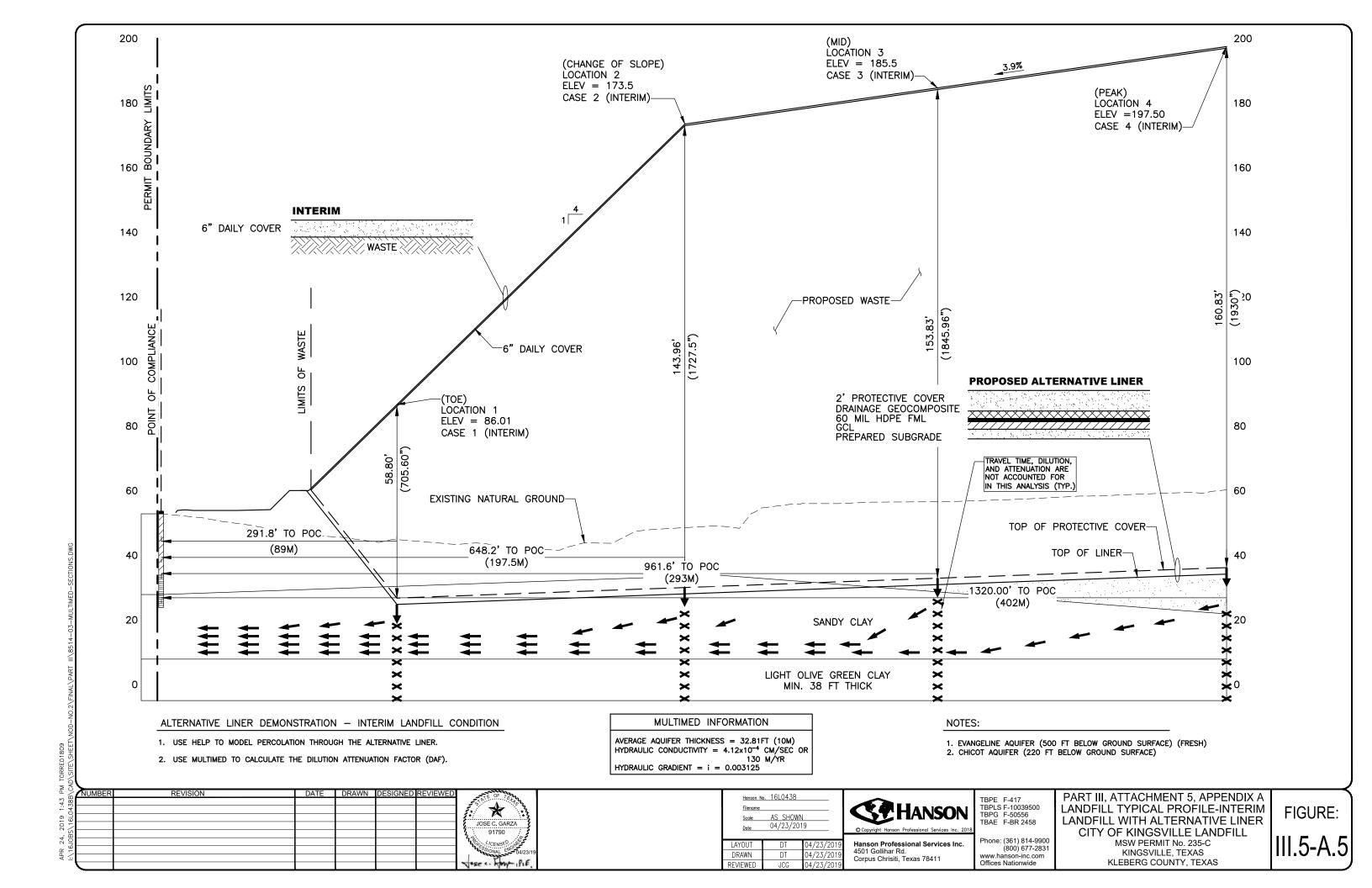


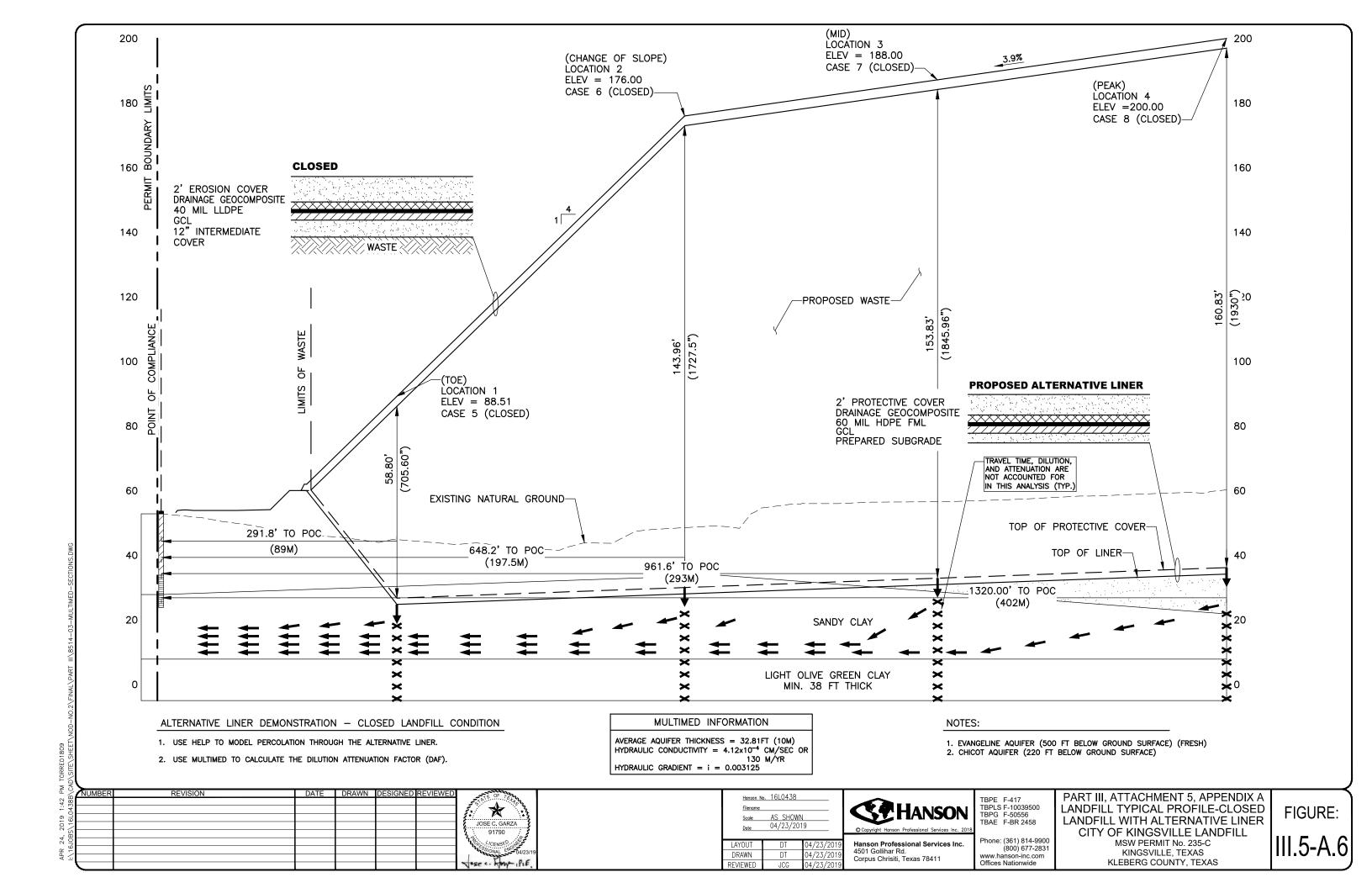
Corpus Chrisiti, Texas 78411

FIGURE:

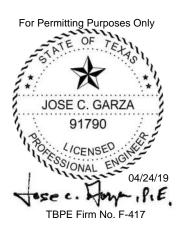
KLEBERG COUNTY, TEXAS







APPENDIX B HELP MODEL ANALYSIS ALTERNATIVE LINER



APPENDIX B.1 HELP MODEL/MULTIMED MODEL-SUMMARY OF CASES 1-8



Project No. 8514-3 Permit Amendment

Description: HELP Model/MULTIMED Model-Summary of Cases 1-8

Date: 3/01/17

By: JCG

<u>Case 1-Interim Landfill (Location 1)</u>- An open landfill with a Geosynthetic Clay Liner (GCL), a 60 mil HDPE Flexible Membrane Liner (FML), a Geocomposite drainage layer (Geonet), a 24 inch protective soil layer (Protective Cover),58.80 feet of waste with 250 foot drain length at 2%, and 6 inches of daily soil cover.

<u>Case 2-Interim Landfill (Location 2)</u>- An open landfill with a Geosynthetic Clay Liner (GCL), a 60 mil HDPE Flexible Membrane Liner (FML), a Geocomposite drainage layer (Geonet), a 24 inch protective soil layer (Protective Cover), 143.96 feet of waste with 500 foot drain length at 2%, and 6 inches of daily soil cover.

<u>Case 3-Interim Landfill (Location 3)</u>- An open landfill with a Geosynthetic Clay Liner (GCL), a 60 mil HDPE Flexible Membrane Liner (FML), a Geocomposite drainage layer (Geonet), a 24 inch protective soil layer (Protective Cover), 153.83 feet of waste with 500 foot drain length at 2%, and 6 inches of daily soil cover.

<u>Case 4-Interim Landfill (Location 4)</u>- An open landfill with a Geosynthetic Clay Liner (GCL), a 60 mil HDPE Flexible Membrane Liner (FML), a Geocomposite drainage layer (Geonet), a 24 inch protective soil layer (Protective Cover), 160.83 feet of waste with 500 foot drain length at 2%, and 6 inches of daily soil cover.

<u>Case 5-Closed Landfill (Location 1)</u> - A closed landfill with a Geosynthetic Clay Liner (GCL), a 60 mil HDPE Flexible Membrane Liner (FML), a Geocomposite drainage layer (Geonet), a 24 inch protective soil layer (Protective Cover), 58.80 feet of waste with 250 foot drain length at 2%, and 12 inches of intermediate cover, a GCL, a 40 mil LLDPE membrane, a Geocomposite drainage layer, and 24 inch erosion cover.

<u>Case 6-Closed Landfill (Location 2)</u>- A closed landfill with a Geosynthetic Clay Liner (GCL), a 60 mil HDPE Flexible Membrane Liner (FML), a Geocomposite drainage layer (Geonet), a 24 inch protective soil layer (Protective Cover), 143.96 feet of waste with 500 foot drain length at 2%, and 12 inches of intermediate cover, a GCL, a 40 mil LLDPE membrane, a Geocomposite drainage layer, and 24 inch erosion cover.

<u>Case7-Closed Landfill (Location 3)</u>- A closed landfill with a Geosynthetic Clay Liner (GCL), a 60 mil HDPE Flexible Membrane Liner (FML), a Geocomposite drainage layer (Geonet), a 12 inch protective soil layer (Protective Cover), 153.83 feet of waste with 500 foot drain length at 2%, and 12 inches of intermediate cover, a GCL, a 40 mil LLDPE membrane, a Geocomposite drainage layer, and 24 inch erosion cover.

<u>Case 8-Closed Landfill (Location 4)</u>- A closed landfill with a Geosynthetic Clay Liner (GCL), a 60 mil HDPE Flexible Membrane Liner (FML), a Geocomposite drainage layer (Geonet), a 24 inch protective soil layer (Protective Cover), 160.83 feet of waste with 500 foot drain length at 2%, and 12 inches of intermediate cover, a GCL, a 40 mil LLDPE membrane, a Geocomposite drainage layer, and 24 inch erosion cover.

APPENDIX B.2 HELP MODEL CASE SUMMARY



HELP MODEL CASE SUMMARY

Case Alternative Liner	Average Precipitation (IN/YR)	Average Runoff (IN/YR)	Average Evapotranspiration (IN/YR)	Average Percolation Through Liner (CF/YR)	Peak Percolation Through Liner (CF/DAY)	*Peak Percolation Through Liner (M/YR)
Interim Landfill HELP Information						
Location 1						
• 58.80 feet of waste (Case 1)						
20 yr	25.74	2.391	21.632	0.004	0.000050	1.28E-07
Location 2						
• 143.96 feet of waste (Case 2)						
20 yr	25.74	2.135	21.716	0.004	0.00007	1.79E-07
Location 3						
• 153.83 feet of waste (Case 3)						
20 yr	25.74	2.197	21.691	0.004	0.00007	1.79E-07
Location 4						
• 160.83 feet of waste (Case 4)						
20 yr	25.74	1.907	21.787	0.005	0.00007	1.79E-07
Closed Landfill HELP Information						
Location 1						
• 58.80 feet of waste (Case 5)						
30 yr	27.20	1.880	21.749	0.001	0.00002	5.11E-08
Location 2						
• 143.96 feet of waste (Case 6)						
30 yr	27.20	1.680	21.481	0.004	0.00002	5.11E-08
Location 3						
• 153.83 feet of waste (Case 7)						
30 yr	27.20	1.711	21.470	0.004	0.00002	5.11E-08
Location 4						
• 160.83 feet of waste (Case 8)						
30 yr	27.20	1.533	21.495	0.004	0.00002	5.11E-08

^{*} Determined Using Peak Daily Percolation/Leakage Rate Through GCL and Converted to (M/YR) Example: $((.00005 \text{ FT}^3/\text{Day-Acre})x(1 \text{ Acre}/43,560 \text{ FT}^2)/(1 \text{ Meter}/3.28 \text{ FT})) \times (365 \text{ Days}/1 \text{ YR}) = 1.28 \times 10^{-7} \text{ M/YR}$

APPENDIX B.3 HELP OUTPUT FOR ALTERNATIVE LINER INTERIM CASE 1LOCATION 1



	CASE1	R20.OUT
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**		**
** HYDROLOGTC	EVALUATION OF LANDFILL PERFORM	MANCE **
	EL VERSION 3.07 (1 NOVEMBER 19	
TELL HODE	•	•
DEVELOR	PED BY ENVIRONMENTAL LABORATOR	**
OSAC	WATERWAYS EXPERIMENT STATION	
	ISK REDUCTION ENGINEERING LABOR	
€ *		**
K-k		**

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PRECIPITATION DATA FILE:	C:\HELP3\MDATA\KGVPR20Y.D4	
TEMPERATURE DATA FILE:	C:\HELP3\MDATA\KGVTE20Y.D7	
SOLAR RADIATION DATA FILE:	C:\HELP3\MDATA\KGVSO20Y.D13	
VAPOTRANSPIRATION DATA:	C:\HELP3\MDATA\KGVEV20Y.D11	
	C:\HELP3\MDATA\CASE1R.D10	
OUTPUT DATA FILE:	C:\HELP3\MDATA\CASE1R20.OUT	Company of the Compan
STATE OF WARMEN LABOR.	a. Times a himsen franchistration	
		the contract of the contract o
FIME: 8:28 DATE: 4/	(22.12010	
FIME: 8:28 DATE: 4/	/22/2019	***************************************

ITILE: CITY OF KINDSV	/ILLE SOLID WASTE LANDFILL-CASI	1 (Location 1)
ITILE: CITY OF KINGSV	/ILLE SOLID WASTE LANDFILL-CASI	1 (Location 1)
111FE: C11A OL K1402A	/ILLE SOLID WASTE LANDFILL-CAS	1 (Location 1)
**************************************	/TLLE SOLID WASTE LANDFILL-CASI	1 (Location 1)
111FE: C114 OF KIMODA	/TLLE SOLID WASTE LANDFILL-CASI	: 1 (Location 1)
111FE: C114 OL KIWOD	/TLLE SOLID WASTE LANDFILL-CASI	E 1 (Location 1)
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NOTE: INITIAL MOISTUR COMPUTED AS N TYPE 1 MA THICKNESS POROSITY	RE CONTENT OF THE LAYERS AND SOME REARLY STEADY-STATE VALUES BY THE LAYER 1 LAYER 1 LOWERTICAL PERCOLATION LAYER ATERIAL TEXTURE NUMBER 13 E 6.00 INCH 0.4300 VOL	WOW WATER WERE THE PROGRAM. JES /VOL
NOTE: INITIAL MOISTUR COMPUTED AS N TYPE 1 MA THICKNESS POROSITY FIELD CAPACITY	LAYER 1 L- VERTICAL PERCOLATION LAYER ATERIAL TEXTURE NUMBER 13 = 6.00 INCH = 0.4300 VOL = 0.3210 VOL	VOW WATER WERE THE PROGRAM. JES TVOL
NOTE: INITIAL MOISTUR COMPUTED AS N TYPE 1 MA THICKNESS POROSITY	LAYER 1 LAYER 1 L- VERTICAL PERCOLATION LAYER ATERIAL TEXTURE NUMBER 13 = 6.00 INCH = 0.4300 VOL, = 0.2210 VOL,	WATER WERE THE PROGRAM. JES /VOL /VOL
NOTE: INITIAL MOISTUR COMPUTED AS N TYPE 1 MA THICKNESS POROSITY FIELD CAPACITY WILTING POINT INITIAL SOIL WAT	LAYER 1 L- VERTICAL PERCOLATION LAYER ATTENDED TO THE LAYERS AND SEARLY STEADY-STATE VALUES BY THE LAYER ATTENDED TO THE LAYER AND STATE ATTENDED TO THE LAYER AND SEARCH AND STATE ATTENDED TO THE LAYER AND SEARCH	WATER WERE THE PROGRAM. HES VOL VOL VOL VOL
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NOTE: INITIAL MOISTUR COMPUTED AS N TYPE 1 MA THICKNESS POROSITY FIELD CAPACITY WILTING POINT INITIAL SOIL WAT EFFECTIVE SAT. H	LAYER 1 L- VERTICAL PERCOLATION LAYER ATTENDED TO THE LAYERS AND SEARLY STEADY-STATE VALUES BY THE LAYER ATTENDED TO THE LAYER AND STATE ATTENDED TO THE LAYER AND SEARCH AND STATE ATTENDED TO THE LAYER AND SEARCH	WOW WATER WERE THE PROGRAM. JES TVOL TVOL TVOL TVOL TVOL TVOL TVOL TVOL
NOTE: INITIAL MOISTUR COMPUTED AS N TYPE 1 MA THICKNESS POROSITY FIELD CAPACITY WILTING POINT INITIAL SOIL WAT EFFECTIVE SAT. H NOTE: SATURATED H	LAYER 1 LAYER 1 L LAYER 1 L L	WATER WERE THE PROGRAM. SES TVOL TVOL TVOL TVOL TVOL TVOL TVOL TVOL
NOTE: INITIAL MOISTUR COMPUTED AS N TYPE 1 MA THICKNESS POROSITY FIELD CAPACITY WILTING POINT INITIAL SOIL WAT EFFECTIVE SAT. H NOTE: SATURATED H	LAYER 1 LAYER 10.4300 VOL, LAYER 0.3210 VOL, LAYER 0.2210 VOL, LAYER 0.2393 VOL, LAYER 0.330000003000000000000000000000000000	WOW WATER WERE THE PROGRAM. HES /VOL /VOL /VOL /VOL /VOL /VOL E-04 CM/SEC [PLIED BY 3.00
NOTE: INITIAL MOISTUR COMPUTED AS N TYPE 1 MA THICKNESS POROSITY FIELD CAPACITY WILTING POINT INITIAL SOIL WAT EFFECTIVE SAT. H NOTE: SATURATED H	LAYER 1 LAYER 10.4300 VOL, LAYER 0.3210 VOL, LAYER 0.2210 VOL, LAYER 0.2393 VOL, LAYER 0.330000003000000000000000000000000000	WOW WATER WERE THE PROGRAM. FES TVOL TVOL TVOL TVOL FE-04 CM/SEC TPLIED BY 3.00 RATIVE ZONE.
NOTE: INITIAL MOISTUR COMPUTED AS N TYPE 1 MA THICKNESS POROSITY FIELD CAPACITY WILTING POINT INITIAL SOIL WAT EFFECTIVE SAT. H NOTE: SATURATED H	LAYER 1 LAYER 10.4300 VOL, LAYER 0.3210 VOL, LAYER 0.2210 VOL, LAYER 0.2393 VOL, LAYER 0.330000003000000000000000000000000000	WATER WERE THE PROGRAM. SES TVOL TVOL TVOL TVOL TVOL TVOL TVOL TVOL
NOTE: INITIAL MOISTUR COMPUTED AS N TYPE 1 MA THICKNESS POROSITY FIELD CAPACITY WILTING POINT INITIAL SOIL WAT EFFECTIVE SAT. H NOTE: SATURATED H	LAYER 1 LAYER 10.4300 VOL, LAYER 0.3210 VOL, LAYER 0.2210 VOL, LAYER 0.2393 VOL, LAYER 0.330000003000000000000000000000000000	WOW WATER WERE THE PROGRAM. JES VOOL VOL VOL VOL VOL E-04 CM/SEC CPLIED BY 3.00 RATIVE ZONE.
NOTE: INITIAL MOISTUR COMPUTED AS N TYPE 1 MA THICKNESS POROSITY FIELD CAPACITY WILTING POINT INITIAL SOIL WAT EFFECTIVE SAT. H NOTE: SATURATED H	LAYER 1 LAYER 10.4300 VOL, LAYER 0.3210 VOL, LAYER 0.2210 VOL, LAYER 0.2393 VOL, LAYER 0.330000003000000000000000000000000000	WOW WATER WERE THE PROGRAM. FES TVOL TVOL TVOL TVOL FE-04 CM/SEC TPLIED BY 3.00 RATIVE ZONE.
NOTE: INITIAL MOISTUR COMPUTED AS N TYPE 1 MA THICKNESS POROSITY FIELD CAPACITY WILTING POINT INITIAL SOIL WAT EFFECTIVE SAT. H NOTE: SATURATED H	LAYER 1 LAYER 1 LAYER 1 LAYER 1 LOUIS DE CONTENT OF THE LAYERS AND SY THE LAYER AND SY THE LAYERS AND SY THE LAYER AT LAYER AT LAYER AT LAYER NUMBER 13 LOUIS DE COUNTE DE COUNTY DE COUNTY DE CONTENT DE CONDUCTIVITY IS MULTICHANNELS IN TOP HALF OF EVAPOR	WOW WATER WERE THE PROGRAM. JES VOOL VOL VOL VOL VOL E-04 CM/SEC CPLIED BY 3.00 RATIVE ZONE.
NOTE: INITIAL MOISTUR COMPUTED AS N TYPE 1 MA THICKNESS POROSITY FIELD CAPACITY WILTING POINT INITIAL SOIL WAT EFFECTIVE SAT. H NOTE: SATURATED H	LAYER 1 LAYER 1 LAYER 1 L- VERTICAL PERCOLATION LAYER ATERIAL TEXTURE NUMBER 13 = 6.00 INCH = 0.4300 VOL, = 0.2210 VOL, = 0.2210 VOL, FER CONTENT = 0.3360000030000000000000000000000000000	WOW WATER WERE THE PROGRAM. JES VOOL VOL VOL VOL VOL E-04 CM/SEC CPLIED BY 3.00 RATIVE ZONE.
NOTE: INITIAL MOISTUR COMPUTED AS N TYPE 1 MA THICKNESS POROSITY FIELD CAPACITY WILTING POINT INITIAL SOIL WAT EFFECTIVE SAT. H NOTE: SATURATED H FOR ROOT	RE CONTENT OF THE LAYERS AND SAMEARLY STEADY-STATE VALUES BY THE LAYER AND SAMEARLY STEADY-STATE VALUES BY THE LAYER ATERIAL TEXTURE NUMBER 13 = 6.00 INCLUDE = 0.4300 VOL. = 0.3210 VOL. = 0.2210 VOL. = 0.2393 VOL. IFER CONTENT = 0.330000003000000000000000000000000000	WOW WATER WERE THE PROGRAM. JES //VOL //VOL //VOL //VOL JE-04 CM/SEC CPLIED BY 3.00 RATIVE ZONE.
NOTE: INITIAL MOISTUR COMPUTED AS N TYPE 1 MA THICKNESS POROSITY FIELD CAPACITY WILTING POINT INITIAL SOIL WAT EFFECTIVE SAT. H NOTE: SATURATED H FOR ROOT	RE CONTENT OF THE LAYERS AND SAME ARLY STEADY-STATE VALUES BY TO SHEARLY STEADY-STATE VALUES BY TO SHEARLY STEADY-STATE VALUES BY TO SHEARLY STEADY-STATE NUMBER 13 LAYER 1 CHANNELS IN TOP HALF OF EVAPORATION LAYER 2 LAYER 2 LAYER 2 LAYER 2	WOW WATER WERE THE PROGRAM. JES //VOL //VOL //VOL //VOL JE-04 CM/SEC CPLIED BY 3.00 RATIVE ZONE.
NOTE: INITIAL MOISTUR COMPUTED AS N TYPE 1 MA THICKNESS POROSITY FIELD CAPACITY WILTING POINT INITIAL SOIL WAT EFFECTIVE SAT. H NOTE: SATURATED H FOR ROOT	RE CONTENT OF THE LAYERS AND SAMEARLY STEADY-STATE VALUES BY THE LAYER AND SAMEARLY STEADY-STATE VALUES BY THE LAYER ATTERIAL TEXTURE NUMBER 13 = 6.00 INC. = 0.4300 VOL. = 0.3210 VOL. = 0.2210 VOL. = 0.2210 VOL. = 0.2210 VOL. = 0.2393 VOL. = 0.2400 VOL.	WOW WATER WERE THE PROGRAM. SES VOOL VOL VOL VOL E-04 CM/SEC CPLIED BY 3.00 RATIVE ZONE.
NOTE: INITIAL MOISTUR COMPUTED AS N TYPE 1 MA THICKNESS POROSITY FIELD CAPACITY WILTING POINT INITIAL SOIL WAT EFFECTIVE SAT. H NOTE: SATURATED H FOR ROOT	RE CONTENT OF THE LAYERS AND SAME ARLY STEADY-STATE VALUES BY TO LAYER ATERIAL TEXTURE NUMBER 13	WOW WATER WERE THE PROGRAM. SES VOOL VOL VOL VOL E-04 CM/SEC CPLIED BY 3.00 RATIVE ZONE.

CASE1R20.OUT

POROSITY = 0.6710 VOL/VOL

FIELD CAPACITY = 0.2920 VOL/VOL

WILTING POINT = 0.0770 VOL/VOL

INITIAL SOIL WATER CONTENT = 0.2905 VOL/VOL

EFFECTIVE SAT. HYD. COND = 0.100000005000E-02 CM/SEC

LAYER 3

TYPE 1 - VERTICAL PERCOLATION LAYER

MATERIAL TEXTURE NUMBER 13
THICKNESS = 24,00 INCHES

POROSITY = 0.4300 VOL/VOL
FIELD CAPACITY = 0.3210 VOL/VOL
WILTING POINT = 0.2210 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.3244 VOL/VOL

EFFECTIVE SAT. HYD. COND. = 0.330000003000E-04 CM/SEC

LAYER 4

TYPE 2 - LATERAL DRAINAGE LAYER MATERIAL TEXTURE NUMBER 20

THICKNESS = 0.20 INCHES
POROSITY = 0.8500 VOL/VOL
FIELD CAPACITY = 0.0100 VOL/VOL
WILTING POINT = 0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0152 VOL/VOL

DRAINAGE LENGTH

INITIAL SOIL WATER CONTENT = 0.0152 VOL/VOL EFFECTIVE SAT. HYD. COND. = 10.0000000000 CM/SEC SLOPE = 2.00 PERCENT

250.0

FEET

LAYER 5

TYPE 4 - FLEXIBLE MEMBRANE LINER MATERIAL TEXTURE NUMBER 35

THICKNESS = 0.06 INCHES
POROSITY = 0.0000 VOL/VOL
FIELD CAPACITY = 0.0000 VOL/VOL
WILTING POINT = 0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.199999996000E-12 CM/SEC

EFFECTIVE SAT. HYD. COND. = 0.199999996000E-12 CM/SEC FML PINHOLE DENSITY = 1.00 HOLES/ACRE FML INSTALLATION DEFECTS = 2.00 HOLES/ACRE

FML PLACEMENT QUALITY = 3 - GOOD

LAYER 6

TYPE 3 - BARRIER SOIL LINER MATERIAL TEXTURE NUMBER 17

 THICKNESS
 =
 0.24
 INCHES

 POROSITY
 =
 0.7500
 VOL/VOL

 FIELD CAPACITY
 =
 0.7470
 VOL/VOL

WILTING POINT = 0.4000 VOL/VOL INITIAL SOIL WATER CONTENT = 0.7500 VOL/VOL

EFFECTIVE SAT. HYD. COND. = 0.300000003000E-08 CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE #13 WITH A FAIR STAND OF GRASS, A SURFACE SLOPE OF 25.% AND A SLOPE LENGTH OF 100. FEET.

SCS RUNOFF CURVE NUMBER 89,50 FRACTION OF AREA ALLOWING RUNOFF 80.0 PERCENT AREA PROJECTED ON HORIZONTAL PLANE = 1,000 ACRES EVAPORATIVE ZONE DEPTH 12,0 INCHES INITIAL WATER IN EVAPORATIVE ZONE 2,124 INCHES UPPER LIMIT OF EVAPORATIVE STORAGE = 6,606 INCHES 1.788 INCHES LOWER LIMIT OF EVAPORATIVE STORAGE INITIAL SNOW WATER 0.000 INCHES INITIAL WATER IN LAYER MATERIALS 214.375 INCHES 214.375 INCHES TOTAL INITIAL WATER 0.00 TOTAL SUBSURFACE INFLOW INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM CORPUS CHRISTI TEXAS

STATION LATITUDE 27.77 DEGREES MAXIMUM LEAF AREA INDEX 2.00 START OF GROWING SEASON (JULIAN DATE) 0 END OF GROWING SEASON (JULIAN DATE) 367 EVAPORATIVE ZONE DEPTH = 12,0 INCHES AVERAGE ANNUAL WIND SPEED = 12.00 MPH AVERAGE 1ST QUARTER RELATIVE HUMIDITY = 76.00 % AVERAGE 2ND QUARTER RELATIVE HUMIDITY = 78.00 % AVERAGE 3RD QUARTER RELATIVE NUMIDITY = 76.00 % AVERAGE 4TH QUARTER RELATIVE HUMIDITY = 76.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	VON/YAM	JUN/DEC
1,63	1.69	1.20	1.57	3,29	3.12
2.26	2,78	5.31	2,92	1.61	1.17

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

				CASE1R20.0U	Τ.
JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	OM/DEC

56.30	59.30	65.90	73.00	78,10	82.70
84.90	85,00	81.50	74.00	65,80	59.10

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS AND STATION LATITUDE = 27.77 DEGREES

AVERAGE MONTH	LY VALUES II	N INCHES	FOR YEARS	1 THR	OUGH 20		
	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	DUN/DEC	
PRECIPITATION							
TOTALS	1.15 2.43	2.02 2.37	1.05 5.38	1.42 2.30	2.41 1.33	2.71	
STD. DEVIATIONS	0.63 2.55	1,18	0,55 3.12	1.20 1.75	1.88 1.17	2.04 0.85	
RUNOFF							
TOTALS	0.015 0.380	0.067 0.193	0,006 0.784	0,104 0.181	0.281 0.073	0.288 0.020	
STD. DEVIATIONS	0.043 0.817	0.081 0.198	0.009 0.914	0.237 0.274	0.504 0.212	0.348 0.070	
EVAPOTRANSPIRATION							
TOTALS	0.939 2.037	2.086 1.875	1.297 3.620	1,241 2,256	1.988 1.089	2.114 1.091	
STD. DEVIATIONS	0.543 1.606	0,911 1.312	0.701 1.225	0.915 1.220	1.322 Ø.757	1.388 0.583	
LATERAL DRAINAGE COL	LECTED FROM	LAYER 4					·
TOTALS	0.0661 0.1445						
STD. DEVIATIONS	0.0861 0.2592						
PERCOLATION/LEAKAGE	THROUGH LAY	ER 6					
TOTALS	0.0000 0.0000						
STD. DEVIATIONS	0,9999 0,9999						
	S OF MONTHE						

DAILY AVERAGE HEAD ON TOP OF LAYER 5							
AVERAGES	0.0005	0.0002	0.0005	0.0004	0.0003	0.0004	
	0.0010	0.0013	0.0007	0.0029	0.0030	0.0014	
STD. DEVIATIONS	0.0006	0,0002	0.0010	0.0008	0.0004	0.0008	
	0.0018	0.0025	0.0015	0.0042	0.0055	0.0023	

AVERAGE ANNUAL TOTALS & ((STD. DEVIATIO	ONS) FOR YEA	ARS 1 THROUG	iH 20
	INCHES	,	CU. FEET	PERCENT
PRECIPITATION			93448.9	100.00
RUNOFF	2.391 (1.2854)	8679.79	9.288
EVAPOTRANSPIRATION	21,632 (3.6809)	78522.88	84.028
LATERAL DRAINAGE COLLECTED FROM LAYER 4	1.73689 (1,43661)	6304,908	6.74699
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.00000 (0.00000)	0.004	0.00000
AVERAGE HEAD ON TOP OF LAYER 5	0.001 (0.001)		
CHANGE IN WATER STORAGE	-0.016 (0.5277)	-58.67	-0.063

PEAK DAILY VALUES FOR YEARS	1 THROUGH	28
	(INCHES)	(CU. FT.)
PRECIPITATION	5.07	18404.102
RUNOFF	2.138	7761.3745
DRAINAGE COLLECTED FROM LAYER 4	0.16413	595,80011
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.000000	0,00005
AVERAGE HEAD ON TOP OF LAYER 5	0.036	
MAXIMUM HEAD ON TOP OF LAYER 5	0.072	
LOCATION OF MAXIMUM HEAD IN LAYER 4 (DISTANCE FROM DRAIN)	2.7 FEET	
SNOW WATER	0.00	9.0000
MAXIMUM VEG. SOIL WATER (VOL/VOL)	0. Page	387 <u>9</u> 5

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CHULL	NAU.	, ,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,

MINIMUM VEG. SOIL WATER (VOL/VOL)

0.1490

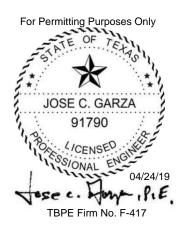
*** Maximum heads are computed using McEnroe's equations.

Reference: Maximum Saturated Depth over Landfill Liner by Bruce M. McEnroe, University of Kansas ASCE Journal of Environmental Engineering Vol. 119, No. 2, March 1993, pp. 262-270.

FINAL	WATER	STORAGE	ΑT	END	OF	YEAR	20

ŁA			DL/VOL)
		4211	ð.236 9
2	2 204.	7451	0,2902
:	7.	7040	0.3210
4	4 Ø.:	0020	0.0100
!	9.	0000	0.0000
ŧ	5 0.	1800	0.7500
SNOW	WATER 0.	000	

APPENDIX B.4 HELP OUTPUT FOR ALTERNATIVE LINER INTERIM CASE 2-LOCATION 2



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**		**
**		**
**	HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE	**
**	HELP MODEL VERSION 3.07 (1 NOVEMBER 1997)	**
**	DEVELOPED BY ENVIRONMENTAL LABORATORY	**
**	USAE WATERWAYS EXPERIMENT STATION	**
**	FOR USEPA RISK REDUCTION ENGINEERING LABORATORY	**
**		**
**		**
*****	******************	*****
******	*********************	******

TEMPERATURE DATA FILE: EVAPOTRANSPIRATION DATA: SOIL AND DESIGN DATA FILE: C:\HELP3\MDATA\CASE2R.D10

PRECIPITATION DATA FILE: C:\HELP3\MDATA\KGVPR20Y.D4 C:\HELP3\MDATA\KGVTE20Y.D7 SOLAR RADIATION DATA FILE: C:\HELP3\MDATA\KGVSO20Y.D13 C:\HELP3\MDATA\KGVEV20Y.D11

OUTPUT DATA FILE:

C:\HELP3\MDATA\CASE2R20.OUT

TIME: 15:24

DATE: 4/14/2019

********************** TITLE: CITY OF KINGSVILLE SOLID WASTE LANDFILL-CASE 2 (LOCATION 2)

NOTE: INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE

LAYER 1

COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

TYPE 1 - VERTICAL PERCOLATION LAYER

MATERIAL TEXTURE NUMBER 13

THICKNESS 6.00 0.4300 VOL/VOL POROSITY 0.3210 VOL/VOL FIELD CAPACITY 0.2210 VOL/VOL WILTING POINT INITIAL SOIL WATER CONTENT = 0.2391 VOL/VOL EFFECTIVE SAT. HYD. COND. = 0.330000003000E-04 CM/SEC

NOTE: SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY 3.00 FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.

LAYER 2

TYPE 1 - VERTICAL PERCOLATION LAYER MATERIAL TEXTURE NUMBER 18

THICKNESS

1727.50 INCHES

POROSITY = 0.6710 VOL/VOL FIELD CAPACITY = 0.2920 VOL/VOL WILTING POINT = 0.0770 VOL/VOL INITIAL SOIL WATER CONTENT = 0.2914 VOL/VOL

EFFECTIVE SAT. HYD. COND. = 0.100000005000E-02 CM/SEC

LAYER 3

TYPE 1 - VERTICAL PERCOLATION LAYER

MATERIAL TEXTURE NUMBER 13

THICKNESS = 24.00 INCHES

POROSITY = 0.4300 VOL/VOL

FIELD CAPACITY = 0.3210 VOL/VOL

WILTING POINT = 0.2210 VOL/VOL

INITIAL SOIL WATER CONTENT = 0.3245 VOL/VOL

EFFECTIVE SAT. HYD. COND. = 0.330000003000E-04 CM/SEC

LAYER 4

TYPE 2 - LATERAL DRAINAGE LAYER MATERIAL TEXTURE NUMBER 20

THICKNESS = 0.20 INCHES
POROSITY = 0.8500 VOL/VOL
FIELD CAPACITY = 0.0100 VOL/VOL
WILTING POINT = 0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0205 VOL/VOL

EFFECTIVE SAT. HYD. COND. = 10.0000000000 CM/SEC SLOPE = 2.00 PERCENT

SLOPE = 2.00 PERCENT DRAINAGE LENGTH = 500.0 FEET

LAYER 5

TYPE 4 - FLEXIBLE MEMBRANE LINER

MATERIAL TEXTURE NUMBER 35

THICKNESS = 0.06 INCHES
POROSITY = 0.0000 VOL/VOL
FIELD CAPACITY = 0.0000 VOL/VOL
WILTING POINT = 0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0000 VOL/VOL

EFFECTIVE SAT. HYD. COND. = 0.199999996000E-12 CM/SEC FML PINHOLE DENSITY = 1.00 HOLES/ACRE FML INSTALLATION DEFECTS = 2.00 HOLES/ACRE

FML PLACEMENT QUALITY = 3 - GOOD

LAYER 6

TYPE 3 - BARRIER SOIL LINER MATERIAL TEXTURE NUMBER 17

THICKNESS = 0.24 INCHES
POROSITY = 0.7500 VOL/VOL
FIELD CAPACITY = 0.7470 VOL/VOL
Page 2

WILTING POINT = 0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.7500 VOL/VOL

EFFECTIVE SAT. HYD. COND. = 0.300000003000E-08 CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE #13 WITH A FAIR STAND OF GRASS, A SURFACE SLOPE OF 25.% AND A SLOPE LENGTH OF 350. FEET.

SCS RUNOFF CURVE NUMBER	=	88.80	
FRACTION OF AREA ALLOWING RUNOFF	=	80.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	12.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	2.124	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	==	6.606	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	1.788	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	512.775	INCHES
TOTAL INITIAL WATER	=	512.775	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM CORPUS CHRISTI TEXAS

= 27.77 DEGREES STATION LATITUDE MAXIMUM LEAF AREA INDEX 2.00 START OF GROWING SEASON (JULIAN DATE) = 0 END OF GROWING SEASON (JULIAN DATE) 367 EVAPORATIVE ZONE DEPTH = 12.0 INCHES AVERAGE ANNUAL WIND SPEED = 12.00 MPH AVERAGE 1ST QUARTER RELATIVE HUMIDITY = 76.00 % AVERAGE 2ND QUARTER RELATIVE HUMIDITY = 78.00 % AVERAGE 3RD QUARTER RELATIVE HUMIDITY = 76.00 % AVERAGE 4TH QUARTER RELATIVE HUMIDITY = 76.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JUC/NAC	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
1.63	1.69	1.20	1.57	3.29	3.12
2.26	2.78	5.31	2.92	1.61	1.17

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL				Т	
	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
56.30	59.30	65.90	73.00	78.10	82.70
84.90	85.00	81.50	74.00	65.00	59.10

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS AND STATION LATITUDE = 27.77 DEGREES

AVERAGE MONTH	LY VALUES IN					
	JAN/JUL	FEB/AUG	MAR/SEP		1773 V. 1875 O. 1877 D. 1884 D. 1877 D. 1884 D. 1877 D. 1884 D. 1874 D. 1874 D. 1874 D. 1874 D. 1874 D. 1874 D	JUN/DEC
PRECIPITATION						
	4 45	2 02	1.05	1.42	2.41	2.71
TOTALS	1.15 2.43	2.02	5.38	2.30	1.33	1.18
CTD DEVITATIONS	0.63	1 10	0.55	1 20	1.88	2.04
STD. DEVIATIONS	2.55	1.63		1.75	1.17	0.85
RUNOFF						
TOTALS	0.012	0.055	0.003	0.092	0.254	0.252
TOTALS	0.350	0.170	0.716		0.066	0.016
STD. DEVIATIONS	0.037	0.071	0.006	0.216	0.479	0.315
SID. DEVIATIONS	0.770	0.181	0.864	0.234	0.199	0.057
EVAPOTRANSPIRATION						
TOTALS	0.932	2.093	1.304	1.251	1.993	2.128
	2.048	1.899	3.628	2.264	1.098	1.076
STD. DEVIATIONS	0.540	0.899	0.714	0.930	1.317	1.382
	1.634	1.319	1.222	1.208	0.786	0.592
LATERAL DRAINAGE COL						
TOTALS		0.0326		0.0598	0.0433	
	0.1629	0.1994	0.1144	0.4246	0.4282	0.229
STD. DEVIATIONS	0.0919	0.052	0.1373	0.1034		
	0.3039	0.4252	0.2386	0.5907	0.7366	0.418
PERCOLATION/LEAKAGE		ER 6				
TOTALS	0.0000	0.000				
	0.0000	0.000	0.0000	0.0000	0.0000	0.000
STD. DEVIATIONS	0.0000	0.000	0.0000	0.0000		
	0.0000	0.000	0.0000	0.0000	0.0000	0.000

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Revision: 3 - April 2019

AVERAGES	0.0010	0.0005	0.0010	0.0009	0.0006	0.0010
AT ELITISES	0.0023	0.0028	0.0017	0.0060	0.0063	0.0033
STD. DEVIATIONS	0.0013	0.0008	0.0020	0.0015	0.0010	0.0021
	0.0043	0.0061	0.0035	0.0084	0.0108	0.0060
********	*****	******	*****	*****	*****	******
********	*****	*******	******	******	******	******

	INC	HES		CU. FEET	PERCENT
PRECIPITATION	25.74	(5.706)	93448.9	100.00
RUNOFF	2.135	(1.1936)	7751.57	8.295
EVAPOTRANSPIRATION	21.716	(3.6903)	78829.24	84.355
LATERAL DRAINAGE COLLECTED FROM LAYER 4	1.90751	(1.54779)	6924.272	7.40969
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.00000	(0.00000)	0.004	0.0000
AVERAGE HEAD ON TOP OF LAYER 5	0.002 (0.002)		
CHANGE IN WATER STORAGE	-0.015	(0.5511)	-56.18	-0.060

^ ***********************************

PEAK DAILY VALUES FOR YEARS	1 THROUGH	20
	(INCHES)	(CU. FT.)
PRECIPITATION	5.07	18404.102
RUNOFF	2.088	7578.4883
DRAINAGE COLLECTED FROM LAYER 4	0.15857	575.60864
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.000000	0.00007
AVERAGE HEAD ON TOP OF LAYER 5	0.070	
MAXIMUM HEAD ON TOP OF LAYER 5	0.139	
LOCATION OF MAXIMUM HEAD IN LAYER 4 (DISTANCE FROM DRAIN)	2.3 FEET	
SNOW WATER	0.00	0.0000
MAXIMUM VEG. SOIL WATER (VOL/VOL)	0. Page	3901

MINIMUM VEG. SOIL WATER (VOL/VOL)

0.1490

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner by Bruce M. McEnroe, University of Kansas ASCE Journal of Environmental Engineering Vol. 119, No. 2, March 1993, pp. 262-270.

FINAL	WATER	STORAGE	AT	END	OF	YEAR	20	

LAYER	(INCHES)	(VOL/VOL)
1	1.4393	0.2399
2	503.1399	0.2913
3	7.7040	0.3210
4	0.0020	0.0100
5	0.0000	0.0000
6	0.1800	0.7500
SNOW WATER	0.000	

APPENDIX B.5 HELP OUTPUT FOR ALTERNATIVE LINER INTERIM CASE 3LOCATION 3



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**		**
**		**
**	HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE	**
**	HELP MODEL VERSION 3.07 (1 NOVEMBER 1997)	**
**	DEVELOPED BY ENVIRONMENTAL LABORATORY	**
**	USAE WATERWAYS EXPERIMENT STATION	**
**	FOR USEPA RISK REDUCTION ENGINEERING LABORATORY	**
**		**
**		**
*****	**************	*******
****	***************************************	*****

PRECIPITATION DATA FILE: C:\HELP3\MDATA\KGVPR20Y.D4
TEMPERATURE DATA FILE: C:\HELP3\MDATA\KGVFE20Y.D7
SOLAR RADIATION DATA FILE: C:\HELP3\MDATA\KGVS020Y.D13
EVAPOTRANSPIRATION DATA: C:\HELP3\MDATA\KGVEV20Y.D11
SOIL AND DESIGN DATA FILE: C:\HELP3\MDATA\CASE3R.D10
OUTPUT DATA FILE: C:\HELP3\MDATA\CASE3R.D0UT

TIME: 8:37 DATE: 4/22/2019

TITLE: CITY OF KINGSVILLE SOLID WASTE LANDFILL-CASE 3 (LOCATION 3)

NOTE: INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

LAYER 1

TYPE 1 - VERTICAL PERCOLATION LAYER MATERIAL TEXTURE NUMBER 13

THICKNESS 6.00 INCHES POROSITY = 0.4300 VOL/VOL FIELD CAPACITY 0.3210 VOL/VOL = WILTING POINT 0.2210 VOL/VOL INITIAL SOIL WATER CONTENT = 0.2391 VOL/VOL EFFECTIVE SAT. HYD. COND. ■ 0.330000003000E-04 CM/SEC NOTE: SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY 3.00 FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.

LAYER 2

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18

THICKNESS = 1845,90 INCHES

POROSITY = 0.6710 VOL/VOL
FIELD CAPACITY = 0.2920 VOL/VOL
WILTING POINT = 0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.2914 VOL/VOL

EFFECTIVE SAT, HYD. COND. = 0.10000005000E-02 CM/SEC

LAYER 3

TYPE 1 - VERTICAL PERCOLATION LAYER MATERIAL TEXTURE NUMBER 13

 THICKNESS
 =
 24.00 INCHES

 POROSITY
 =
 0.4300 VOL/VOL

 FIELD CAPACITY
 =
 0.3210 VOL/VOL

 WILTING POINT
 =
 0.2210 VOL/VOL

 INITIAL SOIL WATER CONTENT
 =
 0.3245 VOL/VOL

EFFECTIVE SAT. HYD. COND. = 0.330000003000E-04 CM/SEC

LAYER 4

TYPE 2 - LATERAL DRAINAGE LAYER MATERIAL TEXTURE NUMBER 20

THICKNESS = 0.20 INCHES

POROSITY = 0.8500 VOL/VOL

FIELD CAPACITY = 0.0100 VOL/VOL

WILTING POINT = 0.0050 VOL/VOL

INITIAL SOIL WATER CONTENT = 0.0205 VOL/VOL

EFFECTIVE SAT. HYD. COND. = 10.0000000000 CM/SEC

SLOPE = 2.00 PERCENT DRAINAGE LENGTH = 500.0 FEET

LAYER S

TYPE 4 - FLEXIBLE MEMBRANE LINER MATERIAL TEXTURE NUMBER 35

THICKNESS = 0.06 INCHES
POROSITY = 0.0000 VOL/VOL
FIELD CAPACITY = 0.0000 VOL/VOL
WILTING POINT = 0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.199999996000E-12 CM/SEC

FML PINHOLE DENSITY = 1.00 HOLES/ACRE
FML INSTALLATION DEFECTS = 2.00 HOLES/ACRE

FML PLACEMENT QUALITY = 3 - GOOD

LAYER 6

TYPE 3 - BARRIER SOIL LINER MATERIAL TEXTURE NUMBER 17

THICKNESS = 0.24 INCHES
POROSITY = 0.7500 VOL/VOL
FIELD CAPACITY = 0.7470 VOL/VOL

WILTING POINT = 0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.7500 VOL/VOL
EFFECTIVE SAT, HYD, COND. = 0.300000003000E-08 CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE #13 WITH A FAIR STAND OF GRASS, A SURFACE SLOPE OF 12.% AND A SLOPE LENGTH OF 200. FEET.

SCS RUNOFF CURVE NUMBER	=	89.00	
FRACTION OF AREA ALLOWING RUNOFF	=	80.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1,000	ACRES
EVAPORATIVE ZONE DEPTH	=	12.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	2.124	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	6.606	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	1.788	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	547.348	INCHES
TOTAL INITIAL WATER	=	547.348	INCHES
TOTAL SUBSURFACE INFLOW	=	0.99	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM CORPUS CHRISTI TEXAS

= 27.77 DEGREES STATION LATITUDE MAXIMUM LEAF AREA INDEX 2.00 START OF GROWING SEASON (JULIAN DATE) = ø END OF GROWING SEASON (JULIAN DATE) 367 = 12.0 INCHES EVAPORATIVE ZONE DEPTH AVERAGE ANNUAL WIND SPEED = 12.00 MPH AVERAGE 1ST QUARTER RELATIVE HUMIDITY = 76.00 % AVERAGE 2ND QUARTER RELATIVE HUMIDITY = 78.00 % AVERAGE 3RD QUARTER RELATIVE HUMIDITY = 76.00 % AVERAGE 4TH QUARTER RELATIVE HUMIDITY = 76.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
1.63	1.69	1.20	1.57	3.29	3.12
2.26	2.78	5,31	2.92	1.61	1.17

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

			CASE3R20.OUT				
JUC/NAC	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC		
			******	++	******		
56.30	59.30	65.90	73.00	78.10	82.70		
84.90	85.00	81.50	74.00	65.00	59.10		

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS

AND STATION LATITUDE = 27.77 DEGREES

AVERAGE MONTHI	Y VALUES I	N INCHES :	FOR YEARS	1 THR	OUGH 20	
	JAN/JUL	FE8/AUG	MAR/SEP	APR/OCT	MAY/NOV	OUN/DEC
PRECIPITATION						
TOTALS	1 15	2.02	1.05	1.42	2.41	2.71
TOTALS	2.43		5.38		1.33	
STD. DEVIATIONS	0.63	1.18	0.55 3.12	1,20	1,88	2.04
	2.55	1.63	3.12	1,75	1,17	0.85
RUNOFF						
TOTALS	0.013	0.058	0.004	0.095	0.261	0.26
	0.358	0.176	0.733	0.155	0.067	0.01
STD. DEVIATIONS	0.038	0.074	0.007	0.221		
	0.783	0.186	0.879	0.241	0.20 2	0.05
EVAPOTRANSPIRATION						
TOTALS		2,093				
	2,045	1.896	3.629	2.258	1.099	1.07
STD. DEVIATIONS	0.537		0.710	0.928	1.312	1.38
	1.629	1,315	1.227	1,202	0,786	0.59
ATERAL DRAINAGE COLI	ECTED FROM					
TOTALS		0.0358	0.0747	0.0581	0.0416	0.06
	0.1587	0.1953	0.1104	0.4155	0.4199	0.22
STD. DEVIATIONS		0.0545				
	0.2949	0.4190	0.2386	0.5824	0.7312	0.41
PERCOLATION/LEAKAGE 1	THROUGH LAY	ER 6				
TOTALS	0.0000		0.0000			
	9.0000	9.0000	0.0000	0.0000	0.0000	0.00
STD. DEVIATIONS		0.0000				
	0.0000	0.0000	0.0000	0.0000	0.0000	0.00

DAILY AVERAGE HEAD ON	TOP OF LAYE	R 5				
AVERAGES	0,0010	0.9996	0.0011	0.0009	0.0006	0.0009
	0.0023	0.0028	0.0016	0.0059	0.0062	0.0032
STD, DEVIATIONS	0.0013	0.0009	0.0020	0.0015	0.0010	0.0021
	0.0042	0.0060	0.0035	0.0083	0.0108	0.0059

AVERAGE ANNUAL TOTALS & (STD, DEVIA	reo	NS) FOR YE	ARS 1 THROUG	H 20	
	INCHES			CU. FEET	PERCENT	
PRECIPITATION	25.74	(5.706)	93448.9	100.00	
RUNOFF	2.197	(1.2161)	7975.32	8,534	
EVAPOTRANSPIRATION	21.691	(3,6830)	78736.87	84.257	
LATERAL DRAINAGE COLLECTED FROM LAYER 4	1.87134	(1.53422)	6792.958	7.26917	
PERCOLATION/LEAKAGE THROUGH LAYER 6	9.00000	(0.00000)	0.004	0.00000	
AVERAGE HEAD ON TOP OF LAYER 5	0.002 (6.002)			
CHANGE IN WATER STORAGE	-0.015	(0.5521)	-56 .24	-0.060	
*******			*****	***	ste de ste de ste ste ste ste ste ste ste	

PEAK DAILY VALUES FOR YEARS	1 THROUGH	20
	(INCHES)	(CU. FT.)
PRECIPITATION	5.07	18404.102
RUNOFF	2.106	7646.4312
DRAINAGE COLLECTED FROM LAYER 4	0.16188	587,61462
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.000000	0.00007
AVERAGE HEAD ON TOP OF LAYER 5	0.071	
MAXIMUM HEAD ON TOP OF LAYER 5	0.142	
LOCATION OF MAXIMUM HEAD IN LAYER 4 (DISTANCE FROM DRAIN)	1.9 FEET	
SNOW WATER	0.90	0,0000
MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.	3893
• • •	Page	5

MINIMUM VEG. SOIL WATER (VOL/VOL)

0.1490

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner by Bruce M. McEnroe, University of Kansas ASCE Journal of Environmental Engineering Vol. 119, No. 2, March 1993, pp. 262-270.

FINAL	WATER	STORAGE	AΤ	END	OF	YEAR	20

LAYER	(INCHES)	(VOL/VOL)
1	1.4394	0.2399
2	537,7128	0.2 9 13
3	7.7040	0.3210
4	0.0020	0.0100
5	0.0000	0.0000
6	0.1800	0.7500
SNOW WATER	0.000	

APPENDIX B.6 HELP OUTPUT FOR ALTERNATIVE LINER INTERIM CASE 4LOCATION 4



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******	********************	*******
*******	*******************	******
**	e e	**
**		**
**	HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE	**
**	HELP MODEL VERSION 3.07 (1 NOVEMBER 1997)	**
**	DEVELOPED BY ENVIRONMENTAL LABORATORY	**
**	USAE WATERWAYS EXPERIMENT STATION	**
**	FOR USEPA RISK REDUCTION ENGINEERING LABORATORY	**
**		**
**		**
******	******************	*****
*****	*****************	*****

PRECIPITATION DATA FILE: C:\HELP3\MDATA\KGVPR20Y.D4
TEMPERATURE DATA FILE: C:\HELP3\MDATA\KGVPR20Y.D7
SOLAR RADIATION DATA FILE: C:\HELP3\MDATA\KGVS020Y.D13
EVAPOTRANSPIRATION DATA: C:\HELP3\MDATA\KGVEV20Y.D11
SOIL AND DESIGN DATA FILE: C:\HELP3\MDATA\CASE4R.D10

OUTPUT DATA FILE:

C:\HELP3\MDATA\CASE4R20.OUT

TIME: 15:39 DATE: 4/14/2019

NOTE: INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

LAYER 1

TYPE 1 - VERTICAL PERCOLATION LAYER

MATERIAL TEXTURE NUMBER 13

THICKNESS = 6.00 INCHES
POROSITY = 0.4300 VOL/VOL
FIELD CAPACITY = 0.3210 VOL/VOL
WILTING POINT = 0.2210 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.2210 VOL/VOL

EFFECTIVE SAT. HYD. COND. = 0.330000003000E-04 CM/SEC NOTE: SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY 3.00 FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.

LAYER 2

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18

THICKNESS

= 1930.00 INCHES

POROSITY 0.6710 VOL/VOL FIELD CAPACITY 0.2920 VOL/VOL 0.0770 VOL/VOL WILTING POINT 0.2914 VOL/VOL INITIAL SOIL WATER CONTENT =

EFFECTIVE SAT. HYD. COND. = 0.100000005000E-02 CM/SEC

LAYER 3

TYPE 1 - VERTICAL PERCOLATION LAYER

MATERIAL TEXTURE NUMBER 13

THICKNESS 24.00 INCHES = 0.4300 VOL/VOL POROSITY 0.3210 VOL/VOL FIELD CAPACITY 0.2210 VOL/VOL WILTING POINT INITIAL SOIL WATER CONTENT = 0.3246 VOL/VOL EFFECTIVE SAT. HYD. COND. = 0.330000003000E-04 CM/SEC

LAYER 4

TYPE 2 - LATERAL DRAINAGE LAYER MATERIAL TEXTURE NUMBER 20

0.20 INCHES **THICKNESS** 0.8500 VOL/VOL POROSITY 0.0100 VOL/VOL FIELD CAPACITY 0.0050 VOL/VOL WILTING POINT INITIAL SOIL WATER CONTENT = 0.0206 VOL/VOL EFFECTIVE SAT. HYD. COND. = 10.0000000000 CM/SEC 2.00 PERCENT SLOPE 500.0 FEET DRAINAGE LENGTH

LAYER 5

TYPE 4 - FLEXIBLE MEMBRANE LINER

MATERIAL TEXTURE NUMBER 35

0.06 INCHES THICKNESS = 0.0000 VOL/VOL POROSITY = 0.0000 VOL/VOL FIELD CAPACITY WILTING POINT = 0.0000 VOL/VOL INITIAL SOIL WATER CONTENT = 0.0000 VOL/VOL

EFFECTIVE SAT. HYD. COND. = 0.199999996000E-12 CM/SEC FML PINHOLE DENSITY = 1.00 HOLES/ACRE FML INSTALLATION DEFECTS = 2.00 HOLES/ACRE

= 3 - GOOD FML PLACEMENT QUALITY

LAYER 6

TYPE 3 - BARRIER SOIL LINER MATERIAL TEXTURE NUMBER 17

0.24 INCHES THICKNESS = 0.7500 VOL/VOL POROSITY 0.7470 VOL/VOL FIELD CAPACITY Page 2

WILTING POINT = 0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.7500 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.300000003000E-08 CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE #13 WITH A FAIR STAND OF GRASS, A SURFACE SLOPE OF 4.% AND A SLOPE LENGTH OF 600. FEET.

SCS RUNOFF CURVE NUMBER	=	88.00	
FRACTION OF AREA ALLOWING RUNOFF	=	80.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	12.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	1.920	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	6.606	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	1.788	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	571.702	INCHES
TOTAL INITIAL WATER	=	571.702	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM CORPUS CHRISTI TEXAS

STATION LATITUDE	=	27.77	DEGREES
MAXIMUM LEAF AREA INDEX	=	2.00	
START OF GROWING SEASON (JULIAN DATE)	=	0	
END OF GROWING SEASON (JULIAN DATE)	=	367	
EVAPORATIVE ZONE DEPTH			INCHES
AVERAGE ANNUAL WIND SPEED	=	12.00	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	76.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	78.00	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	76.00	%
AVERAGE 4TH OUARTER RELATIVE HUMIDITY			

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
1.63	1.69	1.20	1.57	3.29	3.12
2.26	2.78	5.31	2.92	1.61	1.17

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

			CASE4R20.OUT				
JUC/NAC	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC		
56.30	59.30	65.90	73.00	78.10	82.70		
84.90	85.00	81.50	74.00	65.00	59.10		

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS AND STATION LATITUDE = 27.77 DEGREES

AVERAGE MONTHLY	VALUES IN	INCHES	FOR YEARS		OUGH 20	
		FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	1.15	2.02	1.05	1.42	2.41	2.71
TOTALS	2.43	2.37	5.38	2.30	1.33	1.18
STD. DEVIATIONS	0.63	1.18	0.55	1.20	1.88	2.04
	2.55	1.63	3.12	1.75	1.17	0.85
RUNOFF						
TOTALS	0.010	0.044	0.002	0.080	0.229	0.222
	0.322	0.145	0.650	0.131	0.058	0.013
STD. DEVIATIONS	0.032	0.059	0.004	0.198	0.452	0.284
SID. DEVIANTAGIO	0.721	0.160	0.809	0.208	0.182	0.047
EVAPOTRANSPIRATION						
TOTALS	0.926	2.091	1.307	1.259	2.002	2.140
	2.063	1.908	3.649	2.262	1.101	1.086
STD. DEVIATIONS	0.553	0.908	0.722	0.938	1.315	1.392
	1.651	1.324	1.215	1.209	0.795	0.582
LATERAL DRAINAGE COLL	ECTED FROM	LAYER 4	1			
TOTALS	0.0726	0.0392	0.0796	0.0589	0.0482	0.075
	0.1774	0.2167	0.1255	0.4498	0.4595	0.252
STD. DEVIATIONS	0.0955	0.0557	0.1545	0.1063		
	0.3182	0.4582	0.2771	0.6084	0.7550	0.458
PERCOLATION/LEAKAGE T						
TOTALS	0.0000		0.0000	0.0000	0.0000	0.000
	0.0000	0.000	0.0000	0.0000	0.0000	0.000
STD. DEVIATIONS	0.0000	0.000	0.0000	0.0000		
	0.0000	0.000	0.0000	0.0000	0.0000	0.000

**************************************	**************************************	********* DEVIATIO	********* NS) FOR YI	******** EARS 1	******** THROUGH	******* 20
********	******	*******	*******	******	*****	******
*******	*****	******	******	******	******	******
SID. DEVIATIONS	0.0045	0.0065	0.0041	0.0087	0.0111	0.0065
STD. DEVIATIONS	0.0014	0.0009	0.0022	0.0016	0.0011	0.0023
	0.0025	0.0031	0.0018	0.0064	0.0068	0.0036
AVERAGES		0.0006	0.0011	0.0009	0.0007	0.0011

	INC	HES		CU. FEET	PERCENT
PRECIPITATION	25.74	(5.706)	93448.9	100.00
RUNOFF	1.907	(1.1083)	6921.00	7.406
EVAPOTRANSPIRATION	21.787	(3.6980)	79085.98	84.630
LATERAL DRAINAGE COLLECTED FROM LAYER 4	2.05535	(1.61445)	7460.923	7.98396
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.00000	(0.00000)	0.005	0.00000
AVERAGE HEAD ON TOP OF LAYER 5	0.002 (0.002)		
CHANGE IN WATER STORAGE	-0.005	(0.5759)	-18.99	-0.020

PEAK DAILY VALUES FOR YEARS	1 THROUGH	20
	(INCHES)	(CU. FT.)
PRECIPITATION	5.07	18404.102
RUNOFF	2.016	7318.0361
DRAINAGE COLLECTED FROM LAYER 4	0.16119	585.10394
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.000000	0.00007
AVERAGE HEAD ON TOP OF LAYER 5	0.071	
MAXIMUM HEAD ON TOP OF LAYER 5	0.142	
LOCATION OF MAXIMUM HEAD IN LAYER 4 (DISTANCE FROM DRAIN)	1.6 FEET	
SNOW WATER	0.00	0.0000
MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.	3947
SMANUTERING CONCENTRATION STATES THE PROPERTY OF THE TOTAL TO STATES AND THE STAT	Page	5

MINIMUM VEG. SOIL WATER (VOL/VOL)

0.1490

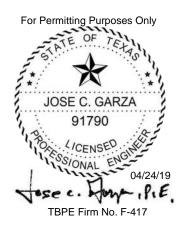
*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner by Bruce M. McEnroe, University of Kansas ASCE Journal of Environmental Engineering Vol. 119, No. 2, March 1993, pp. 262-270.

FTNAL	WATER	STORAGE	AT	END	OF	YEAR	20
LTIAME	MALITIM	DIOMAGE		-1110			-

LAYER	(INCHES)	(VOL/VOL)	
1	1.4410	0.2402	
2	562.2700	0.2913	
3	7.7040	0.3210	
4	0.0020	0.0100	
5	0.0000	0.0000	
6	0.1800	0.7500	
SNOW WATER	0.000		

APPENDIX B.7 HELP OUTPUT FOR ALTERNATIVE LINER CLOSED CASE 5-LOCATION 1



CASE5R30.OUT

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**		**
**	HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE	**
**	HELP MODEL VERSION 3.07 (1 NOVEMBER 1997)	**
**	DEVELOPED BY ENVIRONMENTAL LABORATORY	**
**	USAE WATERWAYS EXPERIMENT STATION	**
**	FOR USEPA RISK REDUCTION ENGINEERING LABORATORY	**
**		**
**		**
****	********************	*****
all the state of the state of the		

PRECIPITATION DATA FILE: C:\HELP3\MDATA\KGVPR30Y.D4
TEMPERATURE DATA FILE: C:\HELP3\MDATA\KGVPR30Y.D7
SOLAR RADIATION DATA FILE: C:\HELP3\MDATA\KGVS030Y.D13
EVAPOTRANSPIRATION DATA; C:\HELP3\MDATA\KGVEV30Y.D11
SOIL AND DESIGN DATA FILE: C:\HELP3\MDATA\CASE5R.D10
OUTPUT DATA FILE: C:\HELP3\MDATA\CASE5R30.OUT

TIME: 8:47 DATE: 4/22/2019

TITLE: CITY OF KINGSVILLE SOLID WASTE LANDFILL-CASE 5 (LOCATION 1)

NOTE: INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE

COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

LAYER 1

TYPE 1 - VERTICAL PERCOLATION LAYER MATERIAL TEXTURE NUMBER 13

THICKNESS = 24.00 INCHES
POROSITY = 0.4300 VOL/VOL
FIELD CAPACITY = 0.3210 VOL/VOL
WILTING POINT = 0.2210 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.2719 VOL/VOL
EFFECTIVE SAT, HYD, COND, = 0.330000003000E-04 CM/SEC

NOTE: SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY 4.63 FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.

LAYER 2

TYPE 2 - LATERAL DRAINAGE LAYER MATERIAL TEXTURE NUMBER 20

THICKNESS = 0.20 INCHES

CASE5R30.OUT

POROSITY = 0.8500 VOL/VOL
FIELD CAPACITY = 0.0100 VOL/VOL
WILTING POINT = 0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0100 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 10.0000000000 CM/SEC

SLOPE = 2.00 PERCENT DRAINAGE LENGTH = 250.0 FEET

LAYER 3

TYPE 4 - FLEXIBLE MEMBRANE LINER MATERIAL TEXTURE NUMBER 36

THICKNESS = 0.04 INCHES

POROSITY = 0.0000 VOL/VOL

FIELD CAPACITY = 0.0000 VOL/VOL

WILTING POINT = 0.0000 VOL/VOL

INITIAL SOIL WATER CONTENT = 0.0000 VOL/VOL

EFFECTIVE SAT. HYD. COND. = 0.39999993000E-12 CM/SEC

FML PINHOLE DENSITY = 1.00 HOLES/ACRE FML INSTALLATION DEFECTS = 2.00 HOLES/ACRE

FML PLACEMENT QUALITY == 3 - GOOD

LAYER 4

TYPE 3 - BARRIER SOIL LINER MATERIAL TEXTURE NUMBER 17

THICKNESS = 0.24 INCHES
POROSITY = 0.7500 VOL/VOL
FIELD CAPACITY = 0.7470 VOL/VOL
WILTING POINT = 0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.7500 VOL/VOL

EFFECTIVE SAT. HYD. COND. = 0.300000003000E-08 CM/SEC

LAYER 5

TYPE 1 - VERTICAL PERCOLATION LAYER

MATERIAL TEXTURE NUMBER 13

THICKNESS = 12.00 INCHES
POROSITY = 0.4300 VOL/VOL
FIELD CAPACITY = 0.3210 VOL/VOL
WILTING POINT = 0.2210 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.3210 VOL/VOL

EFFECTIVE SAT. HYD. COND. = 0.330000003000E-04 CM/SEC

LAYER 6

TYPE 1 - VERTICAL PERCOLATION LAYER MATERIAL TEXTURE NUMBER 18

THICKNESS = 705.60 INCHES
POROSITY = 0.5710 VOL/VOL
FIELD CAPACITY = 0.2920 VOL/VOL

CASESR30.OUT

WILTING POINT = 0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.2920 VOL/VOL

EFFECTIVE SAT. HYD. COND. = 0.100000005000E-02 CM/SEC

LAYER 7

TYPE 1 - VERTICAL PERCOLATION LAYER MATERIAL TEXTURE NUMBER 13

THICKNESS = 24.00 INCHES
POROSITY = 0.4300 VOL/VOL
FIELD CAPACITY = 0.3210 VOL/VOL
WILTING POINT = 0.2210 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.3210 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.330000003000E-04 CM/SEC

LAYER 8

TYPE 2 - LATERAL DRAINAGE LAYER MATERIAL TEXTURE NUMBER 20

THICKNESS = 0.20 INCHES
POROSITY = 0.8500 VOL/VOL
FIELD CAPACITY = 0.0100 VOL/VOL
WILTING POINT = 0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0100 VOL/VOL

EFFECTIVE SAT. HYD, COND. = 10.000000000 CM/SEC

SLOPE = 2.00 PERCENT DRAINAGE LENGTH = 250.0 FEET

LAYER 9

TYPE 4 - FLEXIBLE MEMBRANE LINER MATERIAL TEXTURE NUMBER 35

THICKNESS = 0.06 INCHES
POROSITY = 0.0000 VOL/VOL
FIELD CAPACITY = 0.0000 VOL/VOL
WILTING POINT = 0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0000 VOL/VOL
EFFECTIVE SAT, HYD, COND. = 0.199999996000E-12 CM/SEC

FML PINHOLE DENSITY = 1.00 HOLES/ACRE FML INSTALLATION DEFECTS = 2.00 HOLES/ACRE

FML PLACEMENT QUALITY $= 3 \sim GOOD$

LAYER 10

TYPE 3 - BARRIER SOIL LINER MATERIAL TEXTURE NUMBER 17

THICKNESS = 0.24 INCHES
POROSITY = 0.7500 VOL/VOL
FIELD CAPACITY = 0.7470 VOL/VOL
WILTING POINT = 0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.7500 VOL/VOL

CASESR30.OUT EFFECTIVE SAT. HYD. COND. = 0.300000003000E-08 CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE #13 WITH A GOOD STAND OF GRASS, A SURFACE SLOPE OF 25.% AND A SLOPE LENGTH OF 100. FEET.

SCS RUNOFF CURVE NUMBER	522	85,60	
	_		
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	12.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	2.674	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	5.160	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	2.652	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	224.481	INCHES
TOTAL INITIAL WATER	=	224,481	INCHES
TOTAL SUBSURFACE INFLOW	=	0,00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM CORPUS CHRISTI TEXAS

STATION LATITUDE

MAXIMUM LEAF AREA INDEX

START OF GROWING SEASON (JULIAN DATE)

END OF GROWING SEASON (JULIAN DATE)

EVAPORATIVE ZONE DEPTH

AVERAGE ANNUAL WIND SPEED

AVERAGE ANNUAL WIND SPEED

AVERAGE 2ND QUARTER RELATIVE HUMIDITY

AVERAGE 2ND QUARTER RELATIVE HUMIDITY

AVERAGE 3RD QUARTER RELATIVE HUMIDITY

AVERAGE 4TH QUARTER RELATIVE HUMIDITY

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JUE/NAC	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC

1.63	1.69	1,20	1.57	3,29	3,12
2,26	2.78	5. 31	2,92	1.61	1,17

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL FEB/AUG MAR/SEP APR/OCT MAY/NOV JUN/DEC
Page 4

				CASE5R30.OU	T
56.30	59.30	65,90	73.00	78.10	82,70
84.90	85.00	81.50	74.00	65.00	59.10

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS AND STATION LATITUDE = 27.77 DEGREES

AVERAGE MONTE	HLY VALUES I	N INCHES	FOR YEARS	1 THR	OUGH 30	
		-	MAR/SEP	APR/OCT	MAY/NOV	DUN/DEC
PRECIPITATION	******					
TOTALS	1.37	1,81	1.19	1.40	2.51	2.59
	2.36	2.86	5.39	2,99	1.49	1.25
STD. DEVIATIONS	0.81	1.21	0.57	1.05	1.80	1.82
	2.23	2.36	2.96	1.90	1.16	0.84
RUNOFF						
TOTALS	0.007	0.022	0.005	0,051	0,188	0.174
	0.342	0.218	0.608	0,191	0.067	0.007
STD. DEVIATIONS	0.022	0.041	0.026	0.171	0,500	0.243
	0.789	0.366	0.822	0.318	0.265	0.028
VAPOTRANSPIRATION						
TOTALS	1.093	1.768	1.331	1,252	1,966	2.07
	1,754	2.186	3.474	2.435	1.312	1.10
STD, DEVIATIONS	0.665	0.864	0.621	0.803	1.191	1.22
	1.256	1.504	1.237	1.13 6	0.89 9	0.68
ATERAL DRAINAGE CO						
TOTALS	0.0698	0.2237	0,1155	0.0457	0.1805	0.33
	0.3318	0.3490	0.8839	0,7081	0.2403	0.07
STD. DEVIATIONS	0.1315	0.2604	0.1270	0.1234	0.2785	0.46
	0.5455	0.5857	0. 9 977	0.7204	0.3203	0.11
PERCOLATION/LEAKAGE		ER 4				
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0,00
	0.0000	0.0000	0.0000	0.0000	0,0000	0.00
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0,00
	0.0000	0.0000	0.0000	0,000	0,0000	0.00
LATERAL DRAXNAGE CO						
TOTALS	0.0000			0.0000	0.0000	0,00
,	0.0000	0,0000	0.0000	0.0000	0.0000	0.00
STD, DEVIATIONS	0.0000	9.0000	0.0000	9.0000	0.0000	0.00
				Page 9	5	

			C	ASESR30.0	UT	
	0,0000	0,0000	0.0000	0.0000	0.0000	0.0000
ERCOLATION/LEAKAGE TH	ROUGH LAYE	R 10				
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
AVEDAGES	AC MONTHIV	AVERAGED	DATIV DEL	ANC /TMCHI	EC 1	
AVERAGES	OF MONTHLY	AVERAGED	DATLY HEA	ADS (INCHI	ES)	
AVERAGES AILY AVERAGE HEAD ON AVERAGES		ER 3			0.0013 0.0018	
AILY AVERAGE HEAD ON AVERAGES	0.0005 0.0005 0.0206	ER 3 0.0017 0.0177	0.0008 0.1061	0.9003 0.0240	0.0013 0.0018	0.000
AILY AVERAGE HEAD ON	TOP OF LAY	ER 3 0.0017	9.0008	0.9003	0.0013 0.0018	0.000
AILY AVERAGE HEAD ON AVERAGES	0.0005 0.0005 0.0206 0.0009 0.1028	0.0017 0.0177 0.0177 0.0020 0.0537	0.0008 0.1061 0.0009	0.9003 0.0240 0.0009	0.0013 0.0018 0.0020	
AILY AVERAGE HEAD ON AVERAGES STD. DEVIATIONS AILY AVERAGE HEAD ON	0.0005 0.0005 0.0206 0.0009 0.1028	0.0017 0.0177 0.0177 0.0020 0.0537	0.0008 0.1061 0.0009	0.9003 0.0240 0.0009	0.0013 0.0018 0.0020	0.000 0.041 0.000
AILY AVERAGE HEAD ON AVERAGES STD. DEVIATIONS	0.0005 0.0005 0.0206 0.0009 0.1028	ER 3 0.0017 0.0177 0.0020 0.0537	0.0008 0.1061 0.0009 0.2641	0.9003 0.0240 0.0009 0.0529	0.0013 0.0018 0.0020 0.0024	0.041 0.000
AILY AVERAGE HEAD ON AVERAGES STD. DEVIATIONS AILY AVERAGE HEAD ON	0.0005 0.0005 0.0206 0.0009 0.1028 TOP OF LAYI	e. 3 e.0017 e.0177 e.0020 e.0537 er. 9	0.0008 0.1061 0.0009 0.2641	0.9003 0.0240 0.0009 0.0529	0.0013 0.0018 0.0020 0.0024	0.000

AVERAGE ANNUAL TOTALS &	(STD, DEVIAT	IO	NS) FOR YE	ARS 1 THROUG	5H 30
	INCHES				PERCENT
PRECIPITATION				98722.7	100.00
RUNOFF	1.880	(1,2157)	6825,49	6.914
EVAPOTRANSPIRATION	21.749	(3.7373)	78947.65	79.969
LATERAL DRAINAGE COLLECTED FROM LAYER 2	3.55912	(1.91851)	12919.604	13,08676
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.00001	(0.00001)	0.023	0,00002
AVERAGE HEAD ON TOP OF LAYER 3	0.016 (0.026)		
LATERAL DRAINAGE COLLECTED FROM LAYER 8	0.00001	(0.00001)	0.022	0.00002
PERCOLATION/LEAKAGE THROUGH LAYER 10	0.00000	(0.00000)	0.001	0.00000
AVERAGE HEAD ON TOP OF LAYER 9	0.000 (0.000)		
CHANGE IN WATER STORAGE	860.0	(0.4489)	29.91 Page 6	0.030

CASESR30, OUT

<i>^</i>	
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PEAK DAILY VALUES FOR YEARS	1 THROUGH	30
	(INCHES)	(CU. FT.)
PRECIPITATION	5,07	
RUNOFF	2.585	9382.1035
DRAINAGE COLLECTED FROM LAYER 2	0,91251	3312.41650
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.000012	0.04380
AVERAGE HEAD ON TOP OF LAYER 3	14.568	
MAXIMUM HEAD ON TOP OF LAYER 3	18.997	
LOCATION OF MAXIMUM HEAD IN LAYER 2 (DISTANCE FROM DRAIN)	87.9 FEET	
DRAINAGE COLLECTED FROM LAYER 8	0.00001	0.03665
PERCOLATION/LEAKAGE THROUGH LAYER 10	9,000000	0.00002
AVERAGE HEAD ON TOP OF LAYER 9	0.000	
MAXIMUM HEAD ON TOP OF LAYER 9	0.000	
LOCATION OF MAXIMUM HEAD IN LAYER 8 (DISTANCE FROM DRAIN)	0.0 FEET	
SNOW WATER	0.02	73.7433
MAXIMUM VEG. SOIL WATER (VOL/VOL)		4285
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.	2210

^{***} Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner by Bruce M. McEnroe, University of Kansas ASCE Journal of Environmental Engineering Vol. 119, No. 2, March 1993, pp. 262-270.

FINAL WATER STORAGE AT END OF YEAR 30

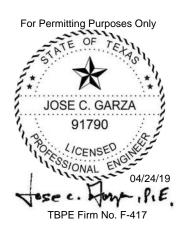
LAYER (INCHES) (VOL/VOL)

1 6.7730 0.2822

		CASE5R30.OUT
2	0.0020	0.0100
3	0.0000	0.0000
4	0.1800	0.7500
5	3,8520	0.3210
6	206.0352	0.2920
7	7.7040	0.3210
8	0.0020	0.0100
9	0.0000	Ø.9 0 00
10	0.1800	0.7500
SNOW WATER	0.000	

Page 8

APPENDIX B.8 HELP OUTPUT FOR ALTERNATIVE LINER CLOSED CASE 6-LOCATION 2



CASE6R30,OUT

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**		**
**		**
**	HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE	**
**	HELP MODEL VERSION 3.07 (1 NOVEMBER 1997)	**
**	DEVELOPED BY ENVIRONMENTAL LABORATORY	**
**	USAE WATERWAYS EXPERIMENT STATION	**
**	FOR USEPA RISK REDUCTION ENGINEERING LABORATORY	**
**		**
**		**
******	**************************************	*****
******	*************************	*****

PRECIPITATION DATA FILE: C:\HELP3\MDATA\KGVPR30Y.D4
TEMPERATURE DATA FILE: C:\HELP3\MDATA\KGVTE30Y.D7
SOLAR RADIATION DATA FILE: C:\HELP3\MDATA\KGVS030Y.D13
EVAPOTRANSPIRATION DATA: C:\HELP3\MDATA\KGVEV30Y.D11
SOIL AND DESIGN DATA FILE: C:\HELP3\MDATA\CASEGR.D10
OUTPUT DATA FILE: C:\HELP3\MDATA\CASEGR30.OUT

TIME: 13:23 DATE: 4/18/2019

NOTE: INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM,

LAYER 1

TYPE 1 - VERTICAL PERCOLATION LAYER MATERIAL TEXTURE NUMBER 13

THICKNESS = 24.00 INCHES
POROSITY = 0.4300 VOL/VOL
FIELD CAPACITY = 0.3210 VOL/VOL
WILTING POINT = 0.2210 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.2754 VOL/VOL
EFFECTIVE SAT. HYD. COND, = 0.330000003000E-04 CM/SEC

NOTE: SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY 4.63
FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.

LAYER 2

TYPE 2 - LATERAL DRAINAGE LAYER MATERIAL TEXTURE NUMBER 20

THICKNESS = 0.20 INCHES

POROSITY = 0.8500 VOL/VOL
FIELD CAPACITY = 0.0100 VOL/VOL
WILTING POINT = 0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0100 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 10.0000000000 CM/SEC

SLOPE = 2.00 PERCENT DRAINAGE LENGTH = 500.0 FEET

LAYER 3

TYPE 4 - FLEXIBLE MEMBRANE LINER MATERIAL TEXTURE NUMBER 36

0.04 INCHES THICKNESS 0.0000 VOL/VOL POROSITY 0.0000 VOL/VOL FIELD CAPACITY = WILTING POINT 0.0000 VOL/VOL 0.0000 VOL/VOL INITIAL SOIL WATER CONTENT = EFFECTIVE SAT. HYO. COND. = 0.39999993000E-12 CM/SEC FML PINHOLE DENSITY 1.00 HOLES/ACRE FML INSTALLATION DEFECTS 2,00 HOLES/ACRE = FML PLACEMENT QUALITY = 3 - GOOD

LAYER 4

TYPE 3 - BARRIER SOIL LINER MATERIAL TEXTURE NUMBER 17

LAYER 5

TYPE 1 - VERTICAL PERCOLATION LAYER MATERIAL TEXTURE NUMBER 13

THICKNESS = 12.00 INCHES

POROSITY = 0.4300 VOL/VOL

FIELD CAPACITY = 0.3210 VOL/VOL

WILTING POINT = 0.2210 VOL/VOL

INITIAL SOIL WATER CONTENT = 0.3210 VOL/VOL

EFFECTIVE SAT. HYD. COND. = 0.330000003000E-04 CM/SEC

LAYER 6

TYPE 1 - VERTICAL PERCOLATION LAYER MATERIAL TEXTURE NUMBER 18

 THICKNESS
 =
 1727.50
 INCHES

 POROSITY
 =
 0.6710
 VOL/VOL

 FIELD CAPACITY
 =
 0.2920
 VOL/VOL

 Page 2

WILTING POINT = 0.0770 VOL/VOL INITIAL SOIL WATER CONTENT = 0.2920 VOL/VOL

EFFECTIVE SAT. HYD. COND. = 0.100000005000E-02 CM/SEC

LAYER 7

TYPE 1 - VERTICAL PERCOLATION LAYER

MATERIAL TEXTURE NUMBER 13

THICKNESS = 24.00 INCHES
POROSITY = 0.4300 VOL/VOL
FIELD CAPACITY = 0.3210 VOL/VOL
WILTING POINT = 0.2210 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.3210 VOL/VOL

EFFECTIVE SAT. HYD. COND. = 0.330000003000E-04 CM/SEC

LAYER 8

TYPE 2 - LATERAL DRAINAGE LAYER MATERIAL TEXTURE NUMBER 20

THICKNESS = 0.20 INCHES
POROSITY = 0.8500 VOL/VOL
FIELD CAPACITY = 0.0100 VOL/VOL
WILTING POINT = 0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0100 VOL/VOL

EFFECTIVE SAT. HYD. COND. = 10.0000000000 CM/SEC

SLOPE = 2.00 PERCENT DRAINAGE LENGTH = 500.0 FEET

LAYER 9

TYPE 4 - FLEXIBLE MEMBRANE LINER MATERIAL TEXTURE NUMBER 35

THICKNESS = 0.06 INCHES

POROSITY = 0.0000 VOL/VOL

FIELD CAPACITY = 0.0000 VOL/VOL

WILTING POINT = 0.0000 VOL/VOL

INITIAL SOIL WATER CONTENT = 0.0000 VOL/VOL

EFFECTIVE SAT. HYD. COND. = 0.199999996000E-12 CM/SEC

FML PINHOLE DENSITY = 1.00 HOLES/ACRE
FML INSTALLATION DEFECTS = 2.00 HOLES/ACRE

FML PLACEMENT QUALITY = 3 - GOOD

LAYER 10

TYPE 3 - BARRIER SOIL LINER MATERIAL TEXTURE NUMBER 17

 THICKNESS
 =
 0.24
 INCHES

 POROSITY
 =
 0.7500
 VOL/VOL

 FIELD CAPACITY
 =
 0.7470
 VOL/VOL

 WILTING POINT
 =
 0.4080
 VOL/VOL

 INITIAL SOIL WATER CONTENT
 =
 0.7500
 VOL/VOL

Page 3

CASEGR30.OUT EFFECTIVE SAT. HYD. COND. = 0.300000003000E-08 CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
SOIL DATA BASE USING SOIL TEXTURE #13 WITH A
GOOD STAND OF GRASS, A SURFACE SLOPE OF 25.%
AND A SLOPE LENGTH OF 350. FEFT.

SCS RUNOFF CURVE NUMBER 84.60 FRACTION OF AREA ALLOWING RUNOFF 100.0 PERCENT AREA PROJECTED ON HORIZONTAL PLANE = 1.000 ACRES EVAPORATIVE ZONE DEPTH 12.0 INCHES INITIAL WATER IN EVAPORATIVE ZONE = 2.757 INCHES UPPER LIMIT OF EVAPORATIVE STORAGE = 5.160 INCHES LOWER LIMIT OF EVAPORATIVE STORAGE = 2.652 INCHES 0.000 INCHES INITIAL SNOW WATER INITIAL WATER IN LAYER MATERIALS = 522,959 INCHES 522.959 INCHES TOTAL INITIAL WATER 0.00 INCHES/YEAR TOTAL SUBSURFACE INFLOW

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM CORPUS CHRISTI TEXAS

= 27.77 DEGREES STATION LATITUDE MAXIMUM LEAF AREA INDEX 3.50 START OF GROWING SEASON (JULIAN DATE) = 0 END OF GROWING SEASON (JULIAN DATE) 367 = 12.0 INCHES EVAPORATIVE ZONE DEPTH AVERAGE ANNUAL WIND SPEED = 12.00 MPH AVERAGE 1ST QUARTER RELATIVE HUMIDITY = 76.00 % AVERAGE 2ND QUARTER RELATIVE HUMIDITY = 78.00 % AVERAGE 3RD QUARTER RELATIVE HUMIDITY = 76.00 % AVERAGE 4TH QUARTER RELATIVE HUMIDITY = 76.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	DUN/DEC
		~			
1.63	1.69	1.20	1.57	3,29	3.12
2.26	2.78	5.31	2.92	1.61	1.17

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL FEB/AUG MAR/SEP APR/OCT MAY/NOV JUN/DEC

			CASE6R30.OUT			
56.30	59.30	65.9 0	73.00	78.10	82,70	
84.90	85.00	81.5 0	74.00	65.00	59,10	

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS AND STATION LATITUDE = 27.77 DEGREES

AVERAGE MONTH	LY VALUES I		FOR YEARS		OUGH 30	
	JAN/JUL	FE8/AUG	MAR/SEP	APR/OCT	MAY/NOV	-
PRECIPITATION						
TOTALS	1,37	1.81	1.19	1,40	2.51	2.59
TOTALS	2.36		5.39		•	
STD. DEVIATIONS	0.81	1,21	0.57	1.05	1,80	1.82
	2.23	2.36	2.96	1.90	1.16	0.84
RUNOFF						
TOTALS	0.005	0.016	0.004	0.047	0.169	0.145
TO TAKE	0.325	0.191	0.568	0.161	0.044	0.004
STO. DEVIATIONS	0.016	0.032	0.020	0.171	0.495	0.206
210. DEATMITONS	0.770					
EVAPOTRANSPIRATION						
TOTALS	1,081	1.760	1.314	1.251	1.928	2.038
(o iniz	1,728					
STD. DEVIATIONS		0.902				
	1,204	1,461	1.229	1,106	0,896	0.689
LATERAL DRAINAGE COL						
TOTALS	0.0809	0.2406	0,1121	0.0567	0,2251	0.3948
	0.37 9 6	0.4275	0.9447	0.7920	0,2900	0.0857
STD. DEVIATIONS		0.2996				
	0.6067	0.6486	0.9618	0.8406	0.4048	0.12 00
PERCOLATION/LEAKAGE						
TOTALS		0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0,0000	9.0000	0.0000
STD. DEVIATIONS	0,0000	0.0000	0.0000	0.0000		
	0,0000	0.0000	0.0000	0,0000	0.0000	0.0009
LATERAL DRAINAGE COL			ļ			
TOTALS	Ø,0000	0.0000			•	
	0.0000	0.0000	0.0000	0.0000	0.0000	0.9000
STD. DEVIATIONS	0.0000	Ø,0 0 00	0.0000	0.0000	0.0000	0.0000
				Page 5	5	

AVERAGE HEAD ON TOP

LATERAL DRAINAGE COLLECTED

PERCOLATION/LEAKAGE THROUGH

OF LAYER 3

FROM LAYER 8

AVERAGE HEAD ON TOP

CHANGE IN WATER STORAGE

OF LAYER 9

LAYER 10

			C.A	\SE6R30.0	UT	
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THE	OUGH LAYE	R 10				
TOTALS	0.0000		0,0000	0.0000	0.0000	
	0.0000	0.0000	0.0000	0.0000	0,0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	6.0000 6.00 0 0	0.0000	
	0.0000	0.0000	0,00 00	0.0000	9.9000	0.0000
AVERAGES (OF MONTHLY	/ AVERAGED	DAILY HEA	DS (INCH	ES)	
DAILY AVERAGE HEAD ON 1	OP OF LAY	/ER 3				
AVERAGES	0.9012		0.0016	0.0008	0.0104	
	0.9681	0.0899	0.3548	0.1774	0.0241	0.0012
STO. DEVIATIONS	0,0020	0.0047	0.0017	0.0022	0.0324	
	0.2573	0.2432	0.7287	0.4575	0.1013	0,0017
DATLY AVERAGE HEAD ON T	OP OF LAY	/ER 9				
AVERAGES	0.0000	0,0000	9.0000	0.0000	9.0000	
	0.0000	0,0000	9.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000		0.0000	0.0000		
	0.0000	0,0000	0.0000	0.0000	0.0000	0,0000
**************************************	*********	*****	*******	********	*****	******
		INCHES		CU. FE	ET	PERCENT
PRECIPITATION		7.20 (9872	2.7	100,00
RUNOFF	:	1.680 (1.1902)	609	9.48	6.178
EVAPOTRANSPIRATION	2:	1.481 (3.7202)	7797	6.52	78,985
LATERAL DRAINAGE COLLECT FROM LAYER 2	TED 4	4.02954 (2.05403)	1462	7.235	14.81649
PERCOLATION/LEAKAGE THRE LAYER 4	OUGH (a.00002 (0.00003)	ı	0,077	9.00008

0.066 (

0.000 (

0.005

0.096)

0.000)

(0.4311)

0.00002 (0.00003)

0.00000 (0.00000)

0.00007

0.00000

0.020

Revision: 3 - April 2019

Page 6

0.073

0.004

19.37

CASEGR30,OUT

李本志亦亦亦亦亦亦亦亦亦亦亦亦亦亦亦亦亦亦亦亦亦亦亦亦亦亦亦亦亦亦亦亦亦亦亦亦

^
水液水水液水水液水溶液涂液涂涂涂涂涂涂涂涂涂涂涂涂涂水涂水水水水水水水水水水水

1 THROUGH	30
(INCHES)	(CU. FT.)
	18404.102
2.585	9382.0957
0.45365	1646.75024
0.000023	0.08305
22.812	
31,119	
158,8 FEET	
0.00002	0.07910
0.000000	0.00002
0.000	
0.000	
0.0 FEET	
0.02	73.7433
0.	4300
9.	2210
	(INCHES) 5.07 2.585 0.45365 0.000023 22.812 31,119 158.8 FEET 0.00002 0.000000 0.000 0.000

Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner by Bruce M. McEnroe, University of Kansas ASCE Journal of Environmental Engineering

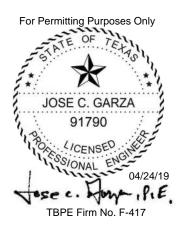
Vol. 119, No. 2, March 1993, pp. 262-270.

FINAL WATER STORAGE AT END OF YEAR 30

(VOL/VOL) LAYER (INCHES) 0,2820 1 6.7691

		CASE6R30.OUT	
2	0.0020	0. 010 9	
3	0.0000	8.0 00 3	
4	0.1800	0.75 0 0	
5	3.8520	0,3210	
6	504,4300	0,2920	
7	7.7040	0.3210	
8	0.0020	0.0100	
9	0.0000	0.0000	
10	0.1800	0.7500	
SNOW WATER	9.000		

APPENDIX B.9 HELP OUTPUT FOR ALTERNATIVE LINER CLOSED CASE 7LOCATION 3



AT .		
******	*********************	*******
******	****************	*******
**		**
**		**
**	HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE	**
**	HELP MODEL VERSION 3.07 (1 NOVEMBER 1997)	**
**	DEVELOPED BY ENVIRONMENTAL LABORATORY	**
**	USAE WATERWAYS EXPERIMENT STATION	**
**	FOR USEPA RISK REDUCTION ENGINEERING LABORATORY	**
**		**
**		**
*****	**************	****
*****	********************************	****

PRECIPITATION DATA FILE: C:\HELP3\MDATA\KGVPR30Y.D4
TEMPERATURE DATA FILE: C:\HELP3\MDATA\KGVPR30Y.D7
SOLAR RADIATION DATA FILE: C:\HELP3\MDATA\KGVS030Y.D13
EVAPOTRANSPIRATION DATA: C:\HELP3\MDATA\KGVEV30Y.D11
SOIL AND DESIGN DATA FILE: C:\HELP3\MDATA\CASE7R.D10
OUTPUT DATA FILE: C:\HELP3\MDATA\CASE7R30.OUT

TIME: 9: 9 DATE: 4/22/2019

TITLE: CITY OF KINGSVILLE SOLID WASTE LANDFILL-CASE 7 (LOCATION 3)

NOTE: INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

LAYER 1

TYPE 1 - VERTICAL PERCOLATION LAYER MATERIAL TEXTURE NUMBER 13

THICKNESS = 24.90 INCHES

POROSITY = 0.4300 VOL/VOL

FIELD CAPACITY = 0.3210 VOL/VOL

WILTING POINT = 0.2210 VOL/VOL

INITIAL SOIL WATER CONTENT = 0.2734 VOL/VOL

EFFECTIVE SAT. HYD. COND. = 0.33000003000E-04 CM/SEC

NOTE: SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY 4.63 FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.

LAYER 2

TYPE 2 - LATERAL DRAINAGE LAYER MATERIAL TEXTURE NUMBER 20

THICKNESS

0.20 INCHES

Page 1

POROSITY = 0.8500 VOL/VOL
FIELD CAPACITY = 0.0100 VOL/VOL
WILTING POINT = 0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0100 VOL/VOL

EFFECTIVE SAT. HYD. COND. = 10.0000000000 CM/SEC

SLOPE = 2.00 PERCENT DRAINAGE LENGTH = 500.0 FEET

LAYER 3

TYPE 4 - FLEXIBLE MEMBRANE LINER MATERIAL TEXTURE NUMBER 36

THICKNESS = 0.04 INCHES

POROSITY = 0.0000 VOL/VOL

FIELD CAPACITY = 0.0000 VOL/VOL

WILTING POINT = 0.0000 VOL/VOL

INITIAL SOIL WATER CONTENT = 0.0000 VOL/VOL

EFFECTIVE SAT. HYD. COND. = 0.39999993000E-12 CM/SEC

FML PINHOLE DENSITY = 1.00 HOLES/ACRE FML INSTALLATION DEFECTS = 2.00 HOLES/ACRE

FML PLACEMENT QUALITY = 3 - GOOD

LAYER 4

TYPE 3 - BARRIER SOIL LINER MATERIAL TEXTURE NUMBER 17

THICKNESS = 0.24 INCHES
POROSITY = 0.7500 VOL/VOL
FIELD CAPACITY = 0.7470 VOL/VOL
WILTING POINT = 0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.7500 VOL/VOL

EFFECTIVE SAT. HYD. COND. = 0.300000003000E-08 CM/SEC

LAYER 5

TYPE 1 - VERTICAL PERCOLATION LAYER MATERIAL TEXTURE NUMBER 13

THICKMESS = 12.00 INCHES
POROSITY = 0.4300 VOL/VOL
FIELD CAPACITY = 0.3210 VOL/VOL
WILTING POINT = 0.2210 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.3210 VOL/VOL

EFFECTIVE SAT. HYD. COND. = 0.330000003000E-04 CM/SEC

LAYER 6

TYPE 1 - VERTICAL PERCOLATION LAYER

MATERIAL TEXTURE NUMBER 18
THICKNESS = 1845.90 INCHES
POROSITY = 0.6710 VOL/VOL

POROSITY = 0.6710 VOL/VOL FIELD CAPACITY = 0.2920 VOL/VOL Page 2

WILTING POINT = 0.0770 VOL/VOL INITIAL SOIL WATER CONTENT = 0.2920 VOL/VOL

EFFECTIVE SAT. HYD. COND. = 0.100000005000E-02 CM/SEC

LAYER 7

TYPE 1 - VERTICAL PERCOLATION LAYER MATERIAL TEXTURE NUMBER 13

THICKNESS = 24.00 INCHES

POROSITY = 0.4300 VOL/VOL

FIELD CAPACITY = 0.3210 VOL/VOL

WILTING POINT = 0.2210 VOL/VOL

INITIAL SOIL WATER CONTENT = 0.3210 VOL/VOL

EFFECTIVE SAT. HYD. COND. = 0.330000003000E-04 CM/SEC

EFFECTIVE SAIL MID. COMP. = 0.3300000030000004 CMJSC

LAYER 8

TYPE 2 - LATERAL DRAINAGE LAYER MATERIAL TEXTURE NUMBER 20

THICKNESS = 0.20 INCHES
POROSITY = 0.8500 VOL/VOL
FIELD CAPACITY = 0.0100 VOL/VOL
WILTING POINT = 0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0100 VOL/VOL

EFFECTIVE SAT. HYD. COND. = 10.0000000000 CM/SEC

SLOPE = 2.00 PERCENT DRAINAGE LENGTH = 500.0 FEET

LAYER 9

TYPE 4 - FLEXIBLE MEMBRANE LINER

MATERIAL TEXTURE NUMBER 35

THICKNESS 0.06 INCHES 0.0000 VOL/VOL POROSTTY = FIELD CAPACITY 0.0000 VOL/VOL 0.0000 VOL/VOL WILTING POINT INITIAL SOIL WATER CONTENT = 0.0000 VOL/VOL EFFECTIVE SAT. HYD. COND. - 0.199999996000E-12 CM/SEC FML PINHOLE DENSITY 1.00 HOLES/ACRE FML INSTALLATION DEFECTS 2.00 HOLES/ACRE

FML PLACEMENT QUALITY = 3 - GOOD

LAYER 10

TYPE 3 - BARRIER SOIL LINER MATERIAL TEXTURE NUMBER 17

THICKNESS = 0.24 INCHES
POROSITY = 0.7500 VOL/VOL
FIELD CAPACITY = 0.7470 VOL/VOL
WILTING POINT = 0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.7500 VOL/VOL

CASE7R30.OUT EFFECTIVE SAT. HYD. COND. = 0.30000003000E-08 CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE #13 WITH A GOOD STAND OF GRASS, A SURFACE SLOPE OF 12.% AND A SLOPE LENGTH OF 200. FEET.

SCS RUNOFF CURVE NUMBER	=	84.80	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	12.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	2.709	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	5.160	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	2,652	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	557 ,48 4	INCHES
TOTAL INITIAL WATER	=	557.484	INCHES
TOTAL SUBSURFACE INFLOW	ы	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM CORPUS CHRISTI TEXAS

STATION LATITUDE = 27.77 DEGREES MAXIMUM LEAF AREA INDEX 3.50 START OF GROWING SEASON (JULIAN DATE) = 0 END OF GROWING SEASON (BULIAN DATE) = 367 EVAPORATIVE ZONE DEPTH = 12.0 INCHES AVERAGE ANNUAL WIND SPEED = 12.00 MPH AVERAGE 1ST QUARTER RELATIVE HUMIDITY = 76.00 % AVERAGE 2ND QUARTER RELATIVE HUMIDITY = 78.00 % AVERAGE 3RD QUARTER RELATIVE HUMIDITY = 76.00 % AVERAGE 4TH QUARTER RELATIVE HUMIDITY = 76.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/DUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
1.63	1.69	1.20	1,57	3,29	3.12
2.26	2.78	5.31	2,92	1.61	1.17

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL FEB/AUG MAR/SEP APR/OCT MAY/NOV JUN/DEC

			CASE7R30.OUT			
56.30	59,30	55.90	73.00	78,10	82.70	
84.90	85.00	81.50	74.00	65,00	59.10	

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS AND STATION LATITUDE = 27.77 DEGREES

AVERAGE MONTH	FLY VALUES IN	N INCHES	FUR YEARS	1 THR	OUGH 30	
	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DE
PRECIPITATION						
TOTALS	1.37	1,81	1.19	1.40	2.51	2.59
	2,36	2,85	5.39	2.99	1.49	1,25
STD. DEVIATIONS	0.81	1.21	0.57	1.05	1.80	
	2.23	2,36	2.96	1.90	1.16	0.84
UNOFF						
TOTALS	0.905	0.017	0.004	0.048	0.172	0.15
	0.327	0.197	0.576	0.165	0.045	0.00
STD. DEVIATIONS	0.017	0.034	0.021	0.172	0.495	0.21
	0.771	0.344	0.849	0.296	0.177	0.01
VAPOTRANSPIRATION						
TOTALS	1.078	1.759	1.312	1,250	1.927	2.03
	1,733	2.138	3,441	2.378	1.302	1.11
STD. DEVIATIONS	0.678	0.893	0.613	0.800	1,166	1.21
	1,208	1,465	1.222	1.103	0.899	0.69
ATERAL DRAINAGE COL		LAYER Z				
TOTALS		0.2413	0.1130	0.0569	0.2266	0.38
	0.3 734	0.4229	0,9423	0.7940	0.2864	0,08
STD. DEVIATIONS	0.1384	0.3007	0.1237	0.1480	0.3277	0.53
	0.6049	0.6418	0,9643	0.8378	0.4003	0.12
PERCOLATION/LEAKAGE						
TOTALS	0.0000		0.0000	0.0000	0.0000	0.00
	0.0000	9.0000	0.0000	0,0000	0.0000	0.00
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000		
	0.0000	0.0000	0.0000	0.0000	0.0000	0.00
ATERAL DRAINAGE COL		LAYER 8				
TOTALS	0.0000	0.0000				
	0,0000	0.0000	0.0000	0.0000	0.0000	0.00
STD. DEVIATIONS	0.0800	0.0000	0.0000	0,0000	0.0000	9.00
				Page 5	;	

		CASE7R30.OUT						
	0.0000	0.0000	0.0000	0.0000	0.0000	0.000		
ERCOLATION/LEAKAGE T	HROUGH LAYE	R 10						
TOTALS	0.0000	9.0000	0.0000	0.0000	0.0000	0.000		
	0.0000	9.0000	0.0000	0.0000	0.0000	0.000		
STD. DEVIATIONS	0.0000	0.0000	0.0000	0,0000	0,0000	0.000		
	0.0000	0.0000	0.0000	0.0000	0.0000	0.000		
AVFRAGES	OF MONTHLY	AVERAGED	DATLY HE	ADS (TNCH	ES)			
AVERAGES	OF MONTHLY	AVERAGED	DAILY HEA	ADS (INCHE	ES)			
AILY AVERAGE HEAD ON	TOP OF LAY		DATLY HE	ADS (INCHE	ES)			
	TOP OF LAY				es) 0.0105	0.058		
AILY AVERAGE HEAD ON	TOP OF LAY	ER 3 6.0038			ng ng pap pa na wa wa na na n			
AILY AVERAGE HEAD ON	TOP OF LAY	ER 3 0.0038 0.0853	0.0016 0.3606	9.9008 9.1844	0.0105	0.00		
AILY AVERAGE HEAD ON AVERAGES	0.0011 0.0675	ER 3 6.0038 6.0853 6.0047	0.0016 0.3606	9.9008 9.1844	0.0105 0.0215 0.0325	0.001 0.189		
AILY AVERAGE HEAD ON AVERAGES	0.0011 0.0675 0.0020 0.2555	e. 0038 6.0038 6.0853 6.0047 6.2308	9.0016 9.3606 9.0018	9.9968 9.1844 9.9922	0.0105 0.0215 0.0325	0.00 0.18		
AILY AVERAGE HEAD ON AVERAGES STD. DEVIATIONS	0.0011 0.0675 0.0020 0.2555	e. 3 6.0038 6.0853 6.0047 6.2308	9.0016 9.3606 9.0018	9.9968 9.1844 9.9922	0.0105 0.0215 0.0325	0.00 0.18 0.00		
AILY AVERAGE HEAD ON AVERAGES STD. DEVIATIONS AILY AVERAGE HEAD ON	0.0011 0.0675 0.0020 0.2555	6.0038 6.0038 6.0853 6.0047 6.2308 ER 9	0.0016 0.3606 0.0018 0.7392	0.0008 0.1844 0.0022 0.4599	0.0105 0.0215 0.0325 0.0994	0.000 0.189 0.000		
AILY AVERAGE HEAD ON AVERAGES STD. DEVIATIONS AILY AVERAGE HEAD ON	0.0011 0.0675 0.0020 0.2555 TOP OF LAY	6.0038 6.0038 6.0853 6.0047 6.2308 ER 9	0.0016 0.3606 0.0018 0.7392 0.0000 0.0000	0.0008 0.1844 0.0022 0.4599	0.0105 0.0215 0.0325 0.0994	0.001 0.189 0.001 0.000		

AVERAGE ANNUAL	TOTALS & (STD.	DEVIATIONS) FOR	YEARS 1	THROUGH :	30

	INC	IES		CU, FEET	PERCENT
PRECIPITATION				98722.7	
RUNOFF	1,711	(1.1947)	6210,31	6.291
EVAPOTRANSPIRATION	21,470	(3.7084)	77936.37	78.945
LATERAL DRAINAGE COLLECTED FROM LAYER 2	4.00840	(2.03256)	14550.508	14.73877
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.00 0 02	(0.00003)	0.078	0.00008
AVERAGE HEAD ON TOP OF LAYER 3	9.066 (0.097)		
LATERAL DRAINAGE COLLECTED FROM LAYER 8	0.00002	(0.00003)	0.073	0.00007
PERCOLATION/LEAKAGE THROUGH LAYER 10	9.00000	(0.00000)	6.00 4	0.00000
AVERAGE HEAD ON TOP OF LAYER 9	0.000 (0.000)		
CHANGE IN WATER STORAGE	0.007	(0.4345)	25.43 Page 6	0.026

李丰李幸中南南南南北南南水南南水南南水南南水南南水南南水南南水南省水南水南水南水南水南省水南南水南南

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PEAK DAILY VALUES FOR YEARS	1 THROUGH	30
	(INCHES)	(CU. FT.)
PRECIPITATION	5,07	18404.102
RUNOFF	2,585	9382.0957
DRAINAGE COLLECTED FROM LAYER 2	0.45365	1646.75073
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.000023	0.08307
AVERAGE HEAD ON TOP OF LAYER 3	22.816	
MAXIMUM HEAD ON TOP OF LAYER 3	31,124	
LOCATION OF MAXIMUM HEAD IN LAYER 2 (DISTANCE FROM DRAIN)	158.8 FEET	
DRAINAGE COLLECTED FROM LAYER 8	0,00002	0.07912
PERCOLATION/LEAKAGE THROUGH LAYER 10	0,000000	0.99862
AVERAGE HEAD ON TOP OF LAYER 9	0.000	
MAXIMUM HEAD ON TOP OF LAYER 9	0.000	
LOCATION OF MAXIMUM HEAD IN LAYER 8 (DISTANCE FROM DRAIN)	Ø.0 FEET	
SNOW WATER	0.02	73,7433
MAXIMUM VEG. SOIL WATER (VOL/VOL)	9	.4300
MINIMUM VEG. SOIL WATER (VOL/VOL)	0	.2210

^{***} Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner by Bruce M. McEnroe, University of Kansas ASCE Journal of Environmental Engineering Vol. 119, No. 2, March 1993, pp. 262-270.

FINAL WATER STORAGE AT END OF YEAR 30

LAYER (INCHES) (VOL/VOL)

1 6.7714 9.2821

		CASE7R30.OUT	
2	0.0020	0,0100	
3	0.0000	0.0000	
4	0.1800	0.7500	
5	3,8520	0.3210	
6	539.0029	0.2920	
7	7.7040	0.3210	
8	0.0020	0.0100	
9	0.0000	0.0090	
10	0.1800	0.7500	
SNOW WATER	0.000		
			

APPENDIX B.10 HELP OUTPUT FOR ALTERNATIVE LINER CLOSED CASE 8LOCATION 4



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*****	*****************	******
****	本本亦亦亦亦亦亦亦亦亦亦亦亦亦亦亦亦亦亦亦亦亦亦亦亦亦亦亦亦亦亦亦亦亦亦亦亦亦	******
**		**
**		**
**	HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE	**
**	HELP MODEL VERSION 3.07 (1 NOVEMBER 1997)	**
**	DEVELOPED BY ENVIRONMENTAL LABORATORY	**
**	USAE WATERWAYS EXPERIMENT STATION	**
**	FOR USEPA RISK REDUCTION ENGINEERING LABORATORY	**
**		**
**		**
*****	************************	******
-1-4-4-4-4-4-4-4-4-4-4-4-4-4-4-4-4-4-4-	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	****

PRECIPITATION DATA FILE: C:\HELP3\MDATA\KGVPR30Y.D4
TEMPERATURE DATA FILE: C:\HELP3\MDATA\KGVPR30Y.D7
SOLAR RADIATION DATA FILE: C:\HELP3\MDATA\KGVS030Y.D13
EVAPOTRANSPIRATION DATA: C:\HELP3\MDATA\KGVEV30Y.D11
SOIL AND DESIGN DATA FILE: C:\HELP3\MDATA\CASE8R.D10
OUTPUT DATA FILE: C:\HELP3\MDATA\CASE8R30.OUT

TIME: 13:42 DATE: 4/18/2019

TITLE: CITY OF KINGSVILLE SOLID WASTE LANDFILL-CASE 8 (LOCATION 4)

NOTE: INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

LAYER 1

TYPE 1 - VERTICAL PERCOLATION LAYER MATERIAL TEXTURE NUMBER 13

THICKNESS = 24.00 INCHES
POROSITY = 0.4300 VOL/VOL
FIELD CAPACITY = 0.3210 VOL/VOL
WILTING POINT = 0.2210 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.2733 VOL/VOL

EFFECTIVE SAT. HYD. COND. = 0.33000003000E-04 CM/SEC NOTE: SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY 4.63 FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.

LAYER 2

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 20

THICKNESS = 0.20 INCHES

Page 1

POROSITY = 0.8500 VOL/VOL
FIELD CAPACITY = 0.0100 VOL/VOL
WILTING POINT = 0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0100 VOL/VOL
EFFECTIVE SAT, HYD, COND. = 10.0000000000 CM/SEC

SLOPE = 2.00 PERCENT DRAINAGE LENGTH = 500.0 FEET

LAYER 3

TYPE 4 - FLEXIBLE MEMBRANE LINER MATERIAL TEXTURE NUMBER 36

THICKNESS 0.04 INCHES 0,0000 VOL/VOL POROSITY = FIELD CAPACITY . 0.0000 VOL/VOL 0.0000 VOL/VOL WILTING POINT 0.0000 VOL/VOL INITIAL SOIL WATER CONTENT = EFFECTIVE SAT, HYD. COND. = 0.39999993000E-12 CM/SEC FML PINHOLE DENSITY -1.00 HOLES/ACRE FML INSTALLATION DEFECTS 2.00 HOLES/ACRE FML PLACEMENT QUALITY = 3 - 600D

LAYER 4

TYPE 3 - BARRIER SOIL LINER MATERIAL TEXTURE NUMBER 17

THICKNESS = 0.24 INCHES
POROSITY = 0.7500 VOL/VOL
FIELD CAPACITY = 0.7470 VOL/VOL
WILTING POINT = 0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.7500 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.300000003000E-08 CM/SEC

LAYER 5

TYPE 1 - VERTICAL PERCOLATION LAYER MATERIAL TEXTURE NUMBER 13

THICKNESS = 12.00 INCHES
POROSITY = 0.4300 VOL/VOL
FIELD CAPACITY = 0.3210 VOL/VOL
WILTING POINT = 0.2210 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.3210 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.33000003000E-04 CM/SEC

LAYER 6

TYPE 1 - VERTICAL PERCOLATION LAYER MATERIAL TEXTURE NUMBER 18

THICKNESS = 1930.00 INCHES
POROSITY = 0.6710 VOL/VOL
FIELD CAPACITY = 0.2920 VOL/VOL

WILTING POINT = 0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.2920 VOL/VOL

EFFECTIVE SAT. HYD. COND. = 0.100000005000E-02 CM/SEC

LAYER 7

TYPE 1 - VERTICAL PERCOLATION LAYER MATERIAL TEXTURE NUMBER 13

THICKNESS = 24.00 INCHES
POROSITY = 0.4300 VOL/VOL
FIELD CAPACITY = 0.3210 VOL/VOL
WILTING POINT = 0.2210 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.3210 VOL/VOL

EFFECTIVE SAT. HYD, COND. = 0.330000003000E-04 CM/SEC

LAYER 8

TYPE 2 - LATERAL DRAINAGE LAYER MATERIAL TEXTURE NUMBER 20

 THICKNESS
 =
 0.20 INCHES

 POROSITY
 =
 0.8500 VOL/VOL

 FIELD CAPACITY
 =
 0.9100 VOL/VOL

 WILTING POINT
 =
 0.0650 VOL/VOL

 INITIAL SOIL WATER CONTENT
 =
 0.0100 VOL/VOL

EFFECTIVE SAT. HYD. COND. = 10.0000000000 CM/SEC

SLOPE = 2.00 PERCENT DRAINAGE LENGTH = 500.0 FEET

LAYER 9

TYPE 4 - FLEXIBLE MEMBRANE LINER MATERIAL TEXTURE NUMBER 35

THICKNESS = 0.06 INCHES
POROSITY = 0.0000 VOL/VOL
FIELD CAPACITY = 0.0000 VOL/VOL
WILTING POINT = 0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.199999995000E-12 CM/SEC

FML PINHOLE DENSITY = 1.00 HOLES/ACRE
FML INSTALLATION DEFECTS = 2.00 HOLES/ACRE

FML PLACEMENT QUALITY = 3 - GOOD

LAYER 10

TYPE 3 - BARRIER SOIL LINER MATERIAL TEXTURE NUMBER 17

THICKNESS = 0.24 INCHES
POROSITY = 0.7590 VOL/VOL
FIELD CAPACITY = 0.7470 VOL/VOL
WILTING POINT = 0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.7500 VOL/VOL

Page 3

CASE8R30.OUT
EFFECTIVE SAT. HYD, COND. = 0.300000003000E-08 CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE #13 WITH A GOOD STAND OF GRASS, A SURFACE SLOPE OF 4.% AND A SLOPE LENGTH OF 600. FEET.

SCS RUNOFF CURVE NUMBER	쿄	83,40	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	12.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	2.708	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	5.160	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	2.652	INCHES
INITIAL SNOW WATER	=	9.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	582.040	INCHES
TOTAL INITIAL WATER	=	582.040	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM CORPUS CHRISTI TEXAS

= 27.77 DEGREES STATION LATITUDE MAXIMUM LEAF AREA INDEX 3.50 START OF GROWING SEASON (JULIAN DATE) = 0 END OF GROWING SEASON (JULIAN DATE) 367 = 12.0 INCHES EVAPORATIVE ZONE DEPTH AVERAGE ANNUAL WIND SPEED = 12.00 MPH AVERAGE 1ST QUARTER RELATIVE HUMIDITY = 76.00 % AVERAGE 2ND QUARTER RELATIVE HUMIDITY = 78.00 % AVERAGE 3RD QUARTER RELATIVE HUMIDITY = 76.00 % AVERAGE 4TH QUARTER RELATIVE HUMIDITY = 76.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

DAN/DUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	DUN/DEC
1.63	1.69	1.20	1.57	3,29	3.12
2.26	2.78	5.31	2.92	1.61	1.17

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
				Page 4	

				CAZERK30.OUT		
56.30	59.30	65.90	73.00	78.10	82.70	
84.90	85,00	81.50	74.00	65.00	59.10	

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS

AND STATION LATITUDE = 27.77 DEGREES

AVERAGE MONTH						
	JUC\MAC	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	1.37 2.36	1.81 2.86	1.19 5.39	1.46 2.99	2,51 1,49	2,59 1,25
STD. DEVIATIONS	0.81 2.23	1.21 2.36	0.57 2.96	1. 0 5 1.90	1.80 1.16	1.82 0.84
RUNOFF						
TOTALS	0.003 0.320	0.011 0.167				0,117 0,002
STD. DEVIATIONS	0.012 0.765	0.024 0.317			0.494 0.166	0.168 0.012
EVAPOTRANSPIRATION						
TOTALS	1.075 1.740	1.755 2,149				2. 03 6 1.111
STD. DEVIATIONS	0.680 1.225	0.89 0 1.476	0.616 1,225		1.174 0.904	
LATERAL DRAINAGE COL						
TOTALS	0.0871	0.2477 0.4325	0.1143	0.0601 0.8286		
STD. DEVIATIONS		0.3090 0.6575				
PERCOLATION/LEAKAGE						
TOTAL5	9.0000 9.0000	0.0000				
STD, DEVIATIONS	0.0000 0.0000					
LATERAL DRAINAGE COL						
TOTALS	0.0000 0.0000	0.000	0.0000			
STD. DEVIATIONS	0.0000	9.000	0.0000	0.0000 Page 9		0.000

			C	ASE8R30,0	UT	
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE Y	HROUGH LAYE	R 10				
TOTALS	9.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0,0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0,0000	0.0000
		AVEDAGED	DATLY HE	ADS (TNCHI		
AVEDACEC					زور	
AVERAGES	OF MONTHLY		DALE: NE			
AVERAGES	OF MONTHLY		DALL HE		, ., .,	
			WALL THE		, , , , , , , , , , , , , , , , , , ,	
DAILY AVERAGE HEAD ON		ER 3	9.0016		0.0104	
DAILY AVERAGE HEAD ON	TOP OF LAY	ER 3 			, <u>, , , , , , , , , , , , , , , , , , </u>	0.0748 0.0012
DAILY AVERAGE HEAD ON	TOP OF LAY	ER 3 0.0039 0.0824	9.0016	0.0009 0.2120	0.0104	
DAILY AVERAGE HEAD ON AVERAGES	0.0012 0.0679	ER 3 0.0039 0.0824	0.0016 0.37 0 7	0.0009 0.2120	0.0104 0.0248	0.0012
DAILY AVERAGE HEAD ON AVERAGES	0.0012 0.0679 0.0023 0.2719	ER 3 0.0039 0.0824 0.0048 0.2347	0.0016 0.3707 0.0017	0.0009 0.2120 0.0024	0.0104 0.0248 0.0323	0.0012 0.2328
DAILY AVERAGE HEAD ON AVERAGES STD. DEVIATIONS	0.0012 0.0679 0.0023 0.2719	ER 3 0.0039 0.0824 0.0048 0.2347	9.0016 9.3707 9.0017 9.7766	0.0009 0.2120 0.0024	0.0104 0.0248 0.0323	0.0012 0.2328 0.0017
DAILY AVERAGE HEAD ON AVERAGES STD. DEVIATIONS DAILY AVERAGE HEAD ON	0.0012 0.0679 0.0023 0.2719	ER 3 0.0039 0.0824 0.0048 0.2347 ER 9	9.0016 9.3707 9.0017 9.7766	0.0009 0.2120 0.0024 0.4906	0.0104 0.0248 0.0323 0.1168	0.0012 0.2328 0.0017 0.0000
DAILY AVERAGE HEAD ON AVERAGES STD. DEVIATIONS DAILY AVERAGE HEAD ON	0.0012 0.0679 6.0023 6.2719 TOP OF LAY	ER 3 	9.0016 9.3707 9.0017 9.7766	0.0009 0.2120 0.0024 0.4906	0.0104 0.0248 0.0323 0.1168 0.0000 0.0000	0.0012 0.2328 0.0017 0.0000

AVERAGE ANNUAL TOTALS &	(STD. DEVIATE	IONS)	FOR YEA	ARS 1 THROU	GH 30
***************************************				CU. FEET	
PRECIPITATION				98722.7	
RUNOFF	1.533	(1.	1930)	5565,96	5.638
EVAPOTRANSPIRATION	21.495	(3,	7381)	78026.06	79.036
LATERAL DRAINAGE COLLECTED FROM LAYER 2	4.16123	(2.	10988)	15105.281	15,30072
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.00002	(Ø.	00003)	0.083	0.00 0 08
AVERAGE HEAD ON TOP OF LAYER 3	0.071 (0.	1 9 4)		
LATERAL DRAINAGE COLLECTED FROM LAYER 8	0.00002	(0.	00003)	0.079	0.00008
PERCOLATION/LEAKAGE THROUGH LAYER 10	0,00000	(0.	0 0000)	9.004	0.00000
AVERAGE HEAD ON TOP OF LAYER 9	0.000 (6.	000)		
CHANGE IN WATER STORAGE	0.007	(0.	4342)	25.30 Page 6	0.026

6

PEAK DAILY VALUES FOR YEARS	1 THROUGH 30	
	(INCHES) (CU.	FT.)
PRECIPITATION	5.07 1849	4.102
RUNOFF	2,585 938	2.0947
DRAINAGE COLLECTED FROM LAYER 2	0.45365 164	6.74548
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.000023	0,08285
AVERAGE HEAD ON TOP OF LAYER 3	22.774	
MAXIMUM HEAD ON TOP OF LAYER 3	31.078	
LOCATION OF MAXIMUM HEAD IN LAYER 2 (DISTANCE FROM DRAIN)	158.7 FEET	
DRAINAGE COLLECTED FROM LAYER 8	0.00002	0.07933
PERCOLATION/LEAKAGE THROUGH LAYER 10	0.000000	0.0 0 002
AVERAGE HEAD ON TOP OF LAYER 9	0.000	
MAXIMUM HEAD ON TOP OF LAYER 9	0.000	
LOCATION OF MAXIMUM HEAD IN LAYER 8 (DISTANCE FROM DRAIN)	0.0 FEET	
SNOW WATER	0.02 7	3.7433
MAXIMUM VEG. SOIL WATER (VOL/VOL)	0. 4300	
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.2210	

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner by Bruce M. McEnroe, University of Kansas ASCE Journal of Environmental Engineering Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 30

LAYER (INCHES) (VOL/VOL)

1 6.7694 0.2821

		CASE8R30.OUT
2	0.0020	0.0100
3	9.0000	0.0000
4	0.1800	0.7500
5	3.8520	0.3210
6	563.5601	0.2920
7	7,7040	0.3210
8	0.0020	0.0100
9	0.0000	0,0000
10	0.1800	0.7500
SNOW WATER	0.000	

APPENDIX B.21 TABLE 1 – HELP MODEL ANALYSIS ALTERNATIVE LINER SUMMARY

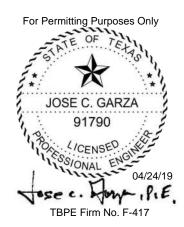
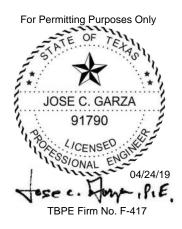


TABLE 1-HELP MODEL ANALYSIS ALTERNATIVE LINER SUMMARY

Case No.	1	2	3	4	5	6	7	8	1OL	2OL	3OL	4OL	5OL	6OL	7OL	8OL
Cover	Interim	Interim	Interim	Interim	Closed	Closed	Closed	Closed	Interim	Interim	Interim	Interim	Closed	Closed	Closed	Closed
Average Waste Thickness (ft) Average Waste Thickness-Above Liner(ft)	58.80	143.96	153.83	160.83	58.80	143.96	153.82	160.83	12	82.5	85.5	119.5	12	82.5	85.5	119.5
Average Waste Thickness-Above Liner(it) Average Waste Thickness-Below Liner(ft)									15.5	34	37	16	15.5	34	37	16
Years	20	20	20	20	30	30	30	30	20	20	20	20	30	30	30	30
Ground Cover	Fair	Fair	Fair	Fair	Good	Good	Good	Good	Fair	Fair	Fair	Fair	Good	Good	Good	Good
Runoff Curve No. Model Area (acre)	89.5 1	88.8 1	89 1	88 1	85.6 1	84.6 1	84.8 1	83.4 1	89.5 1	88.8 1	88.5 1	88 1	85.6 1	84.6 1	84.1 1	83.4 1
Runoff Area (%)	80	80	80	80	100	100	100	100	80	80	80	80	100	100	100	100
Maximum Leaf Area Index	2	2	2	2	3.5	3.5	3.5	3.5	2	2	2	2	3.5	3.5	3.5	3.5
Evaporative Zone Depth (in) Erosion Layer	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
Layer No.					1	1	1	1					1	1	1	1
Туре					Vertical Percolation	Vertical Percolation	Vertical Percolation	Vertical Percolation					Vertical Percolation	Vertical Percolation	Vertical Percolation	Vertical Percolation
Texture No. Thickness (in)					13 24	13 24	13 24	13 24					13 24	13 24	13 24	13 24
Geocomposite					24	24	24	24					24	24	24	24
Layer No.					2	2	2	2					2	2	2	2
Type Texture No.					Lateral Drainage	Lateral Drainage	Lateral Drainage	Lateral Drainage					Lateral Drainage	Lateral Drainage	Lateral Drainage	Lateral Drainage
Thickness (in)					20 0.2	20 0.2	20 0.2	20 0.2					20 0.2	20 0.2	20 0.2	20 0.2
Slope (%)					2	2	2	2					2	2	2	2
Flow Distance (ft)					250	500 10	500 10	500					250 10	250 10	250 10	250
Hydraulic Conductivity (cm/sec) Geomembrane (40-mil LLDPE)					10	10	10	10					10	10	10	10
Layer No.					3	3	3	3					3	3	3	3
Type					Geomembrane Liner	Geomembrane Liner	Geomembrane Liner	Geomembrane Liner					Geomembrane Liner	Geomembrane Liner	Geomembrane Liner	Geomembrane Liner
Texture No. Thickness (in)					36 0.04	36 0.04	36 0.04	36 0.04					36 0.04	36 0.04	36 0.04	36 0.04
Installation Quality					3-Good	3-Good	3-Good	3-Good					3-Good	3-Good	3-Good	3-Good
Defects per acre					2	2	2	2					2	2	2	2
Pinholes per acre Barrier Soil Liner (GCL)					1	1	1	1					1	1	1	1
Layer No.					4	4	4	4					4	4	4	4
Type					Barrier Soil Liner	Barrier Soil Liner	Barrier Soil Liner	Barrier Soil Liner					Barrier Soil Liner	Barrier Soil Liner	Barrier Soil Liner	Barrier Soil Liner
Texture No. Thickness (in)					17 0.24	17 0.24	17 0.24	17 0.24					17 0.24	17 0.24	17 0.24	17 0.24
Daily/Intermediate Cover																
Layer No.	1 Vertical Percolation	1 Vertical Percelation	1 Vertical Percelation	1 Vertical Percolation	5 Vertical Percelation	5 Vertical Percelation	5 Vertical Percolation	5 Vertical Percelation	1 Vertical Percelation	1 Vertical Percelation	1 Vertical Percolation	1 Vertical Percelation	5 Vertical Percelation	5 Vertical Percelaton	5 Vertical Percelation	5 Vertical Percelation
Type Texture No.	Vertical Percolation 13	Vertical Percolation 13	Vertical Percolation 13	Vertical Percolation 13	Vertical Percolation 13	Vertical Percolation 13	Vertical Percolation 13	Vertical Percolation 13	Vertical Percolation 13	Vertical Percolation 13	Vertical Percolation 13	Vertical Percolation 13	Vertical Percolation 13	Vertical Percolaton 13	Vertical Percolation 13	Vertical Percolation 13
Thickness (in)	6	6	6	6	12	12	12	12	6	6	6	6	12	12	12	12
Solid Waste Layer No.	2	2	2	2	6	6	6	6	2	2	2	2	6	6	6	6
Type	Vertical Percolation	Vertical Percolation	Vertical Percolation	Vertical Percolation	Vertical Percolation	Vertical Percolation	Vertical Percolation	Vertical Percolation	Vertical Percolation	Vertical Percolation	Vertical Percolation	Vertical Percolation	Vertical Percolation	Vertical Percolaton	Vertical Percolation	Vertical Percolation
Texture No.	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18
Thickness (in) Protective Soil Cover	705.60	1,727.50	1,845.96	1,930	705.60	1,727.50	1,845.96	1,930	144	990	1,026	1,434	144	990	1,026	1434
Layer No.	3	3	3	3	7	7	7	7	3	3	3	3	7	7	7	7
Туре	Vertical Percolation	Vertical Percolation	Vertical Percolation	Vertical Percolation	Vertical Percolation	Vertical Percolation	Vertical Percolation	Vertical Percolation	Vertical Percolation	Vertical Percolation	Vertical Percolation	Vertical Percolation	Vertical Percolation	Vertical Percolaton	Vertical Percolation	Vertical Percolation
Texture No. Thickness (in)	13 24	13 24	13 24	13 24	13 24	13 24	13 24	13 24	13 24	13 24	13 24	13 24	13 24	13 24	13 24	13 24
Geocomposite	27	27	27	27	27		24	27	27	27	2-7	27	27		27	27
Layer No.	4	4	4	4	8	8	8	8	4	4	4	4	8	8	8	8
Type Texture No.	Lateral Drainage 20	Lateral Drainage 20	Lateral Drainage 20	Lateral Drainage 20	Lateral Drainage 20	Lateral Drainage 20	Lateral Drainage 20	Lateral Drainage 20	Lateral Drainage 20	Lateral Drainage 20	Lateral Drainage 20	Lateral Drainage 20	Lateral Drainage 20	Lateral Drainage 20	Lateral Drainage 20	Lateral Drainage 20
Thickness (in)	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Slope (%)	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Flow Distance (ft) Hydraulic Conductivity (cm/sec)	250 10	500 10	500 10	500 10	250 10	500 10	500 10	500 10	400 10	400 10	400 10	400 10	250 10	250 10	250 10	250 10
Geomembrane (60-mil HDPE)																
Layer No.	5 Goomombrana Linar	5 Geomembrane Liner	5 Geomembrane Liner	5 Goomombrana Linar	9 Goomombrana Linor	9 Goomombrana Linar	9 Goomombrana Linar	9 Geomembrane Liner	5 Goomombrana Liner	5 Goomombrana Liner	5 Geomombrane Liner	5 Goomombrana Linar	9 Goomombrana Linor	9 Goomombrana Linor	9 Geomembrane Liner	9 Goomombrana Linor
Type Texture No.	Geomembrane Liner 35	Geomembrane Liner 35	Geomembrane Liner 35	Geomembrane Liner 35	Geomembrane Liner 35	Geomembrane Liner 35	Geomembrane Liner 35	Geomembrane Liner 35	Geomembrane Liner 35	Geomembrane Liner 35	Geomembrane Liner 35	Geomembrane Liner 35	Geomembrane Liner 35	Geomembrane Liner 35	Geomembrane Liner 35	Geomembrane Liner 35
Thickness (in)	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
Installation Quality	3-Good	3-Good	3-Good	3-Good	3-Good	3-Good	3-Good	3-Good	3-Good	3-Good	3-Good	3-Good	3-Good	3-Good	3-Good	3-Good
Defects per acre Pinholes per acre	2 1	2 1	2 1	2 1	2 1	2 1	2 1	2 1	2 1	2 1	2 1	2 1	2 1	2 1	2 1	2
Barrier Soil Liner (GCL)	•	,	•	·	•		·		·	·	·	·	•			
		•	6	•	10	10	10	10 Barrier Soil Liner	6 Barriar Sail Liner	6 Barriar Sail Liner	6 Posting Soil Lines	6 Parrier Sail Lines	10	10 Barrier Soil Liner	10 Barrier Soil Liner	10
Layer No.	6 Barrier Sail Lines	6 Barriar Sail Liner	-	6 Barrier Call Lines		Dorrice Cell ! !		Harrier Soll Liner	Barrier Soil Liner	Barrier Soil Liner	Barrier Soil Liner	Barrier Soil Liner	Barrier Soil Liner		Harrier Soll Liner	Barrier Soil Liner
Туре	6 Barrier Soil Liner 17	6 Barrier Soil Liner 17	Barrier Soil Liner 17	Barrier Soil Liner 17	Barrier Soil Liner 17	Barrier Soil Liner 17	Barrier Soil Liner 17		17	17	17	17	17	17	17	17
Type Texture No. Thickness (in)	Barrier Soil Liner	Barrier Soil Liner	Barrier Soil Liner	Barrier Soil Liner	Barrier Soil Liner			17 0.24	17 0.24	17 0.24	17 0.24	17 0.24	17 0.24			
Type Texture No. Thickness (in) Erosion Layer	Barrier Soil Liner 17	Barrier Soil Liner 17	Barrier Soil Liner 17	Barrier Soil Liner 17	Barrier Soil Liner 17	17	17	17	0.24	0.24	0.24	0.24	0.24	17 0.24	17 0.24	17 0.24
Type Texture No. Thickness (in)	Barrier Soil Liner 17	Barrier Soil Liner 17	Barrier Soil Liner 17	Barrier Soil Liner 17	Barrier Soil Liner 17	17	17	17						17	17	17
Type Texture No. Thickness (in) Erosion Layer Layer No. Type Texture No.	Barrier Soil Liner 17	Barrier Soil Liner 17	Barrier Soil Liner 17	Barrier Soil Liner 17	Barrier Soil Liner 17	17	17	17	0.24 7 Vertical Percolation 13	0.24 7 Vertical Percolation 13	7 Vertical Percolation 13	0.24 7 Vertical Percolation 13	0.24 11 Vertical Percolation 13	17 0.24 11 Vertical Percolation 13	17 0.24 11 Vertical Percolation 13	17 0.24 11 Vertical Percolation 13
Type Texture No. Thickness (in) Erosion Layer Layer No. Type Texture No. Thickness (in)	Barrier Soil Liner 17	Barrier Soil Liner 17	Barrier Soil Liner 17	Barrier Soil Liner 17	Barrier Soil Liner 17	17	17	17	0.24 7 Vertical Percolation	0.24 11 Vertical Percolation	17 0.24 11 Vertical Percolation	17 0.24 11 Vertical Percolation	17 0.24 11 Vertical Percolation			
Type Texture No. Thickness (in) Erosion Layer Layer No. Type Texture No. Thickness (in) Solid Waste	Barrier Soil Liner 17	Barrier Soil Liner 17	Barrier Soil Liner 17	Barrier Soil Liner 17	Barrier Soil Liner 17	17	17	17	0.24 7 Vertical Percolation 13	0.24 7 Vertical Percolation 13	7 Vertical Percolation 13	0.24 7 Vertical Percolation 13	0.24 11 Vertical Percolation 13	17 0.24 11 Vertical Percolation 13	17 0.24 11 Vertical Percolation 13	17 0.24 11 Vertical Percolation 13
Type Texture No. Thickness (in) Erosion Layer Layer No. Type Texture No. Thickness (in) Solid Waste Layer No. Type	Barrier Soil Liner 17	Barrier Soil Liner 17	Barrier Soil Liner 17	Barrier Soil Liner 17	Barrier Soil Liner 17	17	17	17	0.24 7 Vertical Percolation 13 30 8 Vertical Percolation	0.24 7 Vertical Percolation 13 30 8 Vertical Percolation	0.24 7 Vertical Percolation 13 30 8 Vertical Percolation	0.24 7 Vertical Percolation 13 30 8 Vertical Percolation	0.24 11 Vertical Percolation 13 30 12 Vertical Percolation	17 0.24 11 Vertical Percolation 13 30 12 Vertical Percolation	17 0.24 11 Vertical Percolation 13 30 12 Vertical Percolation	17 0.24 11 Vertical Percolation 13 30 12 Vertical Percolation
Type Texture No. Thickness (in) Erosion Layer Layer No. Type Texture No. Thickness (in) Solid Waste Layer No. Type Texture No.	Barrier Soil Liner 17	Barrier Soil Liner 17	Barrier Soil Liner 17	Barrier Soil Liner 17	Barrier Soil Liner 17	17	17	17	0.24 7 Vertical Percolation 13 30 8 Vertical Percolation 18	0.24 7 Vertical Percolation 13 30 8 Vertical Percolation 18	0.24 7 Vertical Percolation 13 30 8 Vertical Percolation 18	0.24 7 Vertical Percolation 13 30 8 Vertical Percolation 18	0.24 11 Vertical Percolation 13 30 12 Vertical Percolation 18	17 0.24 11 Vertical Percolation 13 30 12 Vertical Percolation 18	17 0.24 11 Vertical Percolation 13 30 12 Vertical Percolation 18	17 0.24 11 Vertical Percolation 13 30 12 Vertical Percolation 18
Type Texture No. Thickness (in) Erosion Layer Layer No. Type Texture No. Thickness (in) Solid Waste Layer No. Type Texture No. Type Texture No. Thickness (in)	Barrier Soil Liner 17 0.24	Barrier Soil Liner 17 0.24	Barrier Soil Liner 17 0.24	Barrier Soil Liner 17 0.24	Barrier Soil Liner 17 0.24	17 0.24	17 0.24	17 0.24	0.24 7 Vertical Percolation 13 30 8 Vertical Percolation 18 186	0.24 7 Vertical Percolation 13 30 8 Vertical Percolation 18 408	0.24 7 Vertical Percolation 13 30 8 Vertical Percolation 18 444	0.24 7 Vertical Percolation 13 30 8 Vertical Percolation 18 192	0.24 11 Vertical Percolation 13 30 12 Vertical Percolation 18 186	17 0.24 11 Vertical Percolation 13 30 12 Vertical Percolation 18 408	17 0.24 11 Vertical Percolation 13 30 12 Vertical Percolation 18 444	17 0.24 11 Vertical Percolation 13 30 12 Vertical Percolation 18 192
Type Texture No. Thickness (in) Erosion Layer Layer No. Type Texture No. Thickness (in) Solid Waste Layer No. Type Texture No. Thickness (in) Average Percolation Through Liner (ct/yr) Max Head on Liner (in/day)	Barrier Soil Liner 17 0.24	Barrier Soil Liner 17 0.24 0.004 0.139	Barrier Soil Liner 17 0.24	Barrier Soil Liner 17 0.24	Barrier Soil Liner 17 0.24 0.001 0.000	0.24 0.004 0.000	0.004 0.000	0.24 0.004 0.000	0.24 7 Vertical Percolation 13 30 8 Vertical Percolation 18 186 0.004 0.139	0.24 7 Vertical Percolation 13 30 8 Vertical Percolation 18 408 0.004 0.116	0.24 7 Vertical Percolation 13 30 8 Vertical Percolation 18 444 0.004 0.113	0.24 7 Vertical Percolation 13 30 8 Vertical Percolation 18 192 0.004 0.115	0.24 11 Vertical Percolation 13 30 12 Vertical Percolation 18 186 0.001 0.000	17 0.24 11 Vertical Percolation 13 30 12 Vertical Percolation 18 408 0.002 0.006	17 0.24 11 Vertical Percolation 13 30 12 Vertical Percolation 18 444 0.002 0.006	17 0.24 11 Vertical Percolation 13 30 12 Vertical Percolation 18 192 0.002 0.006
Type Texture No. Thickness (in) Erosion Layer Layer No. Type Texture No. Thickness (in) Solid Waste Layer No. Type Texture No. Type Texture No. Type Texture No. Thickness (in) Average Percolation Through Liner (ct/yr)	Barrier Soil Liner 17 0.24	Barrier Soil Liner 17 0.24	Barrier Soil Liner 17 0.24	Barrier Soil Liner 17 0.24	Barrier Soil Liner 17 0.24	0.004	17 0.24	17 0.24	0.24 7 Vertical Percolation 13 30 8 Vertical Percolation 18 186 0.004	0.24 7 Vertical Percolation 13 30 8 Vertical Percolation 18 408 0.004	0.24 7 Vertical Percolation 13 30 8 Vertical Percolation 18 444 0.004	0.24 7 Vertical Percolation 13 30 8 Vertical Percolation 18 192 0.004	0.24 11 Vertical Percolation 13 30 12 Vertical Percolation 18 186 0.001	17 0.24 11 Vertical Percolation 13 30 12 Vertical Percolation 18 408 0.002	17 0.24 11 Vertical Percolation 13 30 12 Vertical Percolation 18 444 0.002	17 0.24 11 Vertical Percolation 13 30 12 Vertical Percolation 18 192 0.002

APPENDIX C MULTIMED MODEL ANALYSIS



APPENDIX C.3 MULTIMED SOURCE-SPECIFIC DATA



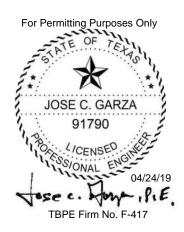
MULTIMED SOURCE - SPECIFIC DATA

Variable Name	Units	Value	Comments
Infiltration rate	m/yr	varies	See table below.
Area of waste disposal unit	m^2	485,623	120 acres
Spread of contaminant source	m	0	Derived by MULTIMED
Recharge rate	m/yr	0.0368	Five percent of average annual precipitation (1.45 inches/yr)
Initial concentration at landfill (C ₀)	mg/L	1.0	Set at 1.0 to find DAF
Length scale of facility	m		Derived by MULTIMED
Width scale of facility	m		Derived by MULTIMED

Case	Infiltration	Comments
5335	Rate (m/yr)	30
Interim cases with Alternative Liner		
• 58.80 feet of waste (Case 1)	7	Calculated using peak daily percolation/
20 yr	*1.28 x 10 ⁻⁷	leakage rate through GCL. See Appx. B.2
• 143.96 feet of waste (Case 2)		Calculated using peak daily percolation/
20 yr	1.79 x 10 ⁻⁷	leakage rate through GCL. See Appx. B.2
,		
• 153.83 feet of waste (Case 3)		Calculated using peak daily percolation/
20 yr	1.79 x 10 ⁻⁷	leakage rate through GCL. See Appx. B.2
• 160.83 feet of waste (Case 4)		Calculated using peak daily percolation/
20 yr	1.79 x 10 ⁻⁷	leakage rate through GCL. See Appx. B.2
20 yi	1.79 % 10	leakage rate tillough GCL. See Appx. B.2
Closed cases with Alternative Liner		
50.00 () () () ()		
• 58.80 feet of waste (Case 5)	5 44 40 ⁻⁸	Calculated using peak daily percolation/
30 yr	5.11 x 10 ⁻⁸	leakage rate through GCL. See Appx. B.2
• 143.96 feet of waste (Case 6)		Calculated using peak daily percolation/
30 yr	5.11 x 10 ⁻⁸	leakage rate through GCL. See Appx. B.2
• 153.83 feet of waste (Case 7)	_	Calculated using peak daily percolation/
30 yr	5.11 x 10 ⁻⁸	leakage rate through GCL. See Appx. B.2
• 160.83 feet of waste (Case 8)		Calculated using peak daily percolation/
30 yr	5.11 x 10 ⁻⁸	leakage rate through GCL. See Appx. B.2
50 y.	3.11 × 10	realings rate through Get. See Appl. B.2
1		

^{*} Determined Using Peak Daily Percolation/Leakage Rate Through GCL and Converted to (M/YR) Example: $((.00005 \, \text{FT}^3/\text{Day-Acre})x(1 \, \text{Acre}/43,560 \, \text{FT}^2)/(1 \, \text{Meter}/3.28 \, \text{FT})) \times (365 \, \text{Days}/1 \, \text{YR}) = 1.28 \, \text{x} \, 10^{-7} \, \text{M/YR}$

APPENDIX C.4 MULTIMED SOURCE-SPECIFIC DATA



MULTIMED SOURCE - SPECIFIC DATA

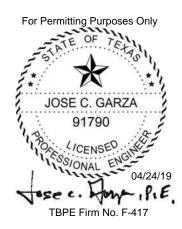
Overliner Demonstration

Variable Name	Units	Value	Comments
Infiltration rate	m/yr	varies	See table below.
Area of waste disposal unit	m ²	485,623	120 acres
Spread of contaminant source	m	0	Derived by MULTIMED
Recharge rate	m/yr	0.0368	Five percent of average annual precipitation (1.45 inches/yr)
Initial concentration at landfill (C ₀)	mg/L	1.0	Set at 1.0 to find DAF
Length scale of facility	m		Derived by MULTIMED
Width scale of facility	m		Derived by MULTIMED

Case	Infiltration	Comments
	Rate (m/yr)	
Interim Cases with Overliner		
Location 1 (Case 1OL)		
• 12 feet of waste above liner		
• 15.5 feet of waste below liner		Calculated using peak daily percolation/
20 yr	*1.79 x 10 ⁻⁷	leakage rate through GCL. See Appx. B.12
20 yi	1.75 × 10	leakage rate through GCL. See Appx. B.12
Location 2 (Case 2OL)		
82.5 feet of waste above liner		
34 feet of waste below liner		Calculated using peak daily percolation/
20 yr	1.53 x 10 ⁻⁷	leakage rate through GCL. See Appx. B.12
·		
Location 3 (Case 3OL)		
85.5 feet of waste above liner		
37 feet of waste below liner		Calculated using peak daily percolation/
20 yr	1.53 x 10 ⁻⁷	leakage rate through GCL. See Appx. B.12
Location 4 (Case 4OL)		
• 119.5 feet of waste above liner		
16 feet of waste below liner	_	Calculated using peak daily percolation/
20 yr	1.53 x 10 ⁻⁷	leakage rate through GCL. See Appx. B.12
Closed cases with Overliner		
Location 1 (Case 5OL)		
• 12 feet of waste above liner		
• 15.5 feet of waste below liner		Calculated using peak daily percolation/
30 yr	5.11 x 10 ⁻⁸	leakage rate through GCL. See Appx. B.12
Location 2 (Case 6OL)		
• 82.5 feet of waste above liner		
• 34 feet of waste below liner		Calculated using peak daily percolation/
30 yr	5.11 x 10 ⁻⁸	leakage rate through GCL. See Appx. B.12
30 yı	J.11 × 10	Teamage rate timough Oct. See Appr. 5.12
Location 3 (Case 7OL)		
85.5 feet of waste above liner		
37 feet of waste below liner		Calculated using peak daily percolation/
30 yr	5.11 x 10 ⁻⁸	leakage rate through GCL. See Appx. B.12
Location 4 (Case 8OL)		
• 119.5 feet of waste above liner		
16 feet of waste below liner		Calculated using peak daily percolation/
30 yr	5.11 x 10 ⁻⁸	leakage rate through GCL. See Appx. B.12

^{*} Determined Using Peak Daily Percolation/Leakage Rate Through GCL and Converted to (M/YR) Example: $((.00007 \text{ FT}^3/\text{Day-Acre})x(1 \text{ Acre}/43,560 \text{ FT}^2)/(1 \text{ Meter}/3.28 \text{ FT})) \times (365 \text{ Days}/1 \text{ YR}) = 1.79 \times 10^{-7} \text{ M/YR}$

APPENDIX C.6 MULTIMED SOURCE-SPECIFIC DATA



MULTIMED AQUIFER - SPECIFIC DATA

Variable Name	Units	Value	Comments
Particle Diameter*	cm	0.0381	From Permit 235-B Amendment Volume II of V
			Pages 36-39 (PDF)-1998
			Reference Appendix C.7.2
			Material ranges from fine to coarse. Use an average
			for medium sand (0.010-0.020 in); 0.015 in or 0.0381 cm
Aquifer porosity*	unitless	0.43	From Permit 235-B Amendment Volume V of V
			Pages 467-473 (PDF)-1998
			Reference Appendix C.7.1
Bulk density	g/cc	1.65	From Permit 235-B Amendment Volume V of V
			Pages 467-473 (PDF)-1998
			Reference Appendix C.7.1
Aquifer thickness	m	10	From Permit 235-B Amendment Volume V of V Pgs.
			467-473 (PDF)-1998 Avg depth of uppermost aquifer
			Reference Appendix C.7.1
Mixing zone depth	m		Derived by MULTIMED
Hydraulic conductivity	m/yr	130	From Permit 235-B Amendment Volume V of V
			Pages 467-473 (PDF)-1998
			Reference Appendix C.7.1
			Average hydraulic conductivity of 4.12 x 10 ⁻⁴ cm/sec
Hydraulic gradient	unitless	0.0031	From Groundwater Contour Map (January 2016)
Groundwater seepage velocity	m/yr		Derived by MULTIMED
Retardation coefficient	unitless		Derived by MULTIMED
Longitudinal dispersivity	m		Derived by MULTIMED
Transveral dispersivity	m		Derived by MULTIMED
Vertical dispersivity	m		Derived by MULTIMED
Organic carbon content	%	0.003	From Permit 235-B Amendment Volume V of V
			Pages 467-473 (PDF)-1998
			Reference Appendix C.7.1
Receptor distance from well	m	Varies	Distance from analysis location to point of
			compliance.
Z-distance from water table	m	0	Assume water table is at bottom of liner.

^{*} If Aquifer porosity is known MULTIMED will not use particle diameter.

APPENDIX C.7 MULTIMED SOURCE-SPECIFIC DATA



MULTIMED AQUIFER - SPECIFIC DATA

Overliner Demonstration

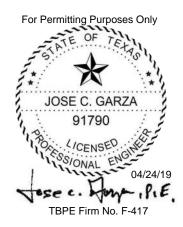
Variable Name	Units	Value	Comments
Particle Diameter*	cm	0.0381	From Permit 235-B Amendment Volume II of V
			Pages 36-39 (PDF)-1998
			Reference Appendix C.7.2
			Material ranges from fine to coarse. Use an average
			for medium sand (0.010-0.020 in); 0.015 in or 0.0381 cm
Aquifer porosity*	unitless	0.43	From Permit 235-B Amendment Volume V of V
			Pages 467-473 (PDF)-1998
			Reference Appendix C.7.1
Bulk density	g/cc	1.65	From Permit 235-B Amendment Volume V of V
			Pages 467-473 (PDF)-1998
			Reference Appendix C.7.1
Aquifer thickness	m	10	From Permit 235-B Amendment Volume V of V Pgs.
			467-473 (PDF)-1998 Avg depth of uppermost aquifer
			Reference Appendix C.7.1
Mixing zone depth	m		Derived by MULTIMED
Hydraulic conductivity	m/yr	130	From Permit 235-B Amendment Volume V of V
			Pages 467-473 (PDF)-1998
			Reference Appendix C.7.1
			Average hydraulic conductivity of 4.12 x 10 ⁻⁴ cm/sec
Hydraulic gradient	unitless	0.002	From Groundwater Contour Map (January 2016)
Groundwater seepage velocity	m/yr		Derived by MULTIMED
Retardation coefficient	unitless		Derived by MULTIMED
Longitudinal dispersivity	m		Derived by MULTIMED
Transveral dispersivity	m		Derived by MULTIMED
Vertical dispersivity	m		Derived by MULTIMED
Organic carbon content	%	0.003	From Permit 235-B Amendment Volume V of V
			Pages 467-473 (PDF)-1998
			Reference Appendix C.7.1
Receptor distance from well	m	Varies	Distance from analysis location to point of
			compliance.
Z-distance from water table	m	0	Assume water table is at bottom of liner.

^{*} If Aquifer porosity is known MULTIMED will not use particle diameter.

APPENDIX D CALCULATIONS OF THE DILUTION ATTENUATION FACTOR (DAF)



APPENDIX D CALCULATIONS OF THE DILUTION ATTENUATION FACTOR (DAF)



CALCULATIONS OF THE DILUTION ATTENUATION FACTOR

Example Calculation for the Interim Case with Alternative Liner

Result from MULTIMED model:

Chemical concentration at the point of compliance = 0.2449 X 10⁻⁴ mg/l (see MULTIMED model output)

To find the resulting DAF, take the recipricol:

DAF= 1/0.2449 X 10⁻⁴ mg/1

DAF= 40,833

Table 1

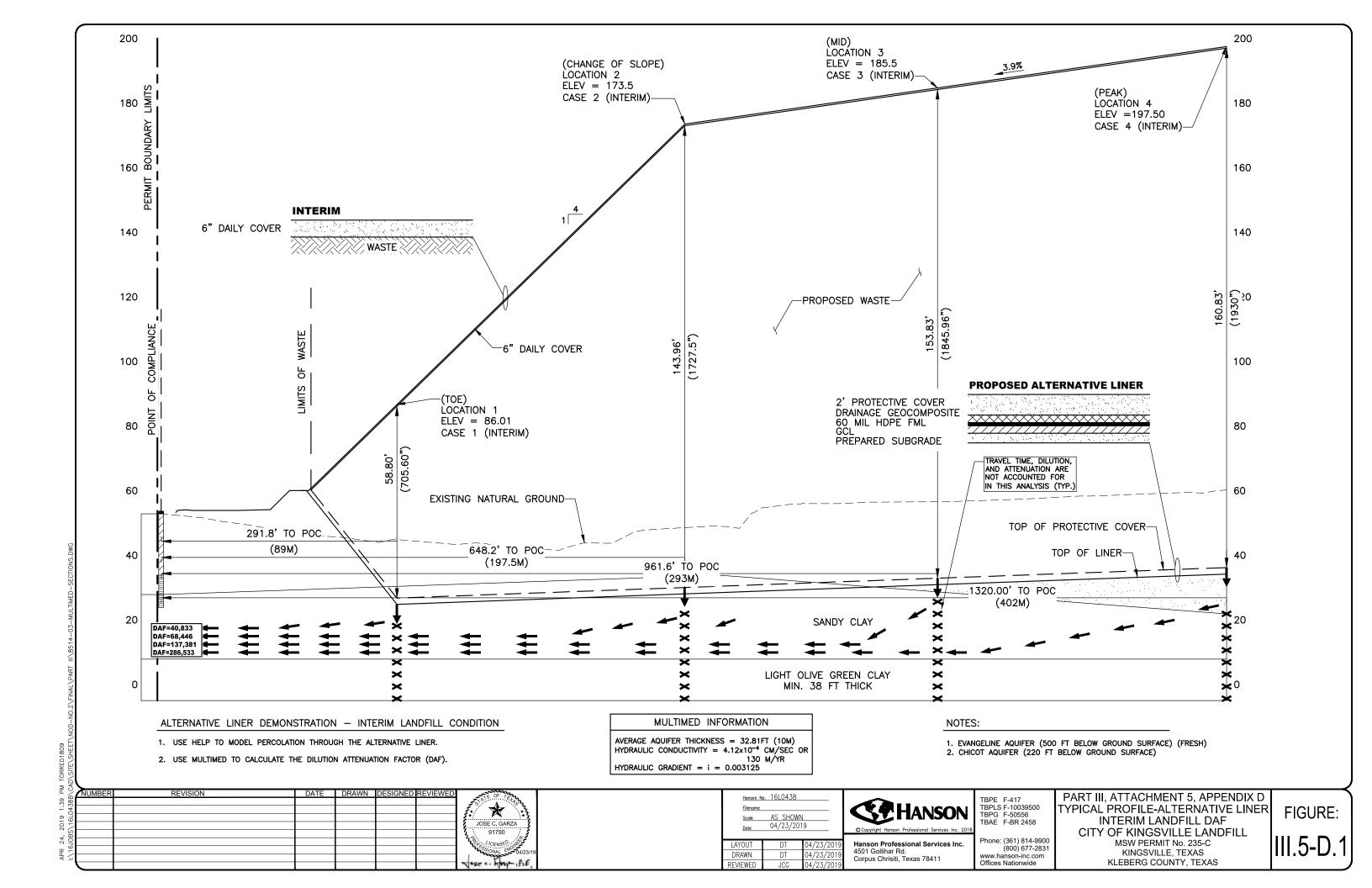
Location	Interim Case DAF	Closed Case DAF
Alternative Liner Location 1	40,833	102,301
Alternative Liner Location 2	68,446	239,750
Alternative Liner Location 3	137,381	481,231
Alternative Liner Location 4	286,533	1,003,814

Location	Interim Case DAF	Closed Case DAF
Overliner Location 1	18,797	65,833
Overliner Location 2	77,640	232,450
Overliner Location 3	158,253	473,934
Overliner Location 4	615,385	1,842,639

Part III, Attachment 5, Appendix D, p.g.-1

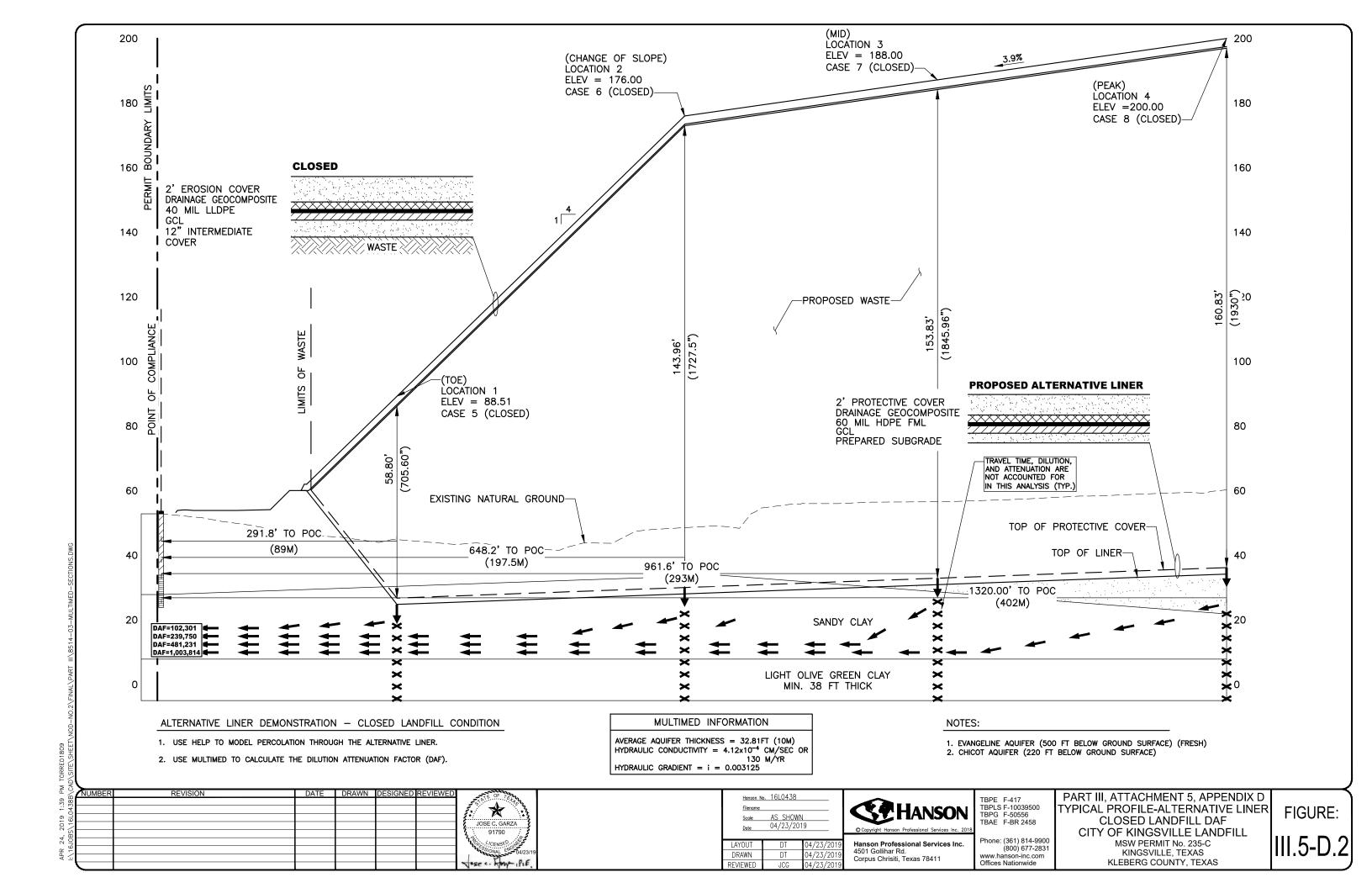
APPENDIX D.1 TYPICAL PROFILE-ALTERNATIVE LINER INTERIM LANDFILL DAF





APPENDIX D.2 TYPICAL PROFILE-ALTERNATIVE LINER CLOSED LANDFILL DAF

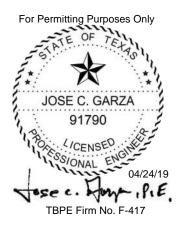




APPENDIX F MULTIMED MODEL OUTPUT



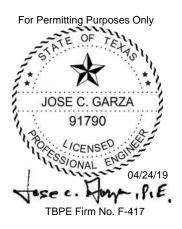
APPENDIX F.1 MULTIMED OUTPUT FOR ALTERNATIVE LINER INTERIM CASE 1LOCATION 1



								LIMITS MIN MAX	0.000E+00 0.100E+11 0.000E+00 0.100E+11 0.000E+00 0.100E+11 0.000E+00 0.999. 0.000E+00 0.999. 0.000E+00 0.999. 0.000E+00 0.100E+11 0.000E+00 0.100E+11 0.000E+00 0.100E+11 0.000E+00 0.100E+11 0.000E+00 10.0
ON AGENCY							នា	PARAMETERS MEAN STD DEV	0.000E+00 -999. 0.000E+00 -999. 0.000E+00 -999. 0.000E+00 -999. 0.000E+00 -999. 20.0 -999. 0.000E+00 -999. 0.000E+00 -999. 0.000E+00 -999. 0.000E+00 -999. 0.000E+00 -999.
CASE1R PROTECTIO	SSESSMENT IA MODEL	(Version 1.01, June 1991)					CHEMICAL SPECIFIC VARIABLES	DISTRIBUTION	CONSTANT
R ↑ A	URE A IMED	(Version				ne model	CHEMICA	UNITS	1/yr 1/yr 1/yr 1/yr 1/m-yr C m1/g 1/yr Cm2/s C g/M mu Hg atm-m^3/M
1 U.S. ENVIRONME	EXPOSI	MULTIMED	I Run options	Case 1	Location 1 Chemical simulated is DEFAULT CHEMICAL	Option Chosen Run was Infiltration input by user Run was steady-state Reject runs if Y coordinate outside plume Reject runs if Z coordinate outside plume Reject runs if Z coordinate outside plume 1 1 1		VARIA	Solid phase decay coefficient Dissolved phase decay coefficient Overall chemical decay coefficient Acid catalyzed hydrolysis rate Neutral hydrolysis rate constant Base catalyzed hydrolysis rate Normalized distribution coefficient Distribution coefficient Biodegradation coefficient Biodegradation coefficient Reference temperature for air diffusion Molecular weight Mole fraction of solute Vapor pressure of solute Henry's law constant

SQURCE SPECIFIC VARIABLES NUMBER SQURCE SPECIFIC VARIABLES NUMBER STD DEV NUMBER NUMBER STD DEV STD SET STD DEV STD SET	ı) }
The control of the		SOURC	E SPECIFIC VARIABLES				
## CONSTANT 0.128E-06 -999. 0.1086-09 ## CONSTANT 0.486E406 -999. 0.1086-09 ## CONSTANT 0.486E406 -999. 0.1086-08 ## CONSTANT 0.486E406 -999. 0.1086-08 ## CONSTANT 0.486E406 -999. 0.1086-08 ## CONSTANT 0.486E40 -999. 0.080E40 ## DERIVED -999999. 0.080E40 ## DERIVED -999999. 0.108E-08 ## DERIVED -999999. 0.108E-08 ## DERIVED -999999. 0.108E-08 ## CONSTANT 0.438 -999. 0.108E-08 ## CONSTANT 0.438 -999. 0.108E-08 ## CONSTANT 0.438 -999. 0.108E-08 ## CONSTANT 1.65 -999. 0.108E-08 ## Myr CONSTANT 1.65 -999. 0.108E-08 ## HINCTION OF X -999999. 1.08 ## FUNCTION OF X -999999. 0.108E-09 ## CONSTANT 7.26 -999. 0.909. ## FUNCTION OF X -999999. 0.108E-09 ## CONSTANT 7.26 -999. 0.909 ## CONSTANT 8.30E-02 ## CONSTANT 8.30E-02 ## CONSTANT 8.30	VARIABLE NAME	UNITS	DISTRIBUTION	PARAME MEAN	TERS STD DEV	1	;
## CONSTANT 0.1226-00-00-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-		****	**************************************		000	04-040- A	- 1000H+11
## CONSTANT -999999. 0.1006E-08 ## DERIVED -999999. 0.1006E-08 ## DERIVED -999999. 0.1006E-08 ## CONSTANT 0.368E-01-999. 0.000E+00 ## CONSTANT 1.06 -999. 0.000E+00 ## DERIVED -999999. 0.100E-08 ## DERIVED -999999. 0.100E-08 ## DERIVED -999999. 0.100E-08 ## CONSTANT 0.430 -999. 0.100E-08 ## CONSTANT 0.430 -999. 0.100E-08 ## CONSTANT 10.0 -999. 0.100E-08 ## DERIVED -999999. 0.100E-09 ## FUNCTION OF X -999999. 0.100E-09 ## FUNCTION OF X -999999. 0.100E-09 ## CONSTANT 7.26 -999. 0.100E-09 ## CONSTANT 7.26 -999. 0.100E-09 ## CONSTANT 7.26 -999. 0.000E+00 ## CONSTANT 7.26 -999. 0.100E-09 ## CONSTANT 7.20 -999. 0.100E-09 ## CONSTANT 7.20 -999. 0.100E-09 ## CONSTANT 8.30E-02-999. 0.000E-09	htilthation rate 16to directlyit	17 V T	TNATZNOO		000	8.100E-01	-999.
## DERIVED -999999. 0.100E-08 ### CONSTANT 0.808E-01 -999. 0.000E+00 #### CONSTANT 0.006E+00 -999. 0.000E+00 ###################################	ted of waste atsposal units	N (CONSTANT	-666-	-999-	9.100E-08	566
## CONSTANT 0.368E-01 -999. 0.000E+00 1/yr CONSTANT 0.368E-01 -999. 0.000E+00 0.000E+00 0.999. 0.000E+00 0.000E+00 0.999. 0.000E+00 0.000E+00 0.999. 0.000E+00 0.999. 0.000E+00 0.000E+00 0.999. 0.000E+00 0.0	Fation of purse	× E	DERTVED	666-	-666	9.100E-08	0.100E+11
Jandfill	read of containing to source	m/yr	CONSTANT	0.368E-01	-999,	9.000E+00	0.100E+11
Jandfill mg/l CONSTANT 1.00 -999. 0.000E+00	לייויים איניים א	1,7	CONSTANT	0 BOBE+88	-666	8.888E+88	-666-
DERIVED		1, ya	FMATANCO	1-98	1000	0.800E+90	- 666-
## DERIVED -999999. 6.100E-08 BELIVED DERIVED 1.00 0.000E+00 0.		1 1 1	1000 C	000	-000	A 198F-98	A. 199F+11
ME DERIVED -999999. 0.100R=400	ngth scale of racility	E	DENIVED			00 1001 0	O TOOPTA
BLE NAWE BLE NAWE BLE NAWE CONSTANT CONSTANT CONSTANT CONSTANT B.38E-01-999. CONSTANT CONSTANT CONSTANT CONSTANT CONSTANT CONSTANT CONSTANT CONSTANT B.310E-02-999. CONSTANT CONST	oth scale of tacility ar field dilution	E	DERIVED	1.86	9.888E+88	0.000E+00	1.00
MEAN STD DEV MIN MIN MIN MIN MIN	VARIABLE NAME	UNITS	DISTRIBUTION	PARAME		IMI	:
CONSTANT 6.381E-01 -999. 6.100E-08 - CONSTANT 1.65 -999. 6.100E-08 E/C CONSTANT 1.65 -999. 6.100E-08 (mixing zone depth) m DERIVED -999999. 6.100E-08 icaulic) m/yr CONSTANT 130999. 6.100E-08 icaulic) m/yr CONSTANT 130999. 6.100E-08 icient DERIVED -999999. 6.100E-07 icient DERIVED -999999. 6.100E-07 icient DERIVED -999999. 6.100E-07 icient DERIVED -999999. 6.100E-07 icient CONSTANT 2.1.0 -999999. 6.100E-08 m FUNCTION OF X -999999999. 6.100E-08 might CONSTANT 2.1.0 -999. 6.100E-05 m FUNCTION OF X -999999. 6.100E-05 might CONSTANT 8.300E-02 -999. 6.100E-05 m site degree CONSTANT 8.300E-02 -999. 7.00 m constant degree CONSTANT 8.000E+00 -999. 6.000E+00 m site degree CONSTANT 8.000E+00 -999. 6.000E+00				MEAN	STD DEV	NHE SHE	MAX
CONSTANT 0.436 -999 0.100E-08		, , , , ,	CONSTANT	0.381E-01	-999.	9.190E-08	169.
S		:	CONSTANT	6,430	-666-	9.100E-08	9.99
e depth) m CONSTANT 10.0 -999. 0.1006-08 CONSTANT 12.0 -999. 0.1006-08 CONSTANT 130999. 0.1006-08 CONSTANT 130999. 0.1006-08 CONSTANT 130999. 0.1006-06 CONSTANT 0.3106-02 -999. 0.1006-07 CONSTANT 0.999999. 0.1006-09	013.01 PO 041.0	9/00	CONSTANT	1,65	.999.	8.188E-01	5.88
e depth) m DERIVED -999999. 0.1006E-08 CONSTANT 130999. 0.1006E-08 CONSTANT 130999. 0.1006E-08 CONSTANT 0.310E-02 -999. 0.100E-07 DERIVED -999999. 0.100E-09 DERIVED -999999. 1.00 The FUNCTION OF X -999999. 1.00 The FUNCTION OF X -999999999. 0.999. 0.999. CONSTANT 21.0 -999. 0.300 The CONSTANT 0.300E-02 -999. 0.100E-03 CONSTANT 0.000E+00 0.300 The CONSTANT 0.000E+00 0.00	infer thickness	i i E	CONSTANT	10.0	-666-	0.100E-08	0.100E+06
m/yr CONSTANT 130, -999, 0.100E-06 CONSTANT 0.310E-02 -999, 0.100E-07 n/yr DERIVED -999, -999, 0.100E-07 n/yr DERIVED -999, -999, 0.100E-09 n FUNCTION OF X -999, -999, -999, n FUNCTION OF X -999, -999, -999, n FUNCTION OF X -999, -999, -999, 0.999, 0.00STANT 0.300E-02 -999, 0.300E-03 n CONSTANT 0.300E-02 -999, 0.300E-03 n CONSTANT 0.000E+00 -999, 0.000E+00 n CONSTANT 0.000E+00 n		=	DERIVED	-999.	-666-	Q.100E-08	9.100E+86
CONSTANT 0.310E-02 -999. 0.100E-07 m/yr DERIVED -999999. 0.100E-09 m FUNCTION OF X -999999999. m FUNCTION OF X -999999999. CONSTANT 21.6 -999999. CONSTANT 7.26 -999. 0.300E-00 CONSTANT 0.300E-02 -999. 0.300E-03 m CONSTANT 0.300E-02 -999. 0.300E-03 m CONSTANT 0.300E-03 -999. 0.300E-03 m CONSTANT 0.300E-03 -999. 0.300E-03 m CONSTANT 0.000E+00 0.000E+00 m CONSTANT 0.000E+00 0.000E+00		m/yr	CONSTANT	130.	.999.	0.100E-06	0.100E+09
m/yr DERIVED -999, -999, 0.100E-09 DERIVED -999, -999, 1.000 FUNCTION OF X -999, -999, -999, 1.000 FUNCTION OF X -999, -999, -999, -999, CONSTANT 7.20 -999, 0.300 -900 -900 -999, 0.300 -900 -900 -999, 0.300 -900 -900 -900 -900 -900 -900 -900 -	adient (hydraulic)	•	CONSTANT	8.310E-82	-999-	0.100E-07	-666-
tion) DERIVED -999999. 1.00 HUCTION OF X -999999999. FUNCTION OF X -999999999. CONSTANT 21.00 -999999999. CONSTANT 7.20 -999. 0.300 CONSTANT 0.300E-02 -999. 0.300 degree CONSTANT 0.000E+00 -999. 0.000E+00 m CONSTANT 0.000E+00 -999. 0.000E+00 m CONSTANT 0.000E+00 -999. 0.000E+00	coundwater seepage velocity	m/yr	DERIVED	-666	-666-	0.100E-09	0.100E+69
ty m FUNCTION OF X -999,	stardation coefficient	1	DERIVED	-999-	-9 9 9.	1.00	0.100E+09
ty m FUNCTION OF X -999999999 r EUNCTION OF X -999	neitudinal dispersivity	탇	ê	.989.	-666-	-999.	-999
r C CONSTANT 21.6 -99	ansverse dispersivity	æ	Ĥ	-666-	-666-	-666-	-666-
r C CONSTANT 21.6 -999. 0.000E+00 CONSTANT 7.20 -999. 0.300 0.300 cONSTANT 7.20 -999. 0.300 cONSTANT 7.20 -999. 0.300 cONSTANT 0.300E+02 -999. 0.100E-05 1.00 constant 0.000E+00 -999. 0.000E+00 constant 0.000E+00 -999. 0.000E+00 constant 0.000E+00 -999. 0.000E+00	ertical dispersivity	Œ	Н	-999-	-666-	-666-	-996
CONSTANT 7.26 -999. 0.308 (fraction)	emperature of aquifer	U	CONSTANT	21.0	-666-	0.000E+00	100.
(fraction)		;	CONSTANT	7.28	-989-	0.300	14.0
CONSTANT 89.0 -999. 1.00 - degree CONSTANT 8.000E+00 -999. 8.000E+00 -999. 8.000E+00			CONSTANT	0.300E-02	-666-	0.100E-05	1.00
degree CONSTANT 8.000E+00 -999. 0.000E+00 .000E+00 .000E+00 .000E+00 .999. 0.000E+00	Months (M. Verricon)	Ë	CONSTANT	89.0	-939.	1.60	.999
m CONSTANT 9.868E+88 -999. 8.888E+88	off coster	degree	CONSTANT	9.969E+90	-986-	0.000E+00	360.
	ell vertical distance	, E	CONSTANT	9.868E+88	-666	8.886E+98	1.00

APPENDIX F.2 MULTIMED OUTPUT FOR ALTERNATIVE LINER INTERIM CASE 2LOCATION 2



										LIMITS MIN MAX	0.000E+00 0.100E+11 0.000E+00 0.100E+11 0.000E+00 0.100E+11 0.000E+00 0.999. 0.000E+00 0.999. 0.000E+00 0.999. 0.000E+00 0.999. 0.000E+00 0.100E+11 0.000E+00 0.100E+11 0.000E+00 0.100E+11 0.000E+00 0.100E+11 0.000E+00 10.0
	N AGENCY								v	PARAMETERS MEAN STD DEV	6.000E+00 -999. 6.000E+00 -999. 6.000E+00 -999. 6.000E+00 -999. 6.000E+00 -999. 20.0 6.000E+00 -999. 6.000E+00 -999. 6.000E+00 -999. 6.000E+00 -999. 6.000E+00 -999. 6.000E+00 -999.
CASE2R	ROTECTI	SSESSEE	A MODEL	(Version 1.01, June 1991)					CHEMICAL SPECIFIC VARIABLES	DISTRIBUTION	CONSTANT
	ь 4 1	URE AS	IMEDI	(Version				ne model	CHEMICAL	UNITS	1/yr 1/yr 1/yr 1/M-yr 1/yr 1/yr cm2/s C C 8/M mh Hg
	U. S. ENVIRONME	I S O & X B	мигт	MULTIMED	1 Run options 	Case 2	Location 2 Chemical simulated is DEFAULT CHEMICAL	Option Chosen Run was Infiltration input by user Run was steady-state Reject runs if Y coordinate outside plume Reject runs if Z coordinate outside plume Gaussian source used in saturated zone model	c f	VARIABLE NAME	Solid phase decay coefficient Dissolved phase decay coefficient Overall chemical decay coefficient Acid catalyzed hydrolysis rate Neutral hydrolysis rate constant Base catalyzed hydrolysis rate Reference temperature Normalized distribution coefficient Distribution coefficient Biodegradation coefficient Reference temperature for air diffusion Molecular weight Molecular weight Wapor pressure of solute Vapor pressure of solute

	SOURCE	SOURCE SPECIFIC VARIABLES				
VARIABLE NAME UN'	UNITS	DISTRIBUTION	PARAMETERS MEAN STD	STD DEV	LIMITS	TS
4 4 4 5 7	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,					
Infiltration rate	m∕yr	CONSTANT	0.179∄-96		0.100E-03	0.100E+11
Area of waste disposal unit	π^2	CONSTANT	0.486E+06		0.180E-01	.999.
	۲۲	CONSTANT	.666	.6661	0.190E-08	-666-
nant source	\ E	DERIVED	- 666	-888-	0.100E-08	0.100E+11
	u/\/E	TANTANOO	A 368F-61	-666-	8.888E+88	0.100E+11
	10.7	FINALOGO	90,0000		00110000	000
	 		2 20		000000	
Land+111	mg/⊥	CONSTANI	DA -		00-1000-0	
Length scale of facility m	=	DERIVED	-999-	-886-	8.188E-88	6.100E+11
		DERTVED	-666	-999	8.100E-08	0.100E+11
	-	DERIVED	1.00	0.000E+00	9.000E+00	1.00
	AQUIFER	AQUIFER SPECIFIC VARIABLES				
MI CARPORE CONTRACTOR		DISTRIBITION	DARAMETERS	FTERS	STIMIT	TS
	<u>!</u>		MEAN	STD DEV	MIK	MAX
		CONSTANT	0.381E-01	-999.	0.100E-08	100.
_		FIA TOMO	0.00		0 100F-08	900
Sity		ENG ASSOCI	27.7	000	0 100E-01	200
	8/ CC	CONSTANT	T . 0	, 000	0 100L-04	20100
	E	CONSTANT	9 10	-622.	0 1005 00	0010010
Source thickness (mixing zone depth) m	E	DERIVED	6661	D - C	0.100E-08	0.1005-00
	m/yr	CONSTANT	130.		8.100E-00	N. TROPE+03
Gradient (hydraulic)		CONSTANT	8.310E-02		0.100E-07	.000-
velocíty	m/yr	DERIVED	-999,	-999.	0.100E-09	6.160E+69
	: }	DERIVED	-999.	-666-	1.66	9.100E+09
ř	E	Щ 2	-999-	-666-	-666-	-666-
	: £	Ç	.999	-666-	-999	-666-
Ž,	. F		000	5	600	600
	= (5			0010000	900
Temperature of aquiter	J	CONSTANT	۵.12	י את ה היים ה	0-2020-0	
	;	CONSTANT	7.20		9.386	14.0
Organic carbon content (Fraction)		CONSTANT	0.300E-02	.000	0.100E-05	1.00
	6	CONSTANT	197.	-666-	1.88	-999-
a	9	CONSTANT	A. BROE+BB	-666-	9.000E+00	360.
	}	TNATANO	0011000 0		A BABE + BB	200

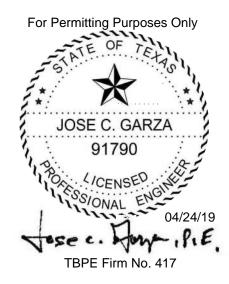
APPENDIX F.3 MULTIMED OUTPUT FOR ALTERNATIVE LINER INTERIM CASE 3LOCATION 3



										LIMITS MAX	6.000E+00 0.100E+11 6.000E+00 0.100E+11 6.000E+00 0.100E+11 6.000E+00 -999. 6.000E+00 -999. 6.000E+00 -999. 6.000E+00 -999. 6.000E+00 -999. 6.000E+00 -999. 6.000E+00 -999. 7.000E+00 -999. 6.000E+00 -999. 7.000E+00 -999. 7.000E+00 -999.
	N AGENCY								ស	PARAMETERS MEAN STD DEV	6.000E+00 -999. 6.000E+00 -999. 6.000E+00 -999. 6.000E+00 -999. 6.000E+00 -999. 799. 6.000E+00 -999.
CASE3R	PROTECTIO	SSESSMENT	IA MODEL	1.01, June 1991)					CHEMICAL SPECIFIC VARIABLËS	DISTRIBUTION	CONSTANT
	MENTAL	OSURE A	LTIMED	MED (Version 1.01,				Saturated zone model DETERMIN Ume model	CHEMICA	SLIND	1/yr 1/yr 1/wr 1/wr 1/wr 1/wr (c m1/g sion C g/M sion C
	I U.S. ENVIRON	л У	Σ	MULTIMED	1 Run options 	Case 3	Location 3 Chemical simulated is DEFAULT CHEMICAL	Option Chosen Run was Infiltration input by user Run was steady-state Reject runs if Y coordinate outside pl Reject runs if Z coordinate outside pl Gaussian source used in saturated zone	ન સ્મ	VARIABLE NAME	Solid phase decay coefficient Dissolved phase decay coefficient Overall chemical decay coefficient Overall chemical decay coefficient Acid catalyzed hydrolysis rate Neutral hydrolysis rate Normalized distribution coefficient Distribution coefficient Biodegradation coefficient Air diffusion coefficient Reference temperature for air diffusion Molecular weight Mole fraction of solute Vapor pressure of solute Henry's law constant

AME unit source	SOURCE UNITS UNITS W/Yr m/yr m/yr m/yr m/yr m/yr AQUIFER AQUIFER	SOURCE SPECIFIC VARIABLES IIS DISTRIBUTION /yr CONSTANT //yr CONSTANT //////////////////////////////////		TERS STD DEV -999.	MIN 0.100E-09 0.100E-09 0.100E-08 0.000E+00 0.000E+00 0.100E-08 0.100E-08 0.000E+00 0.000E-08 0.100E-08	TS MAX 0.108E+11 -999. 0.108E+11 -999. 0.100E+11 0.100E+11 1.00
WAME unit source	units m/yr m/yr m/yr 1/yr mg/l m m m	1 !	1-05 1-06 1-06 1-03 1-03	TERS STD DEV -999. -999. -999. -999. -999. -999. -999. STD DEV	MIN 0.100E-09 0.100E-09 0.100E-09 0.000E+00 0.000E+00 0.000E+00 0.100E-08 0.000E+00	TS MAX 0.100E+11 -999. 0.100E+11 0.100E+11 -999. 0.100E+11 1.00
Infiltration rate Area of waste disposal unit Auration of pulse Spread of contaminant source techarge rate Source decay constant	m/yr m/yr 1/yr mg/l m m m		1-96 1-91 1-92 1-93 1-93 1-93 1-93 1-93 1-93 1-93 1-93	-999. -999. -999. -999. -999. -999. -999. -999. -999. -999. -999. -999.	0.100E-09 0.100E-09 0.100E-08 0.100E-08 0.000E+00 0.000E+00 0.100E-08 0.100E-08	0.100E+11 -999. 0.100E+11 0.100E+11 -999. 0.100E+11 1.00
Infiltration rate Area of waste disposal unit Duration of pulse Spread of contaminant source Recharge rate	m/yr yr 1/yr mg/l m m n AQUIFER		1-81 1-81 1-81	-999. -999. -999. -999. -999. -999. -999. -999. -999. -999. -999.	0.199E-91 0.199E-93 0.199E-93 0.000E+00 0.000E+00 0.160E-08 0.160E-08	-999. -999. 0.100E+11 0.100E+11 -999. 0.100E+11 1.00
Area of waste disposal Unit Duration of pulse Spread of contaminant source Recharge rate Source decay constant	m'yr 1/yr mg/l m AQUIFER	· · · · · · · · · · · · · · · · · · ·	61 +- 62 +- 63 61	-999. -999. -999. -999. -999. -999. -999. -999. -999. -999.	0.199E-98 0.199E-98 0.090E+90 0.090E+90 0.190E-08 0.190E-08	999. 9.180E+11 9.180E+11 -999. 6.180E+11 1.80
	m/yr 1/yr mg/l m m AQUIFER		E-61	-999- -99- -	0.199E-98 0.000E+00 0.000E+00 0.100E-08 0.100E-08	0.100E+11 0.100E+11 -999. -999. 0.100E+11 1.80
	m/yr 1/yr mg/l m m AQUIFER		E+80	-999- -99- -99-	0.000E+00 0.000E+00 0.000E+08 0.100E-08 0.000E+00	0.100E+11 -999. -999. 0.100E+11 1.00
constant	m/yr mg/l m m n AQUIFER			999. 999. 9999. 9999. 9.000E+80	0.000E-00 0.000E-00 0.100E-00 0.000E+00	-999. -999. 6.180E+11 1.80 1.80
	1/yr mg/l m m AQUIFER UNITS			-999. -999. -999. 0.806E+80	0.000E-08 0.100E-08 0.100E-08 0.000E-08	-959. -999. 6.100E+11 1.00 1.00
	mg/l m AQUIFER	!	A PARAME	-999. -999. -999. 0.000E+80	0.000E+00 0.100E-08 0.000E+08 0.000E+00	-999. 6.1006+11 1.00 1.70
Initial concentration at landfill	AQUIFER		A PARAME	-999. -999. 0.000E+80	0.160E-08 0.160E-08 0.080E+00	6.100E+11 0.100E+11 1.00 1.00
	AQUIFER		N N N N N N N N N N N N N N N N N N N	-999. 0.000E+00 TERS	0.000E-08 0.000E+00	0.100E+11 1.00 1.00 7.5 MAX
	AQUIFER	DERIVED SPECIFIC VARIABLES DISTRIBUTION	ARAME	0.000E+80	0.080E+00	1.80 TS MAX
Width state of Tacilly Near field dilution	AQUIFER UNITS	SPECIFIC VARIABLES DISTRIBUTION	PARAME	TERS STD DEV	i -	į
	UNITS	DISTRIBUTION	PARAME MEAN	TERS STD DEV		
VARIABLE NAME			MEAN	STD DEV	MTM	MAX
					H71.	
Particle diameter	5	CONSTANT	0.381E-01	.999,	9.100E-08	186.
Annithen norneitv	;	CONSTANT	0.430	-999.	0.100E-08	966.0
CART OF THE COLUMN	B/CC	CONSTANT	1.65	.999.	0.100E-01	5.00
Open Company of the Chapter of the C	; d) e	CONSTANT	10.6	.999	0.100E-08	0.100E+06
Course thickness (mixing your death)	· E	DERIVED	-666	-999.	0.100E-08	0.100E+06
COOLING CIRCUIDAD (SELVERIA NOTIONAL SELVENIA)	#/vr	TANTANO	130.	-666	9.100E-05	0.100E+09
Conductivity (by defect)		CONSTANT	9.318E-82	-999.	0.100E-07	.999.
Carperty designation and professional profes	4//6	DERTVED	- 666	-999.	0.100E-09	0.100E+09
Carbon Land Color of the Color of the Carbon Land Color of the Color o		CHYTHE	666	-999	1.68	0.100E+09
Ketaraattoi toeti ittiait	ı e		555	-999	666	.0001
Longatus unspension	5 8		000	000	666-	-999
Fransverse alspersively	3 1		. 000	000	000	000
Vertical dispersivity	≣ (0000	
Temperature of aquifer	ن	CONSTANT	0 · 4 · 6		ממשבשמים	• • • • • • • • • • • • • • • • • • •
	ļ	CONSTANT	7.20	.888.	9.500	0.41
Organic carbon content (fraction)		CONSTANT	0.300E-02	- 656-	8.188E-85	1.50
Well distance from site	E	CONSTANT	293.	-000	1.66	-866-
	egree	CONSTANT	0.000E+00	-666-	9.000E+00	360.
stance	, E	CONSTANT	0.000E+00	-666-	0.000E+00	1,00
Temperature of aquifer PH Organic carbon content (fraction) Well distance from site Angle off center Well vertical distance	Gegree	CONSTANT CONSTANT CONSTANT CONSTANT CONSTANT CONSTANT	21.0 7.20 6.300E-02 293. 6.000E+00		0.000E+00 0.300 0.100E-05 1.00 0.000E+00	166. 1.80 1.999. 369.

APPENDIX F.5 MULTIMED OUTPUT FOR ALTERNATIVE LINER CLOSED CASE 5LOCATION 1

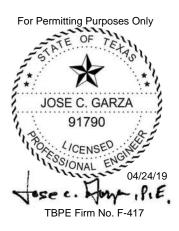


								\$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$	LIMITS MAX	0.000E+00 0.100E+11 0.000E+00 0.100E+11 0.000E+00 0.100E+11 0.000E+00 -999. 0.000E+00 -999.
R On AGENCY								ES	PARAMETERS MEAN STD DEV	0.000E+00 -999. 0.000E+00 -999. 0.000E+00 -999. 0.000E+00 -999. 0.000E+00 -999. 20.0 0.000E+00 -999. 0.000E+00 -999. 0.000E+00 -999. 0.000E+00 -999.
CASESR PROTECTI(SSESSMENT	A MODEL	1.01, June 1991)					CHEMICAL SPECIFIC VARIABLES	DISTRIBUTION	CONSTANT
.π 4.	URE A	IMEDI	(Version 1.01,				ne model	CHEMICAL	UNITS	1/yr 1/yr 1/yr 1/W-yr 1/W-yr (C m.1/g 1/yr cm2/s C G/M
LI. S. EN VIEW NO	EXPOS	MULT	MULTIMED	Run options	Case 5	Location 1 Chemical simulated 1s DEFAULT CHEMICAL	Option Chosen DETERMIN Infiltration input by user Run was steady-state Reject runs if Y coordinate outside plume Reject runs if Z coordinate outside plume Reject runs if Z coordinate outside plume Gaussian source used in saturated zone model		VARIABLE NAME	Solid phase decay coefficient Dissolved phase decay coefficient Overall chemical decay coefficient Acid catalyzed hydrolysis rate Neutral hydrolysis rate constant Base catalyzed hydrolysis rate Reference temperature Normalized distribution coefficient Distribution coefficient Blodegradation coefficient Blodegradation coefficient Air diffusion coefficient Reference temperature for air diffusion Molecular weight Mole fraction of solute Vapor pressure of solute Henry's law constant
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	SOURCE	SOURCE SPECIFIC VARIABLES				
VARIABLE NAME	ONITS	DISTRIBUTION	PARAMETERS MEAN STD	TERS STD DEV	LIMITS	
		(. () ())]]]]	
Infiltration rate	m/yr	CONSTANT		-666-	0.100E-09	Ø.188±+11
Area of waste disposal unit	m^2	CONSTANT	8.486E+96	-888.	0,160E-01	-666-
Dinetion of wiles	5	CONSTANT	-666	-999-	0.188E-88	-666-
	Æ	DEBTYED	666	-666-	0.100E-08	0.180E+11
presd of contaminant source		# TO 1000	2000	000	00000000	A 100F±11
Recharge rate	⊒/y⊓	CONSTANT	To-secta	י ה ה ה	0000010	TTLINGT O
Source decay constant	1/Vr	CONSTANT	0.000E+00	-666-	0.000E+00	.000
Trattal concortantion of landfill	[/am	CONSTANT	1.99	. 666	8.000E+08	-999.
	1	CONTRACTOR OF THE PARTY OF THE		000	2001.00	8 180E±11
Length scale of facility	E	DERIVED	n i			
Width scale of facility	E	DERIVED	.000-	-666-	9.100E-68	9.100E+11
Near field dilution		DERIVED	1.00	0.000E+00	9.880E+88	1.00
	AQUIFE	AQUIFER SPECIFIC VARIABLES			6	: : : : : : : : : : : : : : : : : : :
VARIABLE NAME	S I I	NOTINGEN	MEAN STD	STO DEV	NIM	MAX
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1				000000000000000000000000000000000000000	
Particle diameter	5	CONSTANT	0.381E-01	-444	OF TOOL O	100
Aquifer porosity	-	CONSTANT	0.438	-888-	8.100E-08	956.0
Bulk density	g/cc	CONSTANT	1.65	-666-	0.100E-01	5.69
Aguifer thickness	E	CONSTANT	10.0	-986	0.100E-08	0.100E+06
Source thickness (mixing zone depth)	E	DERIVED	- 666-	.999	0.100E-08	0.180E+06
	m/vr	CONSTANT	130.	-666-	0.100E-06	0.100E+09
() はなるともは、大きなないのでは、これをはない。		CONSTANT	8.310E-02	-666-	9.188E-07	.999.
	400	DEPTVED	999	-999	9.188E-09	9.188E+69
Groundaler vegyage verottery	, A /W	C071000	000	000	1.89	8.188E+89
Ketardation coefficient	:					000
Longitudinal dispersivity	E	5	N N		י החתנ	, h
Transverse dispersivity	æ	FUNCTION OF X	900	-888	י מת מת מת	
Vertical dispersivity	Œ	FUNCTION OF X	-999.	-666-	-989-	-999.
	L	CONSTANT	21.0	-666	0.800E+00	199.
	, ;	CONSTANT	7.20	.999.	9.300	14.0
		THATANA	בפים שפשב מ	000	0 100F-05	1.00
Organic carbon concent (17actual)	i	FEATURE	10000	000	200	000
Well distance from site	E	CONSTANT	2		2007	
Angle off center	degree	CONSTANT	0.B08E+88		0 - 000E+20	300.
Well vertical distance	E	CONSTANT	9.86E+80	-999	0.000E+00	1,00

APPENDIX F.6 MULTIMED OUTPUT FOR ALTERNATIVE LINER CLOSED CASE 6LOCATION 2



CASSER U. S. ENVIRONMENTAL PROTECTION AGENCY EXPOSURE ASSESSMENT MULTIME DIA MODEL MULTIMED (Version 1.01, June 1991) Run options	VARIABLE NAME UNITS DISTRIBUTION PARAMETERS LIMITS VARIABLE NAME Solid phase decay coefficient Dissolude phase decay coefficient Liyr CONSTANT 0.600E+00-999. Acid catalyzed phase decay coefficient Liyr CONSTANT 0.600E+00-999. Acid catalyzed hydrolysis rate Liyr CONSTANT 0.600E+00-999. Neutral hydrolysis rate Liyr CONSTANT 0.600E+00-999. Base catalyzed hydrolysis rate Liyr CONSTANT 0.600E+00-999. Reference temperature C C CONSTANT 0.600E+00-999. Normalized distribution coefficient mil/g CONSTANT 0.600E+00-999. Distribution coefficient Air diffusion coefficient	0.000E+00 - 999. 0.000E+00 - 0.000E+00 - 0.000E+00 - 999. 0.100E+00 - 0.000E+00 - 999. 0.000E+00 - 0.00E+00 - 0.00
---	--	--

	SOURCE	SOURCE SPECIFIC VARIABLES				
VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN STD	TERS STD DEV	LIMITS	TS MAX
# # # T			\$ P		00 300 6	0 1000.11
	TV (E	CONSTANT THATTANT	O JEEFTOR	. 000	0 100E-01	1000
Area of waste disposal unit	7 .≝	FINAL PRODU	0017000	. 000	0 100F-08	500
Duration of pulse		ONC SHOULD	. 000	, 000	0 120F100	100F+11
Spread of contaminant source	£ ,	CONSTANT	258F.01	. 666	P. PROF +OR	0.1006+11
Kecharge rate	11/ XI	TIVELONG	00000000	000	B ABARTAR	566
Source decay constant	1,734	CONSTANT	200.0	- 999	0.000E+00	-999-
INITIAL CONCENTRATION AC MANOTATA	1 20 11	100 CENT 100	000	966	A 199F-9X	0 100F+11
Length scale of Tacility	⊒			. 000	20 1001 2	1005
Width scale of tacility Near field dilution	E	DERIVED	1.89	0.000E+00	9.000E+00	1.90
	AQUIFE	AQUIFER SPECIFIC VARIABLES	 			1
VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS		LIMITS	
	 	1	MEAN	STD DEV	ZHX	XAM
Particle diameter	5	CONSTANT	0.381E-01	-666-	0.100E-08	166.
Aquifer porosity	:	CONSTANT	0.430	,090°	0.108E-88	966.0
Bulk density	g/cc	CONSTANT	1.65	-666-	0.188E-01	5.00
Aguifer thickness	E	CONSTANT	10.0	-666-	0.100E-08	0.188E+86
ource thickness (mixing zone depth)	8	DERIVED	-666-	-939.	0.160E-08	9.160E+06
Conductivity (hydraulic)	m/yr	CONSTANT	130.	-666-	0.100E-06	0.100E+09
Gradient (hydraulic)	•	CONSTANT	0.310E-02	.666°	0.180E-07	-986-
Groundwater seepage velocity	π/γr	DERIVED	.999.	-999	0.180E-09	9.100E+09
Setandation coefficient	` ;	DERIVED	-999-	.666.	1.66	0.100E+09
Loneite dina dinapportivity	E	FUNCTION OF X	.666-	-999.	-888-	-666-
Transcence dispersivity	E	៉	-999.	-9 66	-666-	-666-
A CONTRACT OF THE PROPERTY OF	: 6		-999-	.0000	-666	-999-
ertical displaying	. (į	2.0	900	9. BOOF+00	199
lemperature of aquirer 	J	FIXATONOO	200	000	300	14.6
	!	CONSTANT	02.7		A LAGELAN	20.00
Organic carbon content (Traction)	1	FINAL SMOOT	10701		1.88	666-
Well distance from site	2 4 4 7 7	FNATSHOO	O OOOETO		000 TO	360
Angle off center	ee:ee	TAN HONOL	0.0005100		00011000	. 60
Well vertical distance	E	CONSTANT	0.000		0.000	1

APPENDIX F.7 MULTIMED OUTPUT FOR ALTERNATIVE LINER CLOSED CASE 7LOCATION 3



rte outside plume inte outside plume cutside cutside cutside plume cutside cutside cutside plume cutside cutside cutside plume c
Biodegradation coefficient (sat. zone) 1/yr CONSTANT 0.000E+00 -999, 0.000E+00 -999. Air diffusion coefficient cm2/s CONSTANT 0.000E+00 -999, 0.000E+00 10.0 10.0 Reference temperature for air diffusion C CONSTANT 0.000E+00 -999, 0.000E+00 100. Molecular weight constant mm Hg CONSTANT 0.000E+00 -999, 0.100E-08 1.000 mm Hg CONSTANT 0.000E+00 -999, 0.100E-09 1.000 Henry's law constant atm-m^3/M CONSTANT 0.000E+00 -999. 0.100E-09 1.00

	SOURCE SPEC	SOURCE SPECIFIC VARIABLES				
VARIABLE NAME	UNITS DEST	DESTRIBUTION	PARANETERS MEAN STD	TERS STD DEV	NIM	TS MAX
	m/yr C	CONSTANT	0.511E-07	.999.	0.100E-09	0.100E+11 -999
posal unit		CONSTANT	-999.	.000-	0.100E-08	-999
Curation of putaminant source		DERIVED	-999.	-999.	0.160E-08	0.100E+11
	£	CONSTANT	0.368E-01	-999-	0.000E+00	0.100E+11
constant		CONSTANT	0.000E+00	-666-	8.880E+98	-999.
at landfill	mg/1 C	CONSTANT	1.60	-666	6.090E+00	-999
ity		DERIVED	-999-	-999.	0.100E-08	6.168E+11
	6 6 E	DERIVED DERIVED	-999.	-999. 0.000E+00	9.100E-08 9.000E+00	6.188E+11 1.88
	AQUIFER SPEC	AQUIFER SPECIFIC VARIABLES				
	DIS	DISTRIBUTION	PARAMETERS	ETERS	:3	TS
1			MEAN	STD DEV	NIM	MAX
Orinities diameter (C C	CONSTANT	0.381E-81	-999.	0.100E-08	186.
		CONSTANT	0.430	.986°	0.106E-08	6.998
	O 25/2	CONSTANT	1.65	-666-	0.100E-01	5.69
Kness		CONSTANT	19.9	.999.	0.100E-08	0.100E+06
(mixing zone depth)		DERIVED	-666-	-666-	0.100E-08	0.100E+06
	m/yr C	CONSTANT	130.	-989.	0.100E-06	0.100E+09
		CONSTANT	0.310E-02	-989-	0.100E-07	-6 6 6-
velocity	m/yr D	DERIVED	-999-	.999.	0,180E-09	0.100E+09
		DERIVED	-888-	.999.	1.68	9.188E+89
.£.	E	FUNCTION OF X	.666	.999.	-986-	-999.
	E	FUNCTION OF X	-999.	-999-	-999-	-986-
		FUNCTION OF X	-999.	-666-	-666-	-666-
	U	CONSTANT	21.0	-666-	9.099E+00	160.
		CONSTANT	7,20	-666-	9.390	14.0
p. Opeanic carbon content (fraction)	u	CONSTANT	9.380E-02		0.100E-05	1.00
	0	CONSTANT	293.	-359.	1,00	-666-
dea		CONSTANT	9-888E+88	-999-	9.999E+09	360.
stance	-	CONSTANT	8.888E+88	-999-	0.898E+88	1.00

APPENDIX G ALTERNATE COMPOSITE FINAL COVER DESIGN DEMONSTRATION



Table of Contents

1.0	INTRODUCTION	. 1
1.1	Alternative Composite Liner System	. 1
2.0	EQUIVALENCY	. 1
2.1	Leakage Rate Estimates	. 1
2.2	Wind and Water Erosion	. 2
3.0	SUMMARY	2

List of Appendices

Appendix G.1 Infiltration Rate Comparison-GCL Alternate Final Cover



1.0 INTRODUCTION

This alternate composite final cover design demonstration will demonstrate that the use of a geosynthetic clay liner (GCL) will provide equivalent infiltration and protection from wind and water erosion as the conventional composite final cover defined in 30 TAC §330.457 (a).

1.1 Alternative Composite Liner System

The GCL Alternative Final Cover System is as follows from top to bottom:

25 - inch thick erosion layer Double-sided geocomposite drainage layer 40-mil LLDPE textured geomembrane GCL

GCLs are frequently used in liner systems. GCLs are geocomposite materials of low hydraulic conductivity and are readily available by several manufacturers. The GCLs have varying characteristics. They are generally manufactured by placing powdered or granulated bentonite on a geotextile or geomembrane substrate. The bentonite layer is typically 6 to 10 mm thick (following hydration) and is placed at a unit weight of approximately 0.8 pounds per square feet (lb/ft²). The GCLs with a geotextile substrate also have a covering geotextile, which is often needle-punched, connecting the underlying geotextile to increase the structural integrity. Non-woven and woven geotextiles of various weights are used.

Generally, the permeability of the bentonite component of GCLs ranges from less than 1 x 10^{-9} to 5 x 10^{-9} cm/sec.

2.0 EQUIVALENCY

2.1 Leakage Rate Estimates

The leakage through composite liners can be estimated using the "Giroud equation", as illustrated in Appendix G.1. The method requires assumptions regarding the characteristics of the composite liner. It is assumed that permeation through the full area of the geomembrane is insignificant in comparison to rapid leakage through isolated defects or holes. Also, assumptions need to be made regarding the extent to which intimate contact has been made. A composite liner that has intimate contact has been constructed such that the geomembrane lies flush with the surface of the underlying clay component, with few or no gaps between two liners. When intimate contact has been achieved, the effective area of leakage is very small, and the total liner system leakage is minimized. This phenomenon is referred to as "composite action."

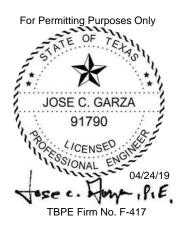
The equation used in the analysis is derived both from theoretical models of fluid flow and from empirical analyses of actual composite liner systems. Flow through a circular defect in a composite liner is calculated as follows:

Q = C[1+0.1(h/t_s)^{0.95}]
$$a^{0.1}h^{0.9}k_s^{0.74}$$
 [Ref 1] in Appendix G.1

Where:

Q = rate of leakage through a defect (m³/sec)

APPENDIX H MULTIMED MODEL SENSITIVITY ANALYSIS



MULTIMED MODEL SENSITIVITY ANALYSIS

RESULTS

Alternate Liner Demonstration Methods

The alternate liner demonstration methods are described in Section 2. ALTERNATE LINER DEMONSTRATION METHODS of this attachment.

Model Input Parameters

Model input parameters are described in Section 3. MODEL INPUT PARAMETERS of this attachment.

Point of Compliance Demonstration Results

Point of compliance Demonstration Results are described in Section 4. POINT OF COMPLIANCE DEMONSTRATION RESULTS of this attachment. Interim cases represent various waste fill heights at various locations (toe of slope, change of slope, midway, and at the peak) with daily cover. Various infiltration rates were determined and analyzed at various waste fill heights at the various locations using MULTIMED. As shown in Section 4, the most conservative case is at Overliner Location 1 with the lowest Interim Case DAF of 18,797. Therefore, Case 1OL (Interim) is selected as the most conservative Base Case for the MULTIMED Model Sensitivity Analysis and 15 variations from the base case are presented in Tables 1 and 2 in Appendix H.1 MULTIMED Model Sensitivity Analysis Tables and discussed below. MULTIMED Model Output Files are in Appendix H.3.

Base Case

The DAF for the base case is 18,797.

Sensitivity to Leakage Rates

As referenced in Appendix H.2 HELP Model Input and Output Files for Case1OL Base Case & Case 1OL Base Case with Liner Defects (4 Defects/Acre); four defects per acre were used in the HELP model (CASE1OL base case with 4 liner defects) to calculate the leakage rate, which is a highly conservative case with a peak daily percolation/leakage rate of (0.00010 ft³/day-ac) or 2.55 x 10-7 m/yr., the DAF decreases from the base case value to 13,194.

Sensitivity to Recharge Rate

If the recharge rate is set to zero, the DAF is reduced to 8,780. The DAF will remain high because most of the dilution is occurring underneath the landfill.

Sensitivity to Aquifer Porosity

Varying the aquifer porosity from 0.2 to 0.6 yields no apparent change in DAFs from the base case because dilution under the landfill is independent of porosity when contaminant decay is neglected.

Sensitivity to Bulk Density

Varying the bulk density from 1.65 g/cc to 1.60 g/cc and 1.70 g/cc yields no apparent change in DAFs from the base case when considering variations of sandy clay and loam and sandy clay loam material.

Sensitivity to Aquifer Thickness

When the thickness of the aquifer is reduced to 5 m, the DAF decreases from the base case value to 18,409. The DAF decreases because the volume of uncontaminated groundwater beneath the landfill is reduced and the volumetric discharge from leakage remains the same.

Sensitivity to Hydraulic Conductivity

Significantly increasing and decreasing the hydraulic conductivity leads to an increase in the DAFs. DAFs range from 95,238 to 183,790. Under these conditions groundwater is moving either very slowly or very quickly through the media and there is more dilution underneath the landfill. An increase in hydraulic conductivity will increase the Darcy velocity. Under these conditions groundwater is moving faster and there is more dilution underneath the landfill due to mechanical dispersion. A decrease in hydraulic conductivity will decrease the Darcy velocity. Under these conditions groundwater is moving slower and there is more dilution underneath the landfill due to chemical diffusion.

Sensitivity to Hydraulic Gradient

Varying the hydraulic gradient from the base case of 2 x 10^{-3} from low (10^{-3}) to high (10^{-1}) causes the DAFs to increase considerably from 18,409 to 446,030. When the hydraulic gradient is decreased, the DAF is lower. Under these conditions groundwater is moving very slowly and there is less dilution underneath the landfill. When the hydraulic gradient is increased, the DAF is very high. Under these conditions groundwater is moving faster and there is more dilution underneath the landfill due to mechanical dispersion.

Sensitivity to Organic Carbon Content

If the organic carbon content is set to zero, the DAF remains the same at 18,797. The Aquifer Specific Data indicates that the organic carbon content is 0.003 and therefore reducing it to zero does not change the DAF.

Sensitivity to Point of Compliance (POC)

If the distance to the POC is reduced conservatively to 2 m instead of 57.9 m, the DAF falls to 8,953. If the distance is increased to 150 m, the DAF rises to 54,705. This is likely due to the recharging of the aquifer and dilution of the contaminant plume with the increased distance.

SUMMARY

- 1. A composite 60 mil HDPE geomembrane and geosynthetic clay liner (GCL) is proposed for use at the City of Kingsville Landfill as an alternative liner in which the GCL is substituted for the clay liner component of the standard clay/geomembrane composite liner.
- 2. A series of MULTIMED models were developed using methodology recommended in EPA (1990) and TWC (1993).
- 3. A conservative base case model was defined and was varied 15 times to evaluate sensitivity to various model parameters, including recharge rate, carbon content, hydraulic gradient, hydraulic conductivity, porosity, number of defects in liner, distance to point of compliance (POC), and aquifer thickness.
- 4. MULTIMED dilution attenuation factors (DAFs) were used to determine the effectiveness of the alternative liner design.
- 5. MULTIMED simulations demonstrate that the proposed alternative liner design and overliner design meets or exceeds the requirements of Title 30 TAC §330.331 (a) (1). The DAF's calculated by the use of HELP and MULTIMED are well in excess of the 260 minimum criterion. The actual DAFs are expected to be substantially higher that the DAFs predicted by this modeling demonstration because the model input was conservatively estimated as discussed in previous sections of this report.

REFERENCES

Sharp-Hanson, S., C. Travers, P. Hummel, and T. Allison, 1990, "A Subtitle D Landfill Application Manual for the Multimedia Exposure Assessment Model (MULTIMED)," Environmental Research Laboratory, Office of Research and Development, U.S. Environmental Protection Agency, Athens, GA.

TWC, 1993, "Alternate Liner Design Handbook, Version 1," August 1993.

APPENDIX H.1 MULTIMED MODEL SENSITIVITY ANALYSIS TABLES



MULTIMED MODEL SENSITIVITY ANALYSIS TABLES

Variable Name	Units	Value	Comments
Area of disposal unit	m ²	0.486 x 10 ⁶	120 acres
Leakage rate	m/yr	0.179 x 10 ⁻⁶	2 defects/acre
(Source Infiltration Rate)		*0.255 X 10 ⁻⁶	4 defects/acre
	m/yr	0.368 x 10 ⁻¹	Reference Appendix C.4
Recharge rate		*0	Variation
Initial concentration at landfill	mg/l	1	Set at 1.0 to find DAF
Aquifer porosity	Unitless	0.43	Reference Appendix C.7.1
		*0.20	Variation
		*0.60	Variation
Bulk density	g/cc	1.65	Reference Appendix C.7.1
		*1.60	Variation (Sandy Clay)
		*1.70	Variation (Loam & Sandy Clay Loam)
Aquifer thickness	m	10	Reference Appendix C.7.1
		*5	Variation
Hydraulic conductivity	m/yr		Reference Appendix C.7.1
		130	(4.12 x 10 ⁻⁴ cm/sec)
		*1,299	(4.12 x 10 ⁻³ cm/sec) Variation
		*12.99	(4.12 x 10 ⁻⁵ cm/sec) Variation
Hydraulic gradient	Unitless	0.200 x 10 ⁻²	From Groundwater Map (January 2016)
		*10 -3	Variation
		*10 -2	Variation
		*10 -1	Variation
Organic carbon content	%	0.003	Reference Appendix C.7.1
		*0	Conservative Assumption
Point of compliance distance	m	58	190 ft
		*2	Variation
		*150	Variation
Z-distance from water table	m	0	Assume water table at bottom of liner.

Table 1. MULTIMED source inputs for the base case values and changes from the base case values used for sensitivity analysis (shown with an asterisk and in italics).

	Peak Percolation Through Liner (cf/day)	Peak Percolation Through Liner (m/yr)	MULTIMED Chemical Concentration at POC (mg/l)	DAF
Base case	0.00007	1.79E-07	5.32E-05	18,797
Varied inputs				
Base case with four defects in liner	0.0001	2.55E-07	7.58E-05	13,194
Base case with zero recharge	0.00007	1.79E-07	1.14E-04	8,780
Base case with porosity = 0.2	0.00007	1.79E-07	5.32E-05	18,797
Base case with porosity = 0.6	0.00007	1.79E-07	5.32E-05	18,797
Base case with bulk density = 1.60 g/cc	0.00007	1.79E-07	5.32E-05	18,797
Base case with bulk density = 1.70 g/cc	0.00007	1.79E-07	5.32E-05	18,797
Base case with aquifer thickness of 5 m	0.00007	1.79E-07	5.43E-05	18,409
Base case with hydraulic conductivity = 1,299 m/yr	0.00007	1.79E-07	1.05E-05	95,238
Base case with hydraulic conductivity = 12.99 m/yr	0.00007	1.79E-07	5.44E-06	183,790
Base case with hydraulic gradient = 10 ⁻³	0.00007	1.79E-07	5.43E-05	18,409
Base case with hydraulic gradient = 10 ⁻²	0.00007	1.79E-07	1.94E-05	51,573
Base case with hydraulic gradient = 10 ⁻¹	0.00007	1.79E-07	2.24E-06	446,030
Base case with organic carbon content = 0%	0.00007	1.79E-07	5.32E-05	18,797
Base case with point of compliance at 2 m	0.00007	1.79E-07	1.12E-04	8,953
Base case with point of compliance at 150 m	0.00007	1.79E-07	1.83E-05	54,705

Table 2. Dilution factors for each of the simulations of transport.

APPENDIX H.2

HELP MODEL INPUT AND OUTPUT FILES FOR CASE1OL BASE CASE & CASE1OL BASE CASE WITH LINER DEFECTS (4 DEFECTS/ACRE)



CASE10LB.OUT

•		
*******	**********************	*******
*******	******************	*****
**		**
**		**
**	HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE	**
**	HELP MODEL VERSION 3.07 (1 NOVEMBER 1997)	**
**	DEVELOPED BY ENVIRONMENTAL LABORATORY	**
**	USAE WATERWAYS EXPERIMENT STATION	**
**	FOR USEPA RISK REDUCTION ENGINEERING LABORATORY	**
**		**
**		**
*******	*********************	*****
******	******************	******

TEMPERATURE DATA FILE: EVAPOTRANSPIRATION DATA:

PRECIPITATION DATA FILE: C:\HELP3\MDATA\KGVPR20Y.D4 C:\HELP3\MDATA\KGVTE20Y.D7 SOLAR RADIATION DATA FILE: C:\HELP3\MDATA\KGVSO20Y.D13

C:\HELP3\MDATA\KGVEV20Y.D11 SOIL AND DESIGN DATA FILE: C:\HELP3\MDATA\CASE1OLB.D10 C:\HELP3\MDATA\CASE1OLB.OUT

TIME: 15:40

OUTPUT DATA FILE:

DATE:

4/11/2019

********************** TITLE: CITY OF KINGSVILLE SOLID WASTE LANDFILL-CASE10L BASE CASE

NOTE: INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

LAYER 1

TYPE 1 - VERTICAL PERCOLATION LAYER

MATERIAL TEXTURE NUMBER 13 THICKNESS 6.00 INCHES

POROSITY 0.4300 VOL/VOL 0.3210 VOL/VOL FIELD CAPACITY 0.2210 VOL/VOL WILTING POINT INITIAL SOIL WATER CONTENT = 0.2210 VOL/VOL

EFFECTIVE SAT. HYD. COND. = 0.330000003000E-04 CM/SEC NOTE: SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY 3.00 FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.

LAYER 2

TYPE 1 - VERTICAL PERCOLATION LAYER MATERIAL TEXTURE NUMBER 18

THICKNESS

144.00 INCHES

Page 1

CASE1OLB, OUT

POROSITY 0.6710 VOL/VOL 0,2920 VOL/VOL FIELD CAPACITY 0.0770 VOL/VOL WILTING POINT 0.2837 VOL/VOL INITIAL SOIL WATER CONTENT = = 0.100000005000E-02 CM/SEC EFFECTIVE SAT, HYD, COND.

LAYER 3

TYPE 1 - VERTICAL PERCOLATION LAYER

MATERIAL TEXTURE NUMBER 13

THICKNESS 24.00 0.4300 VOL/VOL POROSITY FIELD CAPACITY 0.3210 VOL/VOL WILTING POINT 0.2210 VOL/VOL INITIAL SOIL WATER CONTENT = 0.3242 VOL/VOL

EFFECTIVE SAT. HYD. COND. = 0.330000003000E-04 CM/SEC

LAYER 4

TYPE 2 - LATERAL DRAINAGE LAYER

MATERIAL TEXTURE NUMBER 20

INCHES 0.20 THICKNESS 0.8500 VOL/VOL POROSITY 0.0100 VOL/VOL FIELD CAPACITY 0.0050 VOL/VOL WILTING POINT INITIAL SOIL WATER CONTENT = 0.0181 VOL/VOL 10.00000000000 CM/SEC EFFECTIVE SAT. HYD. COND. == -PERCENT SLOPE 2.00 DRAINAGE LENGTH 400.0 FEET

LAYER 5

TYPE 4 - FLEXIBLE MEMBRANE LINER

MATERIAL TEXTURE NUMBER 35

INCHES 0.06 THICKNESS 177 0.0000 VOL/VOL POROSITY 0.0000 VOL/VOL FIELD CAPACITY = 0.0000 VOL/VOL WILTING POINT INITIAL SOIL WATER CONTENT = 0.0000 VOL/VOL EFFECTIVE SAT. HYD. COND. = 0.199999996000E-12 CM/SEC 1.00 HOLES/ACRE FML PINHOLE DENSITY 22 2.00 HOLES/ACRE FML INSTALLATION DEFECTS FML PLACEMENT QUALITY = 3 - GOOD

LAYER 6

TYPE 3 - BARRIER SOIL LINER

MATERIAL TEXTURE NUMBER 17

0.24 INCHES THICKNESS 0.7500 VOL/VOL POROSITY 0.7470 VOL/VOL FIELD CAPACITY Page 2

CASE1OLB.OUT

WILTING POINT = 0.4000 VOL/VOL INITIAL SOIL WATER CONTENT = 0.7500 VOL/VOL

EFFECTIVE SAT. HYD. COND. = 0.300000003000E-08 CM/SEC

LAYER 7

TYPE 1 - VERTICAL PERCOLATION LAYER MATERIAL TEXTURE NUMBER 13

THICKNESS = 30.00 INCHES
POROSITY = 0.4300 VOL/VOL
FIELD CAPACITY = 0.3210 VOL/VOL
WILTING POINT = 0.2210 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.3210 VOL/VOL

EFFECTIVE SAT. HYD. COND. = 0.330000003000E-04 CM/SEC

LAYER 8

TYPE 1 - VERTICAL PERCOLATION LAYER MATERIAL TEXTURE NUMBER 18

THICKNESS = 186.00 INCHES
POROSITY = 0.6710 VOL/VOL
FIELD CAPACITY = 0.2920 VOL/VOL
WILTING POINT = 0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.2919 VOL/VOL
EFFECTIVE SAT, HYD, COND. = 0.100000005000E-02 CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE #13 WITH A FAIR STAND OF GRASS, A SURFACE SLOPE OF 25.% AND A SLOPE LENGTH OF 100, FEET.

SCS RUNOFF CURVE NUMBER	=	89.50	
FRACTION OF AREA ALLOWING RUNOFF	=	80.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	==	12.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	1.886	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	==	6.606	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	==	1.788	INCHES
INITIAL SNOW WATER	22	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	223	114.065	INCHES
TOTAL INITIAL WATER	122	114.065	INCHES
TOTAL SUBSURFACE INFLOW	==	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM CORPUS CHRISTI TEXAS

Page 3

	CAS	E10LB.	OUT
STATION LATITUDE	=	27,77	DEGREES
MAXIMUM LEAF AREA INDEX	=	2,00	
START OF GROWING SEASON (JULIAN DATE)	=	0	
END OF GROWING SEASON (JULIAN DATE)	=	367	
EVAPORATIVE ZONE DEPTH	==	12.0	INCHES
AVERAGE ANNUAL WIND SPEED	=	12.00	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	76.00	%
		78.00	
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	12	76.00	%
AVERAGE ATH QUARTER RELATIVE HUMIDITY		76.00	

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JUC/NAC	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
1.63	1.69	1.20	1.57	3.29	3.12
2.26	2.78	5.31	2.92	1.61	1.17

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JUC/NAC	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC

56,30	59.30	65.90	73.00	78.10	82.70
84.90	85.00	81.50	74.00	65.00	59.10

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS AND STATION LATITUDE = 27.77 DEGREES

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 20

	JUC/NAC	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	1.15	2.02	1.05	1.42	2.41	2.71
	2.43	2.37	5,38	2.30	1.33	1,18
STD, DEVIATIONS	0.63	1,18	0,55	1.20	1.88	2.04
	2.55	1.63	3,12	1.75	1.17	0.85
RUNOFF						
TOTALS	0.015	0.067	0.006	0.103	0.278	0.282
	0.377	0.192	0.779	0.173	0.073	0.019
STD. DEVIATIONS	0.042	0.081	0.009	0.233	0.504	0.344
				Page 4	4	

FROM LAYER 4

				ACCIOLD O	UT	
	0.815	0.200	0.918	ASE10LB.0 0.257	0.214	0.065
EVAPOTRANSPIRATION						
		1000 - 300000			4 004	
TOTALS	0.927 2.038	2.081 1.886	1.305 3.610	1,245 2,255	1,981 1,096	2,108 1,069
STD. DEVIATIONS	0.558 1.630	0.899 1.312	0.714 1.219	0.924 1.213	1.308 0.780	1.378 0.585
LATERAL DRAINAGE COLL	ECTED FROM I	LAYER 4				
TOTALE	0.0557	0.0293	0.0663	0.0567	0.0409	0.0574
TOTALS	0.1701	0.1696	0,1118	0.5501	0.3280	0.147
STD. DEVIATIONS	0.0736 0.2914	0.0491 0.3491	0.1278 0.2088	0,1001 0,8668	0.0685 0.5012	0.1269
PERCOLATION/LEAKAGE T	574755005050014		0.2000	0,0000	0,5022	
						W 5005
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0,0000	0.0000	0.0000	0.0000	0,000
STD. DEVIATIONS	0.0000	0,0000	0.0000	0.0000	0.0000	0.000
	0.0000	0,0000	0,0000	0.0000	0.0000	0.000
PERCOLATION/LEAKAGE T	HROUGH LAYE	R 8				
TOTALS	0.0000	0.0000	0,0000	0.0000	0.0000	0.000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0,0000	0.0000	0.000
	0.0000	0.0000	0.0000	0,0000	0.0000	0.000
	OF MONTHLY			ADS (INCH	ES)	
DAILY AVERAGE HEAD ON	TOP OF LAY	ER 5				
AVERAGES	0.0006	0.0004		0.0007	0.0005	
	0.0019	0.0019	0.0013	0.0063	0.0039	0.001
STD. DEVIATIONS	0.0008	0.0006		0.0012	0.0008	0.001
*******	0.0033	0.0040		0.0099	0.0059	0.002
**********	· ፞ ፞፞፞፞፞፞፞፞፞፞፞፞፞፞፞፞፞፞፞፞፞፞፞፞፞፞፞፞፞፞፞፞፞፞፞	********				
******	******	******	******	******	*****	*****
AVERAGE ANNUAL TO						
	a (3101					
		INCHE	S 	CU, FE		PERCENT
RECIPITATION	25	.74 (5.706)	9344	8.9	100.00
UNOFF	2	.364 (1.2831)	858	80.98	9,183
VAPOTRANSPIRATION	21	.601 (3,6817)	7846	9.91	83.907
ATERAL DRAINAGE COLLI	ECTED 1	.78305 (1.49648)	647	72.482	6.92623

Page 5

			CASE	10LB.OUT	
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.00000	(0.00000)	0.004	0.00000
AVERAGE HEAD ON TOP OF LAYER 5	0.002 (0,001)		
PERCOLATION/LEAKAGE THROUGH LAYER 8	0.00000	(0.00000)	0.000	0.00000
CHANGE IN WATER STORAGE	-0.004	(0.5412)	-14.46	-0.015
*********	*****	***	*****	******	******
^					
^ **************	******	***	*****	******	*****

I INNOUGH 2	20
3	(CU. FT.)
	18404.102
2,156	7827.0879
0,19851	720.60400
0.000000	0.00007
0.070	
0.139	
4.2 FEET	
0.000000	0.00000
0.00	0.0000
0.3	3865
0.:	1490
	5.07 2.156 0.19851 0.000000 0.070 0.139 4.2 FEET 0.000000 0.00

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner by Bruce M. McEnroe, University of Kansas ASCE Journal of Environmental Engineering Vol. 119, No. 2, March 1993, pp. 262-270.

******	********	******	****	****	****	******	***
LAYER (INCHES) (VOL/VOL)	FINAL WATER	STORAGE AT	END	OF '	YEAR	20	
	LAYER	(INCHES)		(VOL/V	OL)	

		CASE10LB.OUT
1.	1.4228	0.2371
2	40.7579	0.2830
3	7.7040	0.3210
4	0.0020	0.0100
5	0.0000	0.0000
6	0.1800	0.7500
7	9,6289	0.3210
8	54.2892	0.2919
SNOW WATER	0.000	

CASE1OLD.OUT

******	*******************	******
******	****************	*****
**		**
**		**
**	HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE	**
**	HELP MODEL VERSION 3.07 (1 NOVEMBER 1997)	**
**	DEVELOPED BY ENVIRONMENTAL LABORATORY	**
**	USAE WATERWAYS EXPERIMENT STATION	**
**	FOR USEPA RISK REDUCTION ENGINEERING LABORATORY	**
**		**
**		**
******	***************	******
******	******************	******

PRECIPITATION DATA FILE: TEMPERATURE DATA FILE: SOLAR RADIATION DATA FILE: C:\HELP3\MDATA\KGVSO20Y.D13 **EVAPOTRANSPIRATION DATA:** SOIL AND DESIGN DATA FILE: C:\HELP3\MDATA\CASE10LD.D10

C:\HELP3\MDATA\KGVPR20Y.D4 C:\HELP3\MDATA\KGVTE20Y.D7 C:\HELP3\MDATA\KGVEV20Y.D11

C:\HELP3\MDATA\CASE1OLD.OUT

TIME: 15:32

OUTPUT DATA FILE:

DATE: 4/11/2019

TITLE: CITY OF KINGSVILLE SOLID WASTE LANDFILL-CASE10L (4 DEF/AC) ***********************

NOTE: INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

LAYER 1

TYPE 1 - VERTICAL PERCOLATION LAYER

MATERIAL TEXTURE NUMBER 13

THICKNESS 6.00 INCHES 0,4300 VOL/VOL POROSITY FIELD CAPACITY 0.3210 VOL/VOL 0.2210 VOL/VOL WILTING POINT INITIAL SOIL WATER CONTENT = 0.2210 VOL/VOL EFFECTIVE SAT. HYD. COND. = 0.330000003000E-04 CM/SEC

NOTE: SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY 3.00 FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.

LAYER 2

TYPE 1 - VERTICAL PERCOLATION LAYER MATERIAL TEXTURE NUMBER 18

THICKNESS

INCHES 144.00

CASE1OLD.OUT

POROSITY = 0.6710 VOL/VOL FIELD CAPACITY = 0.2920 VOL/VOL WILTING POINT = 0.0770 VOL/VOL INITIAL SOIL WATER CONTENT = 0.2837 VOL/VOL EFFECTIVE SAT, HYD. COND. = 0.100000005000E-02 CM/SEC

LAYER 3

TYPE 1 - VERTICAL PERCOLATION LAYER MATERIAL TEXTURE NUMBER 13

THICKNESS = 24.00 INCHES
POROSITY = 0.4300 VOL/VOL
FIELD CAPACITY = 0.3210 VOL/VOL
WILTING POINT = 0.2210 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.3242 VOL/VOL

EFFECTIVE SAT. HYD. COND. = 0.330000003000E-04 CM/SEC

LAYER 4

TYPE 2 - LATERAL DRAINAGE LAYER MATERIAL TEXTURE NUMBER 20

THICKNESS 0.20 INCHES 0.8500 VOL/VOL POROSITY = 0.0100 VOL/VOL FIELD CAPACITY 0.0050 VOL/VOL WILTING POINT 0.0181 VOL/VOL INITIAL SOIL WATER CONTENT = 10.0000000000 CM/SEC EFFECTIVE SAT. HYD. COND. = PERCENT 2.00 SLOPE = DRAINAGE LENGTH 400.0 FEET

LAYER 5

.......

TYPE 4 - FLEXIBLE MEMBRANE LINER MATERIAL TEXTURE NUMBER 35

0.06 INCHES THICKNESS 0.0000 VOL/VOL POROSITY = 0.0000 VOL/VOL FIELD CAPACITY 0.0000 VOL/VOL WILTING POINT INITIAL SOIL WATER CONTENT = 0.0000 VOL/VOL EFFECTIVE SAT. HYD. COND. = 0.199999996000E-12 CM/SEC HOLES/ACRE FML PINHOLE DENSITY = 1.00 HOLES/ACRE FML INSTALLATION DEFECTS 4.00 = 3 - GOOD FML PLACEMENT QUALITY

LAYER 6

TYPE 3 - BARRIER SOIL LINER MATERIAL TEXTURE NUMBER 17

THICKNESS = 0.24 INCHES
POROSITY = 0.7500 VOL/VOL
FIELD CAPACITY = 0.7470 VOL/VOL
Page 2

CASE1OLD.OUT

WILTING POINT INITIAL SOIL WATER CONTENT = 0,4000 VOL/VOL

0.7500 VOL/VOL

EFFECTIVE SAT. HYD. COND. = 0.300000003000E-08 CM/SEC

LAYER 7

TYPE 1 - VERTICAL PERCOLATION LAYER MATERIAL TEXTURE NUMBER 13

THICKNESS	=	30.00 INCHES
POROSITY	=	0.4300 VOL/VOL
FIELD CAPACITY	=	0.3210 VOL/VOL
WILTING POINT	=	0,2210 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3210 VOL/VOL
FEFECTIVE SAT. HYD. COND.		0.330000003000E-04 CM/SE

LAYER 8

TYPE 1 - VERTICAL PERCOLATION LAYER MATERIAL TEXTURE NUMBER 18

THICKNESS	=	186.00 INCHES
POROSITY	=	0.6710 VOL/VOL
FIELD CAPACITY	=	0.2920 VOL/VOL
WILTING POINT	=	0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2919 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000005000E-02 CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE #13 WITH A FAIR STAND OF GRASS, A SURFACE SLOPE OF 25.% AND A SLOPE LENGTH OF 100. FEET.

SCS RUNOFF CURVE NUMBER	=	89.50	
FRACTION OF AREA ALLOWING RUNOFF	==	80.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	22	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	12.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	==	1.886	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	6.606	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	æ	1.788	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	114.065	INCHES
TOTAL INITIAL WATER	222	114.065	INCHES
TOTAL SUBSURFACE INFLOW	==	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM CORPUS CHRISTI **TEXAS**

Page 3

	CAS	E10LD.	OUT
STATION LATITUDE	=	27.77	DEGREES
MAXIMUM LEAF AREA INDEX	111	2,00	
START OF GROWING SEASON (JULIAN DATE)	=	0	
END OF GROWING SEASON (JULIAN DATE)	==	367	
EVAPORATIVE ZONE DEPTH	12	12.0	INCHES
AVERAGE ANNUAL WIND SPEED	22	12,00	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	==	76.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=		%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	76.00	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY		76.00	%

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JUC/NAC	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
1.63	1.69	1.20	1.57	3.29	3.12
2.26	2.78	5.31	2.92	1.61	1.17

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JUC/NAC	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
56.30	59.30	65.90	73.00	78.10	82.70
84.90	85.00	81.50	74.00	65.00	59.10

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS AND STATION LATITUDE = 27.77 DEGREES

AVERAGE MONTH	LY VALUES I	N INCHES	FOR YEARS	1 THR	OUGH 20	
	JUC/NAC	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	1.15	2.02	1.05	1.42	2.41	2.71
10171110	2.43	2.37	5.38	2.30	1.33	1.18
STD. DEVIATIONS	0,63	1.18	0.55	1.20	1.88	2.04
212. 24.4	2.55	1.63	3.12	1.75	1.17	0.85
RUNOFF						
				100000000000000000000000000000000000000		
TOTALS	0.015	0.067	0.006	0.103	0.278	0.28
	0.377	0.192	0.779	0.173	0.073	0.01
STD. DEVIATIONS	0.042	0.081	0.009	0.233	0.504	0.34
				Page 4	4	

	Maningaphanson				ASE1OLD.O		0.065
	0.815	0.200		0.918	0.257	0.214	0.065
EVAPOTRANSPIRATION							
TOTALS	0.927	2.081		1.305	1.245	1,981	2.108
	2.038	1.886		3.610	2.255	1.096	1.069
STD. DEVIATIONS	0.558	0.899		0.714	0.924	1.308	1.378
	1.630	1.312		1.219	1.213	0.780	0.585
LATERAL DRAINAGE COLLECT	ED FROM LA	AYER	4				
TOTALS	0.0557	0.029	3	0.0663	0.0567	0.0409	0.0574
11.7511.155	0.1701	0,169	6	0.1118	0.5501	0.3280	0.1472
STD. DEVIATIONS	0.0736	0.049	1	0.1278	0.1001	0.0685	0.1269
	0.2914	0.349	1	0.2088	0.8668	0.5012	0.2297
PERCOLATION/LEAKAGE THRO	UGH LAYER	6					
TOTALS	0.0000	0.000	0	0.0000	0.0000	0.0000	0.0000
	0.0000	0.000	0	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.000	0	0.0000	0.0000	0.0000	0.0000
	0.0000	0.000	0	0.0000	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THRO	UGH LAYER	8					
TOTALS	0.0000	0.000	10	0.0000	0.0000	0.0000	0.0000
TOTALS	0.0000	0.000		0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.000	10	0.0000	0.0000	0.0000	0.0000
DID! DETERMINATE	0.0000	0.000		0.0000	0.0000	0.0000	0.0000
AVERAGES OF	P OF LAYE						
AVERAGES	0.0006	0.000)4	0.0008	0.0007	0.0005	0.0007
, rivate to	0.0019	0.001		0.0013	0.0063	0.0039	0.0017
STD. DEVIATIONS	0.0008	0.000	16	0.0015	0.0012	0.0008	0.0015
	0.0033	0.004	10	0.0025	0.0099	0.0059	0,0026

AVERAGE ANNUAL TOTALS	& (STD.	DEVIAT	ΓIO	NS) FOR YE	ARS 1	THROUGH	20
		INC			CU. FE		PERCENT
PRECIPITATION				5.706)			100.00
RUNOFF	2.	364	(1.2831)	858	0.98	9.183
			8	3.6817)			
LATERAL DRAINAGE COLLECTE FROM LAYER 4	D 1,	78305	(1.49648)	647	2,482	6.92623

			CASE	10LD,OUT	
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.00000	(0.00000)	0.004	0.00000
AVERAGE HEAD ON TOP OF LAYER 5	0.002 (0.001)		
PERCOLATION/LEAKAGE THROUGH LAYER 8	0.00000	(0.00000)	0.000	0.00000
CHANGE IN WATER STORAGE	-0.004	(0.5412)	-14.46	-0.015
	At the site of the site of the site.	b-d-d		********	******

1 THROUGH 20

PEAK DATLY VALUES FOR YEARS

	(INCHES)	(CU. FT.)
PRECIPITATION		18404,102
RUNOFF	2.156	7827.0879
DRAINAGE COLLECTED FROM LAYER 4	0.19851	720.60400
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.000000	0.00018
AVERAGE HEAD ON TOP OF LAYER 5	0.070	
MAXIMUM HEAD ON TOP OF LAYER 5	0.139	
LOCATION OF MAXIMUM HEAD IN LAYER 4 (DISTANCE FROM DRAIN)	4,2 FEET	
PERCOLATION/LEAKAGE THROUGH LAYER 8	0.000000	0.00000
SNOW WATER	0.00	0.0000
MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.	3865
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.	1490

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner by Bruce M. McEnroe, University of Kansas ASCE Journal of Environmental Engineering Vol. 119, No. 2, March 1993, pp. 262-270.

******	******	*****	****	*****	********
	FINAL WATER	STORAGE AT	END OF	YEAR	20
	LAYER	(INCHES)		(VOL/VO	DL)
					Page 6

		CASE10LD.OUT
1.	1.4228	0.2371
2	40.7579	0,2830
3	7.7040	0.3210
4	0.0020	0.0100
5	0.0000	0.0000
6	0.1800	0.7500
7	9.6289	0.3210
8	54.2892	0.2919
SNOW WATER	0.000	

APPENDIX H.3 MULTIMED MODEL OUTPUT FILES



	AGENCY
CASE10LB	PROTECTION
	ENVIRONMENTAL
	u. s.

ASSESSMENT EXPOSURE

MODEL

MULTIMEDIA

(Version 1.01, June 1991)

MULTIMED

Location 1 Chemical simulated is DEFAULT CHEMICAL CASEIOL Base Case

Run options

Saturated zone model DETERMIN Gaussian source used in saturated zone model Reject runs if Y coordinate outside plume Reject runs if Z coordinate outside plume Infiltration input by user Run was steady-state Option Chosen

CHEMICAL SPECIFIC VARIABLES

LIMITS

PARAMETERS

DISTRIBUTION

UNITS

VARIABLE NAME

			MEAN	STD DEV	MIM	MAX
Solid phase decay coefficient	1/yr	CONSTANT	0.000E+00 -999	-939.	0.000E+00	0.190E+11
Dissolved phase decay coefficient	1/yr	CONSTANT	0.000E+00 -999	-666-	0.000E+00	0.180E+11
Overall chemical decay coefficient	1/yr	CONSTANT	0.000E+00 -999.	-666-	0.000E+00	0.100E+11
Acid catalyzed hydrolysis rate	1/M-yr	CONSTANT	0.808E+88 -999.	-666-	0.000E+00	-999.
Neutral hydrolysis rate constant	1/yr	CONSTANT	0.000E+00 -999.	-666-	0.000E+00	-998.
Base catalyzed hydrolysis rate	1/M-yr	CONSTANT	0.000E+00 -999.	.666.	0.000E+00	-986
Reference temperature	U	CONSTANT	20.9	-666-	0.000E+00	106.
Normalized distribution coefficient	m1/g	CONSTANT	0.000E+00 -999.	-666-	9.000E+00	.999.
Distribution coefficient	'	DERIVED	-888-	-666-	0.000E+00	0.100E+11
Biodegradation coefficient (sat. zone)	1/yr	CONSTANT	0.000E+00 -999.	-666	0.000E+00	-986-
Air diffusion coefficient	cm2/s	CONSTANT	0.000E+00 -999.	-666-	9.000E+00	10.0
Reference temperature for air diffusion	U	CONSTANT	0.000E+00 -999.	-666-	9.000E+00	100.
Molecular weight	B/W	CONSTANT	0.000E+00 -999.	-686-	0.800E+00	-986-
Mole fraction of solute	.	CONSTANT	0.000E+00 -999.	-666-	0.100E-08	1.60
Vapor pressure of solute	man Tig	CONSTANT	0.000E+00 -999	-666-	0.000E+00	100.
Henry's law constant	atm-m^3/M	CONSTANT	8.088E+08 -999	-666-	0.100E-09	1.80
cay sat, zone	1/yr	DERIVED	0.000E+00	9.000E+00 0.000E+00	0.000E+00	1.80

Not currently used Not currently used		CASEIOLB CONSTANT CONSTANT	-999. -999.	-999. -999.	0.060E+00 6.060E+00	1.68 1.98	
	SOURC	SOURCE SPECIFIC VARIABLES	so.				
VARIABLE NAME	UNITS	DISTRIBUTION	PARAM	PARAMETERS	\$IIWIT	\$L	2 2
			MEAN	STD DEV	MIN	МАХ	
Infiltration rate	m/yr	CONSTANT	⊕.179E-06		9.100E-09	0.100E+11	
Area of waste disposal unit	#^2	CONSTANT	9.486E+06		0.100E-01	-666-	
Duration of pulse	٦٧	CONSTANT	-999.	-666-	0.100E-08	- 666 ·	
Spread of contaminant source	E	DERIVED	-999		0.100E-08	0.100E+11	
Recharge rate	m/yr	CONSTANT	9.368E-01		0.000E+00	0.100E+11	
Source decay constant	1/yr	CONSTANT	6. 888E+88		6 - 666 - 66	-999	
Initial concentration at landfill	mg/1	CONSTANT	1.00	-956-	0.000E+88	-999.	
Length scale of facility	E	DEKIVED	. 986-		0.100E-08	0.100E+11	
Width Scale of Facility Near field dilution	E	DERIVED	1.00	-339. 6.080E+08	0.900E+80	1.00	
	AQUIFE	AQUIFER SPECIFIC VARIABLES	s				
	ı						
VADTARI R NAME	STIMI	DISTRIBITION		PARAMETERS	\$1.1WI		-
			MEAN	STD DEV	MIN	MAX	
		1		:			-
Particle diameter	æ	CONSTANT	0.381E-01		8.188E-88	100.	
Aquifer parasity	;	CONSTANT	0.430	-666-	0.100E-08	9.99	
Bulk density	30/8	CONSTANT	1.65	.000	0.109E-01	5.68	
	E	CONSTANT	10.0	.000	9.188E-88	0.188E+85	
Source thickness (mixing zone depth)	E	DERIVED	, 999	. 00.00 0.00	0.100E-08	6.160E+65	
Conductivity (hydraulic)	m/yr	CONSTANT	156.		0.100E-05	0.168E+69	
Gradient (nydraulic)	1,000	CONSTANT	000 mp7	. 0000	0.180E-07	4000	
Groundwater Seepage verolity botondotion coefficient	14 / H	DERIVED	000	. 666	1.98	001100110	
netal dation toelliteit poeitudinal dispersivity	E	N HO	. 666-	-999	-989	-999	
Transverse dispersivity	E		-999	-666	-999-	.999	
Vertical dispersivity	E	9	-666-	-666-	-666-	-999.	
Temperature of addifer	U	CONSTANT	21.0	.666-	B. BBBE+BB	100.	
Ha.	;	CONSTANT	7.28	.999.	0.390	14.0	
Organic carbon content (fraction)		CONSTANT	8.388E-82		0.100E-05	1.00	
Well distance from site	6	CONSTANT	58.8		1.96	-666-	
Angle off center	degree	CONSTANT	9.080E+00		0.000E+00	360.	
Well vertical distance	E	CONSTANT	9.000E+08	.989.	8.886E+98	1.00	
CENTRATION AFTER SATURATED ZONE MODEL 0.53206-04	53206-04						
		C apped					

	AGEN
CASE10LD	PROTECTION
	ENVIRONMENTAL
	U. S.

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ASSESSMENT EXPOSURE

MODEL MULTIMEDIA

(Version 1.01, June 1991)

MULTIMED

1 Run options

CASEIOL Base Case With 4 Defects Per Acre in Liner

Location 1 Chemical simulated is DEFAULT CHEMICAL

Option Chosen

Saturated zone model DETERMIN Reject runs if Y coordinate outside plume Reject runs if Z coordinate outside plume Infiltration input by user Run was steady-state

Gaussian source used in saturated zone model

CHEMICAL SPECIFIC VARIABLES

VARIABLE NAME	UNITE	DISTRIBUTION	PARAMETERS	TERS	LIMITS	TS
			MEAN	STD DEV	MIN	MAX
Solid phase decay coefficient	1/yr	CONSTANT	6.000E+08 -999.	-999,	9.000E+00	Ø.100E+11
Dissolved phase decay coefficient	1/yr	CONSTANT	6.000E+00 -999	-666-	0.000E+00	0.100E+11
Overall chemical decay coefficient	1/yr	CONSTANT	8.800E+88 -999.	.666-	8.886E+68	0.100E+11
Acid catalyzed hydrolysis rate	1/M-yr	CONSTANT	6-606E+66 -566	-666-	0.000E+00	-989.
Neutral hydrolysis rate constant	1/yr	CONSTANT	9.000E+09 -999.	-666-	8.000E+08	-666-
Base catalyzed hydrolysis rate	1/M-yr	CONSTANT	9.000E+00 -339.	.999.	0.000E+00	-939.
Reference temperature	U	CONSTANT	20.0	-999.	0.999E+90	199.
Normalized distribution coefficient	m1/g	CONSTANT	0.000E+00 -999.	-666-	8.800E+80	-666
Distribution coefficient	' ;	DERIVED	-666-	-986-	0.000E+80	0.100E+11
Biodegradation coefficient (sat. zone)	1/yr	CONSTANT	0.000E+80 -999.	.999.	0.800E+80	-686-
Air diffusion coefficient	cm2/s	CONSTANT	9.666E+68 -555.	.666	0.000E+00	10.6
Reference temperature for air diffusion	Ų	CONSTANT	0.000E+00 -999.	-996°	9.800E+80	199.
Molecular weight	g/M	CONSTANT	0.000E+00 -999.	-999.	0.808E+80	-666-
Mole fraction of solute	- 1	CONSTANT	8.888E+88 -999.	.999.	0.100E-08	1.00
Vapor pressure of solute	寄	CONSTANT	8.000E+08 -999.	-999	6.890E+88	180.
	atm-m^3/M	CONSTANT	0.860E+88 -999.	-999-	0.100E-09	1.00
cay sat. zone	1/yr	DERIVED	0.000E+60	8.000E+60 0.000E+00	0.900E+80	1.00

SOURCE SPECIFIC WALAGEES PARAMETES LIDITS	VARIABLE NAME	SOURC	E SPECIFIC VARIABLES				
MILTS DISTRIBUTION PARAMETERS LIMITY L	VARIABLE NAME						
Active	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	UNITS	DISTRIBUTION	PARAM	ETERS STD DEV	i —	!
Authorsal unit	Infiltration rate	m/yr	CONSTANT	0.255E-06	ı	9.190E-09	0.100E+11
CONSTANT -999. -999. 0.1006-08	Area of waste disposal unit	m^2	CONSTANT	0.486E+96		9.188E-01	-666-
DERIVED 0.999. 0.100E-08	Duration of pulse	٦X	CONSTANT	.999.	.999	0.100E-08	-666-
CONSTANT 6.368E-09 6.080E-09 In/yr CONSTANT 6.368E-09 1.090E-09 In facility mg/1 CONSTANT 1.00 -999. 6.080E-09 In facility mg/1 CONSTANT 1.00 1.999. 9.100E-08 In facility mg/1 CONSTANT 1.00 1.999. 9.100E-08 In DERIVED -999. 9.100E-08 AQUIFER SPECIFIC VARIABLES ACOUSTANT 0.381E-01 -999. 0.100E-08 ity g/c CONSTANT 0.381E-01 -999. 0.100E-08 ity g/c CONSTANT 0.430 -999. 0.100E-08 ity CONSTANT 0.400 -999. 0.100E-08 ity CONSTANT 0.2009. 0.999. 0.100E-08 ity CONSTANT 0.2009. 0.999. 0.100E-08 ity CONSTANT 0.2009. 0.999. 0.100E-09 ity CONSTANT 0.2009. 0.999. 0.999. 0.100E-09 ity CONSTANT 0.2009. 0.999. 0.100E-09 ity CONSTANT 0.2009. 0.999. 0.100E-09 ity CONSTANT 0.2009. 0.999. 0.999. 0.100E-09 ity CONSTANT 0.2009. 0.999. 0.999. 0.100E-09 ity CONSTANT 0.2009. 0.999. 0	Spread of contaminant source	E	DERIVED	-666-		9.100E-08	0.100E+11
CONSTANT 0.000E+00 999 0.000E+00	Recharge rate	m/yr	CONSTANT	0.368E-01		9.600E+00	0.100E+11
The facility The	Source decay constant	1/yr	CONSTANT	6.000E+00		9.696E+69	-666-
## DERIVED -999999. 999. 9.100E-08	Initial concentration at landfill	mg/1	CONSTANT	1.00	-999	8.888E+88	-888-
Facility	Length scale of facility	E	DERIVED	-989.	-666-	9.180E-08	0.100E+11
ARIABLE NAME AQUIFER SPECIFIC VARIABLES ARIABLE NAME UNITS DISTRIBUTION MEAN TO CONSTANT	Width scale of facility	E	DERIVED	-999.	-999.	0.100E-08	0.100E+11
AQUIFER SPECIFIC VARIABLES AQUIFER SPECIFIC VARIABLES ARIABLE NAME UNITS DISTRIBUTION MEAN STD DEV MIN CONSTANT 1.65 -999. 0.1006-08 6.006-08 6.006-08 6.006-08 6.006-08 6.006-08 6.006-08 6.006-08 6.006-08 6.006-08 6.006-08 6.006-08 6.006-08 6.006-09 6	יבפן ודבדת מדדמנדלן		1	}	200)
ty CONSTANT CO	VARIABLE NAME	UNITS	DISTRIBUTION	PARAM	ETERS STD DEV	; -	}
CONSTANT 0.430 -999. 0.100E-08 0.100E-09 0	Particle diameter		CONSTANT	0.3816-01	; '	9.190E-08	199.
## CONSTANT 1.65 -999. 0.100E-01 0.005. ## CONSTANT 1.66 -999. 0.100E-02 0.100E-03 0.	**************************************		TAKTORCO	927		0 1005.00	000
Designation	Addition postably	00/8	CONSTANT	254	. 00	0 100E-01	200
## CONSTANT 136, 999, 999, 999, 999, 999, 999, 999, 9	Annifer thickness	; ò E	CONSTANT	10.0	.066	9.198E-88	8.180E+86
(hydraulic)		: 5	DERIVED	-999.	-999	0.100E-08	0.100E+96
CONSTANT 0.200E-02 -999. 0.100E-07		m/vr	CONSTANT	130.	.666	0.100E-06	0.100E+09
eepage velocity m/yr DERIVED DERIVED OF X -999. -999. -999. -100 -100 -100 -100 -100 -100 -100 -100	Gradient (hydraulic)		CONSTANT	0.200E-02		9.190E-07	-999
Oefficient DERIVED -999. -999. 1.00 dispersivity m FUNCTION OF X -999. -999. -999. spersivity m FUNCTION OF X -999. -999. -999. ersivity m FUNCTION OF X -999. -999. -999. f aquifer C CONSTANT 21.0 -999. 0.2006 n content (fraction) m CONSTANT 7.20 -999. 0.1006 from site m CONSTANT 58.0 -999. 0.1006 distance m CONSTANT 0.000E+00 -999. 0.000E+00 distance m CONSTANT 0.000E+00 -999. 0.000E+00 study m CONSTANT 0.000E+00 -999. 0.000E+00 study m CONSTANT 0.000E+00 -999. 0.000E+00	Groundwater seepage velocity	m/yr	DERIVED	-666-		9.100E-09	0.100E+09
Spersivity	Retardation coefficient	`;	DERIVED	-666-	.999.	1.00	0.100E+09
spersivity m FUNCTION OF X -999. -999. -999. ersivity m FUNCTION OF X -999. -999. -999. -999. f aquifer C CONSTANT 21.0 -999. 0.000E+00 -999. 0.000E+00 n content (fraction) m CONSTANT 0.300E+02-999. 0.100E-05 0.100E-05 from site degree CONSTANT 0.000E+00-999. 0.000E+00 0.000E+00 distance m CONSTANT 0.000E+00-999. 0.000E+00 0.000E+00 SATURATED ZONE MODEL 0.7579E-04 0.7579E-04 0.000E+00 0.000E+00 0.000E+00	Longitudinal dispersivity	Ε	늄	-999.	-999-	-999-	-888-
Fequifer C CONSTANT 21.0 -99909990999099909990999099999909	Transverse dispersivity	E	9	-666-	-999.	-999.	.666-
f aquifer C CONSTANT 21.0 -999. 0.000E+00 C CONSTANT 7.20 -999. 0.300 0.300	Vertical dispersivity	E	5	-666-	-666-	-666-	-666-
CONSTANT 7.20 -999, 0.380	Temperature of aquifer	U	CONSTANT	21.0	-666-	0.000E+00	100.
from site	. На	;	CONSTANT	7.20	-666-	0.300	14.0
from site m CONSTANT 58.8 -999. 1.88 -1.88	anic carbo		CONSTANT	0.300E-02		0.109E-85	1.60
ter degree CONSTANT 0.000E+00 -999. 0.000E+00 distance m CONSTANT 0.000E+00 -999. 0.000E+00 SATURATED ZONE MODEL 0.7579E-04	Well distance from site	E	CONSTANT	58.0	-666-	1.66	-666-
distance m CONSTANT 0.000E+00 -999. 0.000E+00 SATURATED ZONE MODEL 0.7579E-04 0.7579E-04 0.7579E-04		degree	CONSTANT	9.880E+86		Ø.000E+00	360.
		턭	CONSTANT	6.800E+86		0.000E+00	1.00
		7579E-84					
			0 0000				

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AGENCY PROTECTION IRONMENTAL ^ **N** ŝ

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ASSESSMENT EXPOSURE

M ○ ○ E MULTIMEDIA

MULTIMED (Version 1.01, June 1991)

Run options

CASE10L Base Case With Zero Recharge

Location 1 Chemical simulated is DEFAULT CHEMICAL

Saturated zone model DETERMIN Option Chosen

Reject runs if Y coordinate outside plume Reject runs if Z coordinate outside plume Gaussian source used in saturated zone model Infiltration input by user Run was steady-state

CHEMICAL SPECIFIC VARIABLES

VARIABLE MAME	UNITS	DISTRIBUTION	PARAMETERS	ERS	LIMITS	75
			MEAN	STD DEV	MIN	XVW
Solid phase decay coefficient	1/yr	CONSTANT	0.000E+00 -999.	999.	0.000E+00	0.100E+11
Dissolved phase decay coefficient	1/yr	CONSTANT	0.000E+00 -999.	.666	0.000E+00	0.100E+11
Overall chemical decay coefficient	1/yr	CONSTANT	0.000E+00 -999.	.666	9.080E+00	0.100E+11
Acid catalyzed hydrolysis rate	1/M-yr	CONSTANT	0.000E+00 -999.	.666	9.888E+88	-666-
Neutral hydrolysis rate constant	1/yr	CONSTANT	0.000E+00 -999.	.666	B. 888E+88	-666-
Base catalyzed hydrolysis rate	1/M-yr	CONSTANT	0.080E+00 -999.	.666	9.880E+88	-666-
Reference temperature	س	CONSTANT	20.0	-666-	8.886E+88	100.
Normalized distribution coefficient	ml/g	CONSTANT	0.060E+00 -999.	.666	0.000E+00	-666-
Distribution coefficient	:	DERIVED	- 666~	-666-	0.000E+00	0.100E+11
Biodegradation coefficient (sat. zone)	1/yr	CONSTANT	8.880E+88 -999.	.666	B. 989E+98	-666-
Air diffusion coefficient	cm2/s	CONSTANT	8.000E+00 -999.	.666	0.000E+00	10.0
	U	CONSTANT	8.000E+00 -999.	.666	9.088E+86	100.
Molecular weight	B/M	CONSTANT	9.000E+08 -399.	.666	8.980E+09	-999.
Mole fraction of solute	. :	CONSTANT	9.000E+00 -999.	.666	0.100E-08	1.00
Vapor pressure of solute	man Hg	CONSTANT	0.888E+88 -999	. 666	0.800E+80	100.
	stm-m^3/M	CONSTANT	9-888E+88 -899	.666	B.188E-89	1.60

AME UNI	SOURCE SPECIFIC VARIABLES	v			
1	DISTRIBUTION	PARAMETERS MEAN STD	STERS STD DEV	LIMITS MIN	rs Max
+	CONSTANT	0.179E-06	-939.	0.100E-09	0.100E+11
dill.	CONSTANT	0.486E+86	.999.	0.188E-81	-999.
	CONSTANT	.999.	. 686	9.199E-98	-225
Spread of contaminant source	DEKIVED	- 7440. G GGGETTGG	-888-	o goot-go	0.100E+11.
	FNATANCO	o generado		9 999E+09	10000
Source decay considers 1/3/ Thitis concopration at landfill ms/1	CONSTANT	1.90	-000	6.000E+00	000
	DERIVED	-666-	-666	0.100E-08	0.160E+11
	CHATAGO	500	- 000	P 100F-08	8 180E+11
_	DERIVED	1.90	0.000E+00	9.000E+00	1.80
The state of the s	MOTE LEGISLE		,	ATTMT :	T.
VAKIABLE NAME UNLIS	DISTRIBUTION	MEAN STD	STD DEV	MIN	Z MAX
orasinos diameter Cm	CONSTANT	0.381E-01	-999.	0.100E-08	166.
	CONSTANT	6.430	-989	0.100E-08	965.8
Bulk density	CONSTANT	1.65	-666	0.100E-01	5.00
Kness	CONSTANT	10,0	-666-	0.100E-08	0.100E+06
(mixi	DERIVED	-666-	-666-	0.100E-08	0.100E+06
Conductivity (hydraulic) m/yr	CONSTANT	130.	-986-	0.100E-06	0.100E+09
Gradiant (hydraulic)	CONSTANT	במים מספר מ	{ { { { { { { { { {	1000	000
		0.200E-02	-868-	O'TOGE-B/	1
Groundwater seepage velocity m/yr	DERIVED	9. 200E-02 -999.	-866-	0.100E-09	0.100E+89
		9. 200E - 02 -999. -999.	. 999 . . 999 .	6.100E-09 1.00	0.100E+89
	유	9. 200E - 02 - 999. - 999.		8.100E-09 1.00 1.00	0.100E+89 0.100E+89 -999.
	<u> </u>	9. ZVOE - 10. - 999. - 999. - 999.		6.166E-69 1.66 1.99	0.100E+09 0.100E+09 -999.
	9 9 9	4. Zaber 192 - 999 . - 999 . - 999 .		6.1886 - 87 1.88 - 89 - 999 - 999 -	0.100E+89 0.100E+89 -999. -999.
	999	-999. -999. -999. -999. -999. 21.0		6.100E-07 6.100E-09 1.00 -999. -999. 0.000E+60	.100E+09 0.100E+09 0.100E+09 -999. 100.
	999	999. -999. -999. -999. -999. 71.0	. 666. 666. 666. 666. 666.	6.100E-07 6.100E-09 1.00 -999. -999. 0.000E+00	9.339. 0.100E+89 0.999. -999. 180.
tion)	9 9 9	9.200E-92. -999. -999. -999. -999. 7.20		6.186E-09 1.00 -999. -999. 0.000E+00 0.300	1939. 0.100E+89 0.100E+89 -999. -999. 100. 14.0
tion)	9 9 9	9.200E-92 -999. -999. -999. 21.0 7.20 6.300E-92		6.186E-09 1.00 1.00 -999. -999. 0.000E+00 0.100E-05	1395 0.100E+89 0.999. 1999. 100. 14.6
tion)	9 9 9	9.200E-02-999. -999. -999. -999. -999. 21.0 7.20 0.300E-02 58.0		0.100E-09 1.00 1.00 -999. -999. 0.000E+00 0.100E-05 1.00	1395. 0.100E+89 0.999. 1989. 1980. 14.6 1.60

AGENCY
ROTECTION
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ENVIRO
U. S.

CASELOLP

EXPOSURE ASSESSMENT

MULTIMEDIA MODEL

MULTIMED (Version 1.01, June 1991)

CASE101 Base Case Aquifer Porosity = 0.2

1 Run options Location 1
Chemical simulated is DEFAULT CHEMICAL

Option Chosen

Run was

Infiltration input by user
Run was steady-state
Rainet runs if Y coordinate outside plume

kun was steady-state
Reject runs if Y coordinate outside plume
Reject runs if Z coordinate outside plume
Gaussian source used in saturated zone model

CHEMICAL SPECIFIC VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN STD	ERS Std dev	LIMITS MIN	TS MAX
Solid phase decay coefficient	1/yr	CONSTANT	8.666E+68 -999	ъ.	0.000E+00	
Dissolved phase decay coefficient	1/yr	CONSTANT	0.800E+80 -999.	φ.	0.999E+69	0.100E+11
werall chemical decay coefficient	1/yr	CONSTANT	0.686≝+88 -999.	ā,	9.000E+00	0.1005+11
Acid catalyzed hydrolysis rate	1/M-yr	CONSTANT	0.000E+00 -999.		9.888E+88	-666
Mentral hydrolysis rate constant	1/VF	CONSTANT	0.808E+80 -999.	ф.	0.806E+88	-999.
Base catalyzed hydrolysis rate	1/M-Vr	CONSTANT	0.000E+00 -999.	, 6	8.898E+88	-666-
Reference temperature	, U	CONSTANT	29.6 -999.	O	8.000E+00	100.
Normalized distribution coefficient	m1/g	CONSTANT	0.808E+88 -999.	g	0.0005+00	-999.
Distribution coefficient	• - -	DERIVED	.686689.	. 6	0.000E+00	0.100E+11
iodegradation coefficient (sat. zone)	1/vr	CONSTANT	0.000E+00 -999.	.6	9.000E+00	-999.
Air diffusion coefficient	cm2/s	CONSTANT	0.000E+00 -999	.6	0.000E+00	10.0
Reference temperature for air diffusion		CONSTANT	0.000E+00 -999	.6	0.000E+00	100.
Molecular weight	M/a	CONSTANT	0.000E+00 -999	. 6	0.000E+00	-999.
Mole fraction of solute	; ;	CONSTANT	8.688E+68 -999	00.	9.190E-08	1.90
solute	man Hg	CONSTANT	0.000E+00 -999.	ĕ.	0.000E+00	169.
ant	atm-m^3/M	CONSTANT	6.668E+86 +999.		8.180E-09	1.00

	SOURCE SPECIFIC VARIABLES			
VARIABLE NAME	S DISTRIBUTION	PARAMETERS MEAN STD DEV	LIMITS	S
Infiltration rate m/yr Arabica of waste disposal unit m/2	r CONSTANT CONSTANT	0.179E-86 -999. 0.486E+06 -999.	0.100E-09 0.100E-01	0.100E+11 ~999.
nant source		5		6.100E+11
kechange rate Source decay constant 1/yr				-999.
at landfill				.999.
>	DERIVED	-999999. -999	0.100E-08	6.190E+11 a 190E+11
.	DERIVED	. ~		1.80
VARIABLE NAME UNITS	S DISTRIBUTION	RAMET	STIMIT	:
	11 11 11 11 11 11 11 11 11 11 11 11 11	MEAN STD DEV	MIN	MAX
Particle diameter cm	CONSTANT	0.381E-01 -999.		168.
らえたソ				8.998
				5.00
Adulter thickness	CONSTANT	TO:000		0.100E+00
Source thickness (mixing zone depon) ##	DERIVED	. 666. 651	B 1885-86	0.100E+00
		E-82		-999.
Groundwater seepage velocity m/vr				0.100E+09
	DERIVED	-999999.		0.100E+09
Longitudinal dispersivity	FUNCTION OF X	-999999.		-989.
Transverse dispersivity	FUNCTION OF X			-999.
Vertical dispersivity m	占	-999999.	-999.	-956
Temperature of aquifer	CONSTANT		0.00E+00	190.
	CONSTANT		9.398	14.6
Organic carbon content (fraction)	CONSTANT	0.300E-02 -999.	0.100E-05	1.00
Well distance from site	CONSTANT	58.0 -999.		-999.
Angle off center degree	CONSTANT	0.888E+88 -999.	0.000E+60	369.
tance	CONSTANT	8.888E+88 ~999.	0.000E+60	1.88

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CASE10LZ

ASSESSMENT EXPOSURE

MODEL

MULTIMEDIA

MULTIMED (Version 1.01, June 1991)

CASE101 Base Case With Aquifer Porosity = $\theta.6$

Run options

Location 1 Chemical simulated is DEFAULT CHEMICAL

Saturated zone model DETERMIN Option Chosen

Run was steady-state Reject runs if Y coordinate outside plume Reject runs if Z coordinate outside plume Gaussian source used in saturated zone model Infiltration input by user

CHEMICAL SPECIFIC VARIABLES

VARIABLE NAME	CNITS	DISTRIBUTION	AMET	ERS	LIMITS	SE.
				7	7	<u>.</u>
Solid obase decay coefficient	1/46	CONSTANT	9.800E+88 -999	.666	9.898E+89	0.100E+11
Dissolved phase decay coefficient	1/4	CONSTANT	8.800E+88 -999.	.666	0.000E+00	
erall chemical decay coefficient	1/vr	CONSTANT	8.660E+68 -999.	.666	9.880E+88	0.108E+11
Acid catalyzed hydrolysis rate	1/M-Yr	CONSTANT	0.888E+88 -999.	.666	0.800E+80	-666-
Neutral hydrolysis rate constant	1/yr	CONSTANT	0.000E+00 -000.	999.	9.000E+00	-666-
Base catalyzed hydrolysis mate	1/M-Vr	CONSTANT	0.800E+00 -999.	.666	0.000E+80	-888
Reference temperature	,	CONSTANT	29.8	.999.	0.000E+60	100.
Normalized distribution coefficient	m1/g	CONSTANT	0.000E+00 -999.	.666	8.888E+88	.999.
Distribution coefficient	1	DERIVED	- 666-	-666-	8.000E+90	0.100E+11
Biodegradation coefficient (sat. zone)	1/vr	CONSTANT	0.808E+88 -999.	999.	0.000E+00	-666
Air diffusion coefficient	cm2/s	CONSTANT	6.808E+88 -999.	.666	0.000E+00	10.0
Reference temperature for air diffusion	U	CONSTANT	8.888E+88 -999	.666	9.000E+00	100.
Molecular weight	M/R	CONSTANT	0.006E+00 -999	.666	8.888E+88	.666-
Mole fraction of solute	; ;	CONSTANT	8-888E+88 -999	.666	0.100E-08	-88 1.99
Vapor pressure of solute	五	CONSTANT	0.000E+00 .999	.666	9.980E+99	100.
101	atm-m/3/M	CONSTANT	0.000E+00 -999	.666	0.100E-09	1.90

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1.80 1.80 1.80	, , , , , , , , , , , , , , , , , , ,	TS MAX	0.100E+11	-999-	n to	0.100E+11	- 000	. 666	A 1995±11	0 1000 - 100 C	0.100F+11	1.00		75	MAX	186.	956.0	5.00	0.100E+96	0.109E+86	Ø.106E+09	-666-	0.100E+09	0.100E+09	-666-	-666-	-666-	100.	14.0	1.68	.999	366.	1.89
0.0005+00 0.0005+00 0.0005+00	#	LIMITS	8.180E-09	6.188E-01	# 180E-08	6.1666-68	a page 100	9-090E+09	1001100	001100110	0.100E-08	9.080E+00		LIMITS	MIN	0.100E-08	0.100E-08	0.100E-01	0.100E-08	0.160E-08	8.188E-86	0.100E-07	0.100E-09	1.00	-666-	-999-	-866-	0.000E+00	0.300	0.100E-05	1.80	0.000E+00	0.000E+00
0.000E+00 0.000E+00 -999999.	;	ETERS STD DEV			. 666	. 666 666 666			000		. W.W.	0.000E+00		ETERS	STD DEV	.999.	.666	-999.	.999.	-999.	-999-		-666-	-666-	.999.	-999.	-666-	.999.	-666-	-666-	.666-	-666-	.999.
		PARAMETERS MEAN STD	8.179E-86	0.486E+96	, no.	1999. 8 3881.81	a George	2000	000	.000	566-	1.99	ςη	PARAMETERS	MEAN	0.3816-01	0.600	1.65	16.6	.666-	130.	0.200E-02	-666-	.666-	.999.	-989.	-999-	21.0	7.28	0.300E-02	58.6	0.000E+00	0.000E+00
CASE10LZ DERIVED CONSTANT CONSTANT	SOURCE SPECIFIC VARIABLES	DISTRIBUTION	CONSTANT	CONSTANT	CONSTANT	COMSTANT	CONCTANT	TWATCHOO	0077600	DENTALED	DEKTVED	DERIVED	AQUIFER SPECIFIC VARIABLËS	DISTRIBUTION		CONSTANT	CONSTANT	CONSTANT	CONSTANT	DERIVED	CONSTANT	CONSTANT	DERIVED	DERIVED	FUNCTION OF X	FUNCTION OF X	FUNCTION OF X	CONSTANT	CONSTANT	CONSTANT	CONSTANT	CONSTANT	CONSTANT
1/yr	SOURC	UNITS	m/yr	m^2	γŗ	E 6	, k	_ \	19 1	ݜ	E		AQUIFE	UNITS		EU	ı J	B/cc	E	Æ	m/yr		m/yr	1	臣	멸	e	υ	:		臣	degree	E
Overall 1st order decay sat. zone Not currently used Not currently used		VARIABLE NAME	Infiltration rate	Area of waste disposal unit		Spread of contaminant source	Catalogy Late Catalogy Adams Constant	Journal Contestantion of Journal		Length Scale of Tatally	Width scale of facility	Near field dilution		VARIABLE NAME		Particle diameter	Aquifer porosity	Bulk density	Aquifer thickness	Source thickness (mixing zone depth)	Conductivity (hydraulic)	Gradient (hydraulic)	Groundwater seepage velocity	Retardation coefficient	Longitudinal dispersivity	Transverse dispersivity	Vertical dispersivity	Temperature of aquifer		Organic carbon content (fraction)	4	Angle off center	Well vertical distance

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ASSESSMENT EXPOSURE

MODEL MULTIMEDIA

MULTIMED (Version 1.01, June 1991)

1 Run options

CASEIOL Base Case Bulk Density = 1.60 (Sandy Clay)

Chemical simulated is DEFAULT CHEMICAL Location 1

Saturated zone model DETERMIN Option Chosen

Infiltration input by user Run was steady-state Reject runs if Y coordinate outside plume Reject runs if Z coordinate outside plume Gaussian source used in saturated zone model

CHEMICAL SPECIFIC VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN STD	TERS STD DEV	STIMIJ MIM	TS MAX
Solid phase decay coefficient	1/yr	CONSTANT	8.080E+08 -999.	-999.	6.000E+00	0.188E+11
Dissolved phase decay coefficient	1/yr	CONSTANT	0.000E+00 -999.	-666-	0.000E+00	0.100E+11
Overall chemical decay coefficient	1/VF	CONSTANT	8.080E+08 -999.	-666-	0.000E+08	8.188E+11
Acid catalyzed hydrolysis rate	1/M-yr	CONSTANT	0.000E+00 -999.	-999.	8.000E+00	-666-
Neutral hydrolysis rate constant	1/yr	CONSTANT	8.000E+00 -999.	-999.	8.000E+00	-988.
Base catalyzed hydrolysis mate	1/M-yr	CONSTANT	6.000E+00 -999.	-666-	0.000E+00	-666-
Reference temperature	, U	CONSTANT	20.0	.666.	9.000E+00	169.
Normalized distribution coefficient	ml/g	CONSTANT	0.000E+08 -999.	-666-	0-6005+60	-666-
Distribution coefficient		DERIVED	-666-	-666-	9-888E+88	0.100E+11
Biodegradation coefficient (sat. zone)	1/4	CONSTANT	9.000E+08 -999.	-666-	0.600E+60	.666-
Air diffusion coefficient	cm2/s	CONSTANT	8.888E+88 -999.	-666-	9.880E+88	19.0
Reference temperature for air diffusion	U	CONSTANT	0.000E+60 -999.	-666-	0.888E+88	199.
Molecular weight	R/M	CONSTANT	9.000E+00 -999.	-986-	0.800E+00	-666
Mole fraction of solute	:	CONSTANT	0.000E+00 -559.	-666-	0.100E-08	1.00
Vapor pressure of solute	man Kg	CONSTANT	0.888E+88 -999.	-999	0.868E+88	100.
	atm-m^3/M	CONSTANT	8.666E+68 -999.	-999	0.100E-09	1.00

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SLE NAME UNI	SOURCE SPECIFIC VARIABLES ITS DISTRIBUTION /yr CONSTANT CONSTANT DETVED /yr CONSTANT S/1 CONSTANT BERIVED DERIVED DERIVE	PARAMETERS MEAN STD DEV 0.179E-06 -999999999999999. 1.00 -999. 1.00 -999999999. 1.00 0.000E+00 PARAMETERS MEAN STD DEV	MIN 1108E-09 0 0 100E-01 0 100E-08 0 0 000E+00 0 0 000E+00 0 0 0 000E+00 0 0 0	S MAX 0.180E+11 9.999. 9.999. 0.180E+11 999. 9.180E+11 1.00
RIABLE NAME	DISTRIBUTION CONSTANT SPECIFIC VARIABLES	1.00	MIN LIMIT NIN C. 100E-09 0.100E-09 0.100E-08 0.000E+00 0.000E+00 0.100E-08 0	0.100E+11 -999. -999. -999. -999. -999. -999. -999. -999. -999. -999.
1	CONSTANT CONSTANT CONSTANT CONSTANT DERIVED CONSTANT CONSTANT CONSTANT DERIVED DERIVED DERIVED SPECIFIC VARIABLES	1.01 1.01 1.01	0.100E-09 0.100E-08 0.100E-08 0.100E-08 0.000E+00 0.100E-08 0.100E-08	0.100E+11 -999. -999. 0.100E+11 -999. -999. 0.100E+11 1.00
+*****	CONSTANT CONSTANT DERIVED CONSTANT CONSTANT CONSTANT DERIVED DERIVED DERIVED DERIVED SPECIFIC VARIABLES	1+06 1+09 1+09	0.100E-01 0.100E-08 0.100E-08 0.000E+00 0.000E+00 0.100E-08 0.100E-08 0.100E-08	-999. -999. 6.100E+11 -999. -999. -999. -100E+11 1.00
מספת מודור	CONSTANT DERIVED CONSTANT CONSTANT CONSTANT DERIVED DERIVED DERIVED SPECIFIC VARIABLES	1.001 1.000	0.100E-08 0.100E-08 0.000E+00 0.000E+00 0.100E+00 0.100E+00 0.100E+00 0.100E+00	-999. 0.100E+11 -999. 0.100E+11 1.00 1.00 MAX
Duration of pulse	DERIVED CONSTANT CONSTANT CONSTANT DERIVED DERIVED DERIVED SPECIFIC VARIABLES	5.400 4.4.4.4.4.4.4.4.4.4.4.4.4.4.4.4.4.4	9.199E-98 9.990E-499 9.190E-48 9.190E-88 9.190E-88 9.500E-88	0.100E+11 -999. -999. -999. 0.100E+11 1.00
caminant source	CONSTANT CONSTANT CONSTANT DERIVED DERIVED DERIVED SPECIFIC VARIABLES	5+00 5+00 4 ARAME	0.000E+00 0.000E+00 0.100E+00 0.100E+00 0.100E+00 0.000E+00	0.100E+11 -999. 0.100E+11 1.00 1.00
	CONSTANT CONSTANT DERIVED DERIVED DERIVED SPECIFIC VARIABLES	E+00	0.000E+00 0.000E+00 0.100E-08 0.000E+00	-999. -999. -999. -9100E+11 1.00
	CONSIANI DERIVED DERIVED DERIVED SPECIFIC VARIABLES	4RAME	0.100E-08 0.100E-08 0.900E+00	0.100E+11 1.00 1.00 1.00 1.00 NAX
Tand#111	DERIVED DERIVED DERIVED SPECIFIC VARIABLES		0.100E-08 0.100E-08 0.900E+00	6,100E+11 1.00 1.00 NAX
·	DERIVED DERIVED SPECIFIC VARIABLES	ARAME:	6.999E+99	9.100E+11 1.00 1.00 7.1.00
Width scale of tacility	SPECIFIC VARIABLES	ARAME	o.eoenttee	<u>.</u>
AQUIFER :		.AMET	F	E C
VARIABLE NAME	DISTRIBUTION	!		
			N Th	
	CONSTANT	0.381E-01 -999.	0.100E-08	166.
Aguifer porosity	CONSTANT	0.436 -999.	0.100E-08	0.598
Bulk density	CONSTANT	1.50 -999.	0.100E-01	5.00
Kness	CONSTANT	10.0 -999.	0.100E-08	0.100E+06
(mixing zone depth)	DERIVED	-999999.	0.100E-08	9.100E+06
	CONSTANT	130999.	0.100E-05	0.100E+09
	CONSTANT	8.200E-82 -999.	0.108E-87	-666-
Groundwater seepage velocity m/yr	DERIVED	-666-	0.100E-09	0.108E+89
			1.98	0.100E+89
Longitudinal dispersivity	FUNCTION OF X	-939939.	-999	-999.
Transverse dispersivity	FUNCTION OF X		-999	-666-
Vertical dispersivity	FUNCTION OF X	.999999.	-686-	-999.
•	CONSTANT	21.8 -999.	0.000E+00	100.
	CONSTANT	7.20 -999.	8,306	14.0
Organic carbon content (fraction)	CONSTANT	0.300E-02 -999.	0.100E-05	1.00
Well distance from site	CONSTANT	58.8 -999.	1.08	-986-
Angle off center	CONSTANT	190	8.080E+80	368.
stance	COMPTANT		8.888E+88	1,69

Part III Attachment 5, Appendix H.3, p.g.-12

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AGENCY PROTECTION ENVIRONMENTAL vi

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ASSESSMENT EXPOSURE

MODEL MULTIMEDIA MULTIMED (Version 1.01, June 1991)

CASEIOL Base Case Bulk Density = 1.70 (Loam & Sandy Clay Loam)

Run options

Location 1 Chemical simulated is DEFAULT CHEMICAL

Saturated zone model DETERMIN Option Chosen

Reject runs if Y coordinate outside plume Reject runs if Z coordinate outside plume Gaussian source used in saturated zone model Infiltration input by user Run was steady-state

CHEMICAL SPECIFIC VARIABLES

	1					
VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN STD	STD DEV	LIMITS MIN	TS MAX
Solid phase decay coefficient	1/vr	CONSTANT	.0.000E+00 -999.	-989.	0.000E+00	3.000E+00 0.100E+11
Dissolved phase decay coefficient	1/vr	CONSTANT	0.000E+00 -939.	-686-	9.888E+88	9.198E+11
Overall chemical decay coefficient	1/yr	CONSTANT	0.000E+00 -999.	-999.	0.000E+90	0.100E+11
Acid catalyzed hydrolysis rate	1/M-yr	CONSTANT	0.008E+00 -999.	-666-	0.000E+00	-999.
Neutral hydrolysis rate constant	1/yr	CONSTANT	0.000E+00 -999.	.999.	9.000E+00	-999.
Base catalyzed hydrolysis rate	1/M-yr	CONSTANT	0.000E+00 -999.	-988	0.000E+00	-999.
Reference temperature	Ü	CONSTANT	20.0	-666-	0.000E+00	100.
Normalized distribution coefficient	m1/g	CONSTANT	0.000E+00 -999.	-666-	9.000E+00	-988.
Distribution coefficient	· ;	DERIVED	-666-	-986-	0.000E+00	-00 0.100E+11
Biodegradation coefficient (sat. zone)	1/yr	CONSTANT	8.986E+68 -999.	-888-	0.060E+00	.666-
Air diffusion coefficient	cm2/s	CONSTANT	0.000E+00 -099.	-666-	0.000E+00	19.9
Reference temperature for air diffusion	v	CONSTANT	0.088E+00 -999.	.999.	9.080E+00	100.
Molecular weight	M/B	CONSTANT	0.000E+00 -999.	-666	0.868E+88	-666
Mole fraction of solute	, 1	CONSTANT	0.000E+00 -999.	-999.	0.180E-08	1.99
Vapor pressure of solute	mm Hg	CONSTANT	0.000E+00 -999.	-986-	9.980E+09	100.
	atm-m^3/M	CONSTANT	0.000E+00 -999.	-999	0.190E-09	1.90

		6.65233	 - - - - -			-	н			П	+								9	9	ø		თ	Φ.									
1.88 1.88 1.88		TS MAX	0.100E+11	-666-	-666-	0.1005+11	0.1006+11	-666-	-666-	0.100E+11	0.100E+11	1.98		TS	MAX	100.	8.998	5.00	0.1005+06	0.109E+96	0.100E+09	-666-	0.100E+09	9.188E+89	-999	.999	.999.	109.	14.0	1.80	-999	360.	1.89
0.080E+08 0.080E+08 0.080E+08		LIMITS MIN	8.180E-09	0.100E-01	8.180E-08	0.100E-08	9-666E+66	9.690E+80	9.686E+68	0.100E-08	0.100E-08	0.600E+00		STIMIT	MIM	0.100E-08	9.100E-08	8.108E-81	0.100E-08	0.108E~88	8.100E-06	0.1005-07	0.100E-09	1.88	-999.	-989-	.999.	9.000E+00	0.300	0.180E-05	1.80	9,899E+98	8.000E+00
0.06081-00 0.00081-00 -999999. -999999.		ETERS STD DEV	-989-	-666-	-999-	-666-	.999	-999.	-966-	-888.	-988	0.000E+00		ETERS	STD DEV	.999	-666-	-999-	-888-	-999.	-999-	-666-		-686-	-666-	-989-	-666-	.666	-999.	-666-	-886-	-666-	
	vı	PARAMETERS MEAN STD	0.179E-06	0.486E+06	-666-	-666-	0.368E-01	6.000E+00	1.00	-666-	-666-	1.00	٧	PARAMETERS	MEAN	0.381E-01	6.430	1.70	10.0	-686-	130.	0.200E-02	-666-	-666-	-666-	-666-	-666-	21.0	7.29	0.300E-02	58.0	0.000E+00	0.000E+00
CASE1OLU DERIVED CONSTANT CONSTANT	SOURCE SPECIFIC VARIABLES	DISTRIBUTION	CONSTANT	CONSTANT	CONSTANT	DERIVED	CONSTANT	CONSTANT	CONSTANT	DERIVED	DERIVED	DERIVED	AQUIFER SPECIFIC VARIABLES	DISTRIBUTION		CONSTANT	CONSTANT	CONSTANT	CONSTANT	DERIVED	CONSTANT	CONSTANT	DERIVED	DERIVED	FUNCTION OF X	P	FUNCTION OF X	CONSTANT	CONSTANT	CONSTANT	CONSTANT	CONSTANT	CONSTANT
1/yr	SOURC	UNITS	m/yr	П^2	Ϋ́	Ε	⊓/yr	1/30	mg/1	E	Ħ		AQUIFE	UNITS		######################################	;	B/cc	Œ	Ħ	m/yr	•	m/vr	1	Ε	8	E	U	;		달	degree) A
Overall 1st order decay sat. zone Not currently used Not currently used		VARIABLE NAME	Infiltration rate	Area of waste disposal unit	Duration of pulse	Spread of contaminant source	Rechange rate	Source decay constant	Initial concentration at landfill	Length scale of facility	Width scale of facility	Near field dilution		VARIABLE NAME		Particle diameter	Aquifer porosity	Bulk density	Aquifer thickness	Source thickness (mixing zone depth)	Conductivity (hydraulic)	Gradient (hydraulic)	Groundwater seepage velocity	Retardation coefficient	Longitudinal dispersivity	Transverse dispersivity	Vertical dispersivity	Temperature of aquifer		Organic carbon content (fraction)		Angle off center	Well vertical distance

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CASE10LA

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ASSESSMENT EXPOSURE

MODEL MULTIMEDIA MULTIMED (Version 1.01, June 1991)

CASEIOL Base Case With Aquifer Thickness of 5 m

Run options

Location 1 Chemical simulated is DEFAULT CHEMICAL

Saturated zone model DETERMIN Option Chosen

Infiltration input by user Run was steady-state Run was

Reject runs if Y coordinate outside plume Reject runs if Z coordinate outside plume Gaussian source used in saturated zone model

CHEMICAL SPECIFIC VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS	TERS	STIMIT	
			MEAN	STO DEV	MIN	MAX
Solid phase decay coefficient	1/yr	CONSTANT	0.000E+00 -999.	-999-	0.000E+90	0.109E+11
Dissolved phase decay coefficient	1/yr	CONSTANT	0.0005+00 -999.	-999.	8.000E+00	0.1006+11
Overall chemical decay coefficient	1/yr	CONSTANT	6- 60E+00 -999	-666-	8.000E+00	0.1006+11
Acid catalyzed hydrolysis rate	1/M-yr	CONSTANT	0.808E+80 -999.	-666-	0.00BE+B0	-666-
Neutral hydrolysis rate constant	1/yr	CONSTANT	6.000E+00 -999.	-989.	0.000E+00	-989.
Base catalyzed hydrolysis rate	1/M-yr	CONSTANT	0.000E+00 -939.	-666-	8.888E+88	.666-
Reference temperature	U	CONSTANT	29.6	-666-	0.000E+00	196.
Normalized distribution coefficient	m1/8	CONSTANT	0.000E+00 -999.	-666-	0.009E+00	-686-
Distribution coefficient	}	DERIVED	-999	-666-	9.000E+00	0.100E+11
Biodegradation coefficient (sat. zone)	1/yr	CONSTANT	0,000E+00 -999.	-666-	0.000E+90	-666
Air diffusion coefficient	cm2/s	CONSTANT	0.000E+00 -999.	-666-	0.000E+00	10.0
Reference temperature for air diffusion	U	CONSTANT	0.008E+00 -999.	-989.	0.000E+00	108.
Molecular weight	g/M	CONSTANT	9.000E+00 -939.	-666-	9.000E+00	-686-
Mole fraction of solute	;	CONSTANT	0.000E+00 -999.	- 666	0.100E-08	1.88
Vapor pressure of solute	mm Hg	CONSTANT	0.008E+00 -999.	-999.	0.000E+00	106.
	аtт-т^3/М	CONSTANT	0.000E+00 -999.	-666-	0.100E-09	1.00

AMETERS STD STD - 999 - 999 - 9999 -	NIN LIMITS DIANTE-09 0 0.100E-09 0 0.100E-08 0 0.000E-08 0 0.000E-08 0 0.100E-08 0	15 MAX 0.100E+11 -999. 0.100E+11 -999. -999. 0.100E+11 0.100E+11 1.00
PARAME MEAN 6.179E-05 6.486E+05 -999. 6.809E+00 1.00 1.00 1.00	MIN 0.1006 0.1006 0.1006 0.0006 0.0006 0.100	15. MAX 0.100E+11 -999. 0.100E+11 0.100E+11 0.100E+11 1.00 1.00
9.179E-06 9.486E+06 -999. 9.368E-01 0.600E+00 1.00 1.00 1.00 1.00		0.100E+11 -999. -999. 0.100E+11 0.100E+11 -999. 0.100E+11 1.00
9.480E+65 -999. -999. 9.869E+90 1.999. -999. 1.90		-999. -999. 0.100E+11 -999. -999. 0.100E+11 1.00
999. 0.368E-01 0.609E+00 1.00 -999. 1.00 1.00		0.100E+11 0.100E+11 -999. 0.100E+11 0.100E+11 1.00
0.368E-01 0.600E+00 1.00 -999. -999. 1.00		0.100E+11 -999. -999. 0.100E+11 1.00 1.00
0.600E+00 1.00 -999. -999. 1.00		-999. -999. 0.100E+11 1.00 1.00
1.00 -999. 1.00 1.00		-999. 6 100E+11 0.100E+11 1.00
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1.80 1.80 PARAME		0. 1696+11 1.66 1.97
PARAME		: :
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0.381E-01 -999.	0.100E-08	106.
	0.100E-08	966.9
	0.100E-01	5.88
	9.100E-08	0.190E+06
	9.100E-08	0.100E+06
	9.198E-86	0.180E+69
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	0.300	14.0
	0.100E-05	1.00
	1.00	-666-
8.888E+88 -999.	9.999E+09	360.
	0000000	1.00
i ×××	PARAME MEAN 0.381E-01 0.430 1.55 5.00 -999. 130. 0.200E-02 -999. -999. 21.0 7.20 0.300E-02 58.0	0.381E-01 -999. 0.438 -999. 1.65 -999. 130999. 0.200E-02 -999999999999999999999. 21.0 -999. 7.20 -999. 58.0 -999.

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CASE10LF

ASSESSMENT EXPOSURE

MULTIMEDIA

MODEL

MULTIMED (Version 1.01, June 1991)

Run options

CASE10L Base Case Hydraulic Conductivity = 1,299 m/yr

Chemical simulated is DEFAULT CHEMICAL location 1

Saturated zone model DETERMIN Option Chosen

Infiltration input by user Run was steady-state

Reject runs if Y coordinate outside plume Reject runs if Z coordinate outside plume Gaussian source used in saturated zone model

CHEMICAL SPECIFIC VARIABLES

VARIABLE NAME	UNITIS	DISTRIBUTION	KAMET	LIMITS	
			MEAN SID DEV	N.T.	\$
solid phase decay coefficient	1/vr	CONSTANT	0.000E+00 -999.	8.889E+88	0.100E+11
Dissolved phase decay coefficient	1/vr	CONSTANT	0.000E+00 -999.	0.000E+90	0.100E+11
Overall chemical decay coefficient	1/vr	CONSTANT	0.000E+00 -999.	0.000E+00	0.100E+11
Acid catalyzed hydrolysis rate	1/M-vr	CONSTANT	0.808E+88 -999.	0.000E+00	-988
Neutral hydrolysis rate constant	1/vr	CONSTANT	0.000E+00 -999.	0.000E+00	-666
Base catalyzed bydrolysis mate	1/M-VF	CONSTANT	8.888E+88 -999.	0.060E+00	-999.
Reference temberature	U	CONSTANT	20.8 -999.	9.868E+88	100.
Normalized distribution coefficient	m1/g	CONSTANT	0.000E+00 -999.	0,000E+80	-666-
Distribution coefficient) 	DERIVED	-999-	9.000E+00	0.100E+11
iodegradation coefficient (sat. zone)	1/VF	CONSTANT	6.000E+00 -999.	8.050E+00	-666-
Air diffusion coefficient	cm2/s	CONSTANT	0.000E+00 -999.	0.000E+00	10.0
Reference temperature for air diffusion		CONSTANT	6.000E+00 -999.	0.000E+00	100.
Molerular weight		CONSTANT	6.000E+00 -999.	9.889E+98	.999.
Mole fraction of solute	;	CONSTANT	6.060E+80 -999.	0.190E-08	4.00
solute	H H	CONSTANT	9.000E+00 -000.	8.000E+00	100.
	W/SVm-mte	TNATANO	000E+00	B.188F-89	1.00

	SOURCE SPECIFIC VARIABLES					
		C VARIABLES				
LE NAMÉ	UNITS DISTRI	DISTRIBUTION	PARAMETERS MEAN STD	ETERS STD DEV	LIMITS	TS MAX
Infiltration rate Management of waste disnosal unit	m/yr CONSTANT	CONSTANT	0.179E-06	-666-	0.100E.09	0.100E+11 -999.
, ! !		CONSTANT	-988		0.100E-08	-956
ant source		VED	-999.	.999.	0.109E-98	0.100E+11
	, k	TANT	0.368E-01		9.000E+00	0.100E+11
constant		CONSTANT	0.000E+90	-666-	0.000E+00	.999
at landfill		CONSTANT	1.88	-999.	0.000E+00	-666-
jtv	DERIVED	VED	-999,	-666-	0.100E-08	0.100E+11
++		ZED ZED	666-	-999	9.100F-08	8.188E+11
Ţ		Z G	1.69	0.000E+08	0.888E+88	1.89
VARIABLE NAMÉ UN	UNITS DISTRI	DISTRIBUTION	PARAMETERS MEAN STD	ETERS STD DEV	LIMITS MIN	T\$ MAX
	5) 1 1 1 1 1 1 1 1 1		MEAN	SID DEV	NTM	MAK.
S	cm CONS	CONSTANT	0.381E-01		8.180E-08	169.
		CONSTANT	0.430	-999-	0.100E~08	966.8
	g/cc cons	CONSTANT	1.65	-989.	0.100E-01	5.88
kness		CONSTANT	10.0	-666-	9.180E-08	0.100E+06
zone depth)		VED	-666-		0.100E-08	0.100E+06
	m/yr CONS	CONSTANT	9.130E+04		8-180E-06	0.100E+09
Gradient (hydraulic)	CONS	CONSTANT	8.200E-02		0.100E-07	-666-
ocity	m/yr DERIVED	VED	.666-	-666-	0.100E-09	0.100E+09
Retardation coefficient	- DERIVED		-999-	-666-	1,00	0.100E+09
Longitudinal dispersivity		FUNCTION OF X	-666-	-666-	-666-	-999
Transverse dispersivity		P	-886-	-666-	-666-	-666-
		FUNCTION OF X	-999.	.999	-989-	-666-
_		CONSTANT	21.0	-666-	9.880E+88	100.
,	CONS	CONSTANT	7.20	-666-	9.396	14.0
Dreamic carbon content (fraction)	CONS	CONSTANT	0.300E-02	-999.	0.100E-85	1.00
Well distance from site m		CONSTANT	58.0	-666-	1.00	-666-
		CONSTANT	0.000E+00	.666- (0.000E+00	360.
		CONSTANT	0.000E+00	-666-	0.000E+00	1.69

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ASSESSMENT EXPOSURE

MODEL MULTIMEDIA MULTIMED (Version 1.01, June 1991)

Run options

CASEIOL Base Case With Hydraulic Conductivity = 12.99 m/yr

Location 1 Chemical simulated is DEFAULT CHEMICAL

Saturated zone model DETERMIN Infiltration input by user Option Chosen

Reject runs if Y coordinate outside plume Reject runs if Z coordinate outside plume Gaussian source used in saturated zone model Run was steady-state

CHEMICAL SPECIFIC VARIABLES

VARIABLE NAME	UNITS	UNITS DISTRIBUTION	PARAMETERS	TERS	LIMITS	TS	i
			MEAN	STD DEV	MIM	MAX	
Solid phase decay coefficient	1/yr	CONSTANT	0.000E+60 -999.	-999.	0.000E+00	0.100E+11	į
Dissolved phase decay coefficient	1/vr	CONSTANT	0.888E+88 -999.	-999.	0.808E+80	0.100E+11	
Overall chemical decay coefficient	1/yr	CONSTANT	8.686E+66 -999.	-666-	0.000E+80	0.108E+11	
Acid catalyzed hydrolysis rate	1/M-yr	CONSTANT	8.888E+98 -999.	-999.	9.880E+88	-666-	
Neutral hydrolysis rate constant	1/yr	CONSTANT	0.800E+80 -999.	-989.	0.808E+80		
Base catalyzed hydrolysis rate	1/M-yr	CONSTANT	0.000E+00 -999.	-999.	0.000E+80	-666-	
Reference temperature	'U	CONSTANT	20.0	-999-	0.000E+00	100.	
Normalized distribution coefficient	m1/8	CONSTANT	0.000E+00 -999.	-666-	8.888E+88	-666-	
Distribution coefficient	1	DERIVED	-939.	.666.	0.000E+00	0.109E+11	
Biodegradation coefficient (sat. zone)	1/yr	CONSTANT	6.666E+00 -999.	.666	0.000E+00		
Air diffusion coefficient	cm2/s	CONSTANT	0.000E+00 -999.	-666	0.000E+00	16.0	
Reference temperature for air diffusion	u	CONSTANT	0.000E+00 -999.	-666-	0.000E+00	100.	
Molecular weight	g/N	CONSTANT	0.000E+00 -999.	-989.	0.000E+00	-999-	
Mole fraction of solute	; ;	CONSTANT	6.888E+88 -999.	-666-	0.100E-08	1.98	
Vapor pressure of solute	men Hg	CONSTANT	0.008E+00 -999.	-999.	9.000E+00	100.	
	atm-m^3/M	CONSTANT	8.888E+88 -999.	.666-	0.100E-09	1.00	

Раде 1

CASE10LY 1/yr DERIVED 0.000E+00 0.000E+00 1.00 CONSTANT -999. 0.000E+00 1.00 CONSTANT -999. 0.000E+00 1.00	SQURCE SPECIFIC VARIABLES	UNITS DISTRIBUTION PARAMETERS LIMITS MEAN STD DEV MIN MAX	m/yr CONSTANT 0.179E-06 -999. 0.100E-09 0.100E+11		-999. 0.100E-08	-999. 0.108E-88	CONSTANT 0.368E-01 -999. 0.000E+00	CONSTANT 0.000E+00 -999. 0.000E+00	T 1.88 -999. 0.000E+00	-999. 0.100E-08	m DERIVED -999. 0.100E-08 0.100E+11	DERIVED 1.00 0.000E+00 0.000E+00 1.00
1/yr	SOURC	UNITS	ш/уг	IIV2	۲۲	=	m/yr	1/yr	mg/l	E	£	
Overall 1st order decay sat. zone Not currently used Not currently used		VARIABLE NAME	Infiltration rate	Area of waste disposal unit	Duration of pulse	Spread of contaminant source	Recharge rate		Initial concentration at landfill	Length scale of facility	Width scale of facility	Near field dilution

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ASSESSMENT EXPOSURE

MODEL MULTIMEDIA MULTIMED (Version 1.01, June 1991)

Run options

CASEIDL Base Case Hydraulic Gradient = 10E-3

Chemical simulated is DEFAULT CHEMICAL Location 1

Saturated zone model DETERMIN Option Chosen

Reject runs if Y coordinate outside plume Reject runs if Z coordinate outside plume Gaussian source used in saturated zone model Infiltration input by user Run was steady-state

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN STD DEV	DEV MIN	LIMITS N	rs Max
Colid phase deray coefficient	1/vr	CONSTANT	0,880E+80 -999,		9.000E+00	0.100E+11
Control product where decise confident	1/10	CONSTANT	8.888F+88 -999	_	9. BOOE+00	8.188E+11
District France Committee Committee	1/vr	CONSTANT	0.900E+90 -999.	•	9.000E+80	0.108E+11
Acid catalyzed hydrolysis mate	1/M-Vr	CONSTANT	0.888E+88 -999.	•	. 000E+00	.999.
Neutral hydrolysis nate constant	1/vr	CONSTANT	0.000E+00 -999.	60	. 000E+00	-666-
Base catalyzed hydrolysis rate	1/M-Vr	CONSTANT	0.808E+80 -999.	6,2	. 000E+00	-666-
Reference temperature	,	CONSTANT	20.6 -999.	ŭ	9.000E+00	100.
Normalized distribution coefficient	ml/g	CONSTANT	0.000E+00 -999.	w	. 000E+00	-999-
Distribution coefficient	1	DERIVED	-666-	20	. 000E+00	0.100E+11
Bindepredation coefficient (sat. zone)	1/vr	CONSTANT	0.000E+00 -999,		.000E+00	-966-
Air diffusion coefficient	Cm2/5	CONSTANT	8.080E+00 -999.		.000E+00	10.0
Reference temperature for air diffusion		CONSTANT	8.888E+88 -999.		. 888E+88	169.
Molecular weight		CONSTANT	8.000E+00 -999.	23	. 000E+00	-666-
Mole fraction of solute	, 1	CONSTANT	0.000E+00 -059.	6.0	.180E-08	1.00
	mm Hg	CONSTANT	6.000E+00 -999.	63)	. 888E+88	169.
Hanny's law constant	atm-m^3/M	CONSTANT	8-999E+88	0,19	1.188E-89	1.90

	SOURCE	SOURCE SPECIFIC VARIABLES				
VARIABLE NAME	UNITS	DISTRIBUTION	PARAM MEAN	PARAMETERS AN STD DEV	LIMITS	FS MAX
	77/E	CONSTANT	0.179E.86		6.189E-09	B.100E+11
Area of waste disposal unit	E 7,7	CONSTANT	0.486E+86		8.180E-01	-999.
Duration of buise	Ϋ́	CONSTANT	666-	-666-	0.100E-08	-999.
Spread of contaminant source	Æ	DERIVED	-666-	- 666-	0.100E-08	0.100E+11
Recharge parts	m/vr	CONSTANT	0.368E-01		8.000E+00	8.188E+11
Court of Court and	1/46	CONSTANT	0.000E+00		8.888E+88	-999
Touthout Contesting of Impation	[/sm	CONSTANT	1.00		G. GGGE+BG	-000-
	è	C07+00C	000	-000	A 100F-0X	1 1 2 2 L 1 1
בוומרון אכשדב הן ושכיידירא	E :	1000			1000	11.000
Width scale of facility	E	DEKLYED	, m	777	a Tage - ag	0.100E+11
Near tield dilution		UEKIVED	1.99	0.000E+00	0.000=+00	AD.I
VARIABLE NAME	UNITS	DISTRIBUTION	PARA	PARAMETERS	LIMITS	¦ .
			MEAN	STD DEV	MIN	MAX
Particle diameter	E	CONSTANT	0.381E-01	-989.	0.100E-08	199.
Annifer porosity	;	CONSTANT	9.430	-666-	0.100E-08	966.6
Bulk density	g/cc	CONSTANT	1.65	.999	0.100E-01	5.88
Aguifer thickness) E	CONSTANT	10.0	-666-	0.100E-08	0.100E+66
Source thickness (mixing zone depth)	æ	DERIVED	.999.	-999-	0.100E-08	0.100E+06
	m/yr	CONSTANT	130.	-999-	0.100E-06	0.100E+09
Gradient (hydraulic)	•	CONSTANT	0.100E-02		0.100E-07	-666-
Groundwater seebage velocity	m/yr	DERIVED	-999.	-999-	0.100E-69	0.100E+09
Retardation coefficient	1	DERIVED	.666-	-986-	1.00	0.100E+09
Longitudinal dispersivity	Ę	FUNCTION OF X	-666-	-666-	-666-	-666-
Transverse dispersivity	뚇	FUNCTION OF X	-999.	-666-	666-	-666-
Vertical dispersivity	E	FUNCTION OF X	-999	-666-	-666-	-6 6 6-
Temperature of aquifer	U		21.0	.999.	0.000E+00	100.
T	1	CONSTANT	7.20	.666	9.388	14.0
pro- Opension reston nontent (Assettion)		CONSTANT	9.300E-02		0.100E-05	1.68
Medical distance from site	æ	CONSTANT	6,85		1.00	.999
Andle off center	49000	CONSTANT	9.000F+00		9.000E+00	368.
Mell vertical distance	, , , ,	CONSTANT	9.889E+98		9.000E+00	1.90
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ASSESSMENT MODEL MULTIMEDIA EXPOSURE

MULTIMED (Version 1.81, June 1991)

CASEIOL Base Case Hydraulic Gradient = 10E-2

Chemical simulated is DEFAULT CHEMICAL Location 1

Saturated zone model DETERMIN Reject runs if Y coordinate outside plume Reject runs if Z coordinate outside plume Gaussian source used in saturated zone model Infiltration input by user Run was steady-state Option Chosen

CHEMICAL SPECIFIC VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS	TERS	TIMIT	
				SIU DEV	NTE	Y.
Solid phase decay coefficient	1/vr	CONSTANT	. 666 96+366.6	.999.	0.808E+80	0.100E+11
Dissolved phase decay coefficient	1/yr	CONSTANT	0.000E+00 -999.	-999.	0.000E+00	0.100E+11
Overall chemical decay coefficient	1/yr	CONSTANT	0.800E+80 -999.	-666-	0.000E+00	0.100E+11
Acid catalyzed hydrolysis rate	1/M-yr	CONSTANT	0.000E+00 -999.	-666-	8.866E+66	-666-
Neutral hydrolysis rate constant	1/yr	CONSTANT	0.808E+80 -999.	-999.	0.008E+80	-999.
Base catalyzed hydrolysis rate	1/M-yr	CONSTANT	0.000E+00 -999.	-999-	8.080E+00	.999.
Reference temperature	Û	CONSTANT	20.0	-666-	8.888E+88	106.
Normalized distribution coefficient	m1/g	CONSTANT	0.000E+00 -999.	-666-	0.000E+00	.999.
Distribution coefficient	1	DERIVED	-666-	.989.	0.000E+00	0.100E+11
Biodegradation coefficient (sat. zone)	1/yr	CONSTANT	0.000E+00 -999.	-666-	0.000E+00	-666-
Air diffusion coefficient	cm2/s	CONSTANT	0.886E+88 -999.	-666-	0.000E+80	10.0
Reference temperature for air diffusion	U	CONSTANT	0.008E+00 -999.	-666-	0.000E+90	106.
Molecular weight	M/g	CONSTANT	0.000E+00 -999.	-666-	0.000E+00	-999.
Mole fraction of solute	. :	CONSTANT	0.000E+00 -999.	-666	0.100E-08	1.80
Vapor pressure of solute	開張	CONSTANT	0.000E+00 -999	-999.	0.900E+80	100.
	atm-m^3/M	CONSTANT	8,080E+00 -999	-666-	0.100E-09	1.99

Page 1

unit m m unit y y source m m tandfill m m ty m m m m m m m m m m m m m m m m	SOURCE SPECIFIC VARIABLES ITS DISTRIBUTION ITS DISTRIBUTION CONSTANT CONSTANT CONSTANT CONSTANT CONSTANT CONSTANT GALL GALL GALL CONSTANT CONST	PARAMETERS MEAN STD DEV 0.179E-86 -999. 0.486E+86 -999999999. 0.368E-81 -999. 0.368E-81 -999. 1.60 -999. 1.60 0.608E+90	MIN 0.100E-09 0.100E-09 0.100E-08 0.100E-08 0.000E+00 0.000E+00 0.100E-08 0.100E-08	\$ MAX 6.100E+11 -999. -999. 6.100E+11 -999. 6.100E+11 1.90
rce branchill, marketill, marketi	_ i i	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	LIMIN MIN 0.100E-09 0.100E-08 0.100E-08 0.000E+00 0.000E+00 0.000E+00 0.100E-08 0.100E-08	\$ MAX 6.100E+11 -999. -999. 6.100E+11 -999. 6.100E+11 1.90
unit y y source mat landfill, maty when when the state of	;	+ 000 + 000 + 000 + 000	0.100E-09 0.100E-09 0.100E-08 0.100E-08 0.000E+00 0.000E+00 0.000E+00 0.000E+00	0.100E+11 -999. -999. 0.100E+11 -999. -999. 0.100E+11 1.90
source material mater	· · · · · · · · · · · · · · · · · · ·	1-01 1-01 1-00 1-00 1-00 1-00 1-00 1-00	0.100E-08 0.100E-08 0.000E+00 0.000E+00 0.100E-08 0.100E-08 0.000E+00	6.100E+11 0.100E+11 -999. -999. 0.100E+11 1.90
source material and ty make with the source material and the source material a	()	1 111	0.100E-08 0.000E+00 0.000E+00 0.100E-08 0.100E-08 0.000E+00	0.100E+11 0.100E+11 -999. -999. 0.100E+11 1.90
at landfill, mm ty VAME LY NAME CC CC CC CC CC CC CC CC CC	()	— і ш	0.000E+00 0.000E+00 0.100E-08 0.100E-08 0.000E+00	0.100E+11 -999. -999. 0.100E+11 1.90 1.90
at landfill m m ty m m ty m m ty m m m m m m m m m	()	- ш	0.000E+00 0.100E-08 0.100E-08 0.000E+00	-999. -999. 0.100E+11 1.90 1.90
ity m mty m mty make make make make make make make make	()	ARAME	0.000E+00 0.100E-08 0.000E+00	-999. 6.100E+11 1.90 1.90
	()	ARAME	0.100E-08 0.100E-08 0.000E+00	1.90 1.90 1.90 1.80
	DERIVED DERIVED CIFIC VARIABLES STRIBUTION	ARAME	6.000E+00	1.90 F
	CIFIC VARIABLES STRIBUTION	ARAME		; ;
UNITS Cm Sg/cc mm	STRIBUTION	RAMET	LIMIT	-
Cm				
CG C		1	MEN	
m m cc		0.381E-01 -999.	0.100E-08	160.
35/88 E			_	966.8
	CONSTANT	1.65 -999.	9.188E-01	5.00
1 (1)	CONSTANT			0.100E+06
zoue debtu) w	DERIVED	-999999.		0.100E+06
m/yr	CONSTANT	130999.		0.100E+09
	CONSTANT	0.100E-01 -999.	0.108E-87	-666-
velocity m/vr	DERIVED	-999999.	0.100E-09	0.100E+89
`;	DERIVED	-999-	1.00	0.100E+09
	N 0F	-999999.	- 666-	-999
ε	FUNCTION OF X	-989989-		-999.
	ä			-666-
	i	_	F+00	180
יים ביים ביים ביים ביים ביים ביים ביים	CONSTANT		2000.0	4.0
Discourse of the second of the	CONSTANT	07	O TOOF OF	1.86
ş	CONSTANT			-666-
# ae 1ae 7	CONSTANT	90	98+	360,
tance =	CONSTANT		9.000E+00	1.89
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		CASE10LG	ø	
1 U. S. ENVIRONE	¥	PROTECTIO	ON AGENCY	
0 d X fi	SURE A	SSESSMENT		
30 €	LTIMEDI	A MODEL		
MULTIME	ED (Version	MULTIMED (Version 1.01, June 1991)		
1 Run options				
CASE10L Base Case Hydraulic Gradient = 10E-1				
Location 1 Chemical simulated is DEFAULT CHEMICAL				
Option Chosen Run was Infiltration input by user Run was steady-state Reject runs if Y coordinate outside plume Reject runs if Z coordinate outside plume Reject runs if Z coordinate outside plume Reject runs if Z coordinate outside plume Gaussian source used in saturated zone model	Saturated zone model DETERMIN ume model			
- 1 - 1	CHEMICAL	CHEMICAL SPECIFIC VARIABLES	:	
VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN STD DEV	TIMI:
Solid phase decay coefficient	1/yr	CONSTANT		0.000E+00
Dissolved phase decay coefficient Overall chamical decay coefficient	1/yr	CONSTANT	8.858E+88 -959.	0.000E+00
Acid catalyzed hydrolysis rate	1/ // 1/M-yr	CONSTANT		0.000E+80
Neutral hydrolysis rate constant	1/yr	CONSTANT		6.000E+09
Base catalyzed hydrolysis rate	1/M-yr	CONSTANT	964	6.000E+00
Remember temperature	' و	CONSTANT	. 20.00 . 20.02	0 000 H00

	UNITS	UNITS DISTRIBUTION	PARAMETERS MEAN STD	TERS STD DEV	LIMITS	TS MAX
Solid phase decay coefficient	1/yr	CONSTANT	0.060E+00 -999.	-939,	0.000E+00	0.100E+11
Dissolved phase decay coefficient	1/yr	CONSTANT	6.888E+88 -999.	-989.	0.000E+00	
Overall chemical decay coefficient	1/yr	CONSTANT	8.888E+88 -999.	-666-	0.000E+00	8.198E+11
Acid catalyzed hydrolysis rate	1/M-yr	CONSTANT	0.000E+00 -000.	-966	0.000E+00	-666-
Neutral hydrolysis rate constant	1/yr	CONSTANT	0.080E+08 -999.	-666-	0.000E+09	-999.
Base catalyzed hydrolysis rate	1/M-yr	CONSTANT	0.000E+08 -999.	-989.	0.000E+00	-666-
Reference temperature	ئ	CONSTANT	20.0	-966	0.000E+00	109.
Normalized distribution coefficient	m1/8	CONSTANT	8.000E+00 -959.	-656-	6.000E+00	-999.
Distribution coefficient	;	DERIVED	-666-	.999.	6.060E+08	0.190E+11
Biodegradation coefficient (sat. zone)	1/yr	CONSTANT	6.600E+86 -999.	.999.	9.000E+00	-666-
Air diffusion coefficient	Cm2/s	CONSTANT	0.000E+00 -999.	-666-	9.000E+00	10.0
Reference temperature for air diffusion	Ų	CONSTANT	8.000E+00 -999.	-666-	9.000E+00	100.
Molecular weight	g/M	CONSTANT	6.690E+66 -999.	-666-	9.000E+00	-666-
Mole fraction of solute		CONSTANT	6.000E+00 -999.	-666-	9.100E-08	1.99
œ)	mm Hg	CONSTANT	6.000E+00 -999.	-666-	9.000E+00	169.
	atm-m^3/M	CONSTANT	8.888E+88 -999.	-666-	0.100E-09	1.88

Overall 1st order decay sat. zone Not currently used Not currently used	1/yr	CASELOLG DERIVED CONSTANT CONSTANT		0.000E+00 0.000E+00 -999999.	0.000E+00 0.000E+00 0.000E+00	4 4 80 80 4 80 80	
	SOURCE	SOURCE SPECIFIC VARIABLES					
VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS	STD DEV	STIMIT!	TS MAX	1
Infiltration rate	11/yr	CONSTANT	0.179E-06	.9999.	0.100E-09	0.100E+11	1
Area of waste disposal unit Duration of pulse	, r , r	CONSTANT	.999.	-999-	0.100E-08	-666-	
Spread of contaminant source	, E	DERIVED	-999.	-999	0.1005-08	0.100E+11	
kecharge rate Source decay constant	1 / Y L	CONSTANT	9.000E+00	. 00001 00001	9.000E+00	-999.	
Initial concentration at Landfill	mg/1	CONSTANT	1.66	-666-	0.000E+80	-666-	
Length scale of facility	E	DERIVED	-999-	-666-	0.100E-08	0.100E+11	
Width scale of facility Near field dilution	E	DERIVED	1.99	-999. 0.000E+06	Ø.109E-98 Ø.009E+99	0.166E+11 1.68	
	AQUIFE	AQUIFER SPECIFIC VARIABLES					
VARIABLE NAME	SLIND	DISTRIBUTION	PARAMETERS	TERS	LIMITS	TS	:
			MEAN	STD DEV	NIM	MAX	
Particle diameter	ES	CONSTANT	0.381E-01	-999.	0.100E-08	198.	
Aquifer porosity	;	CONSTANT	0.430	-666-	0.100E-08	965.9	
Bulk density	32/8	CONSTANT	1.65	-666-	0.100E-01	5.00	
Aquifer thickness	6	CONSTANT	10.0	-999	0.100E-08	8.188E+66	
Source thickness (mixing zone depth)	E 1	DERIVED	, 000 t	-999.	0.100E-08	0.100E+05	
Conductivity (nydrautic) Gradieot (hydramlic)	:: \ \	CONSTANT	6.166	.999.	0.1885-85 8.1885-87	-999	
Groundwater seebage velocity	m/vr	DERIVED	-999	-989	0.188E-89	6.100E+09	
Retardation coefficient	;	DERIVED	-666-	-666	1.60	8.188E+89	
Longitudinal dispersivity	€,	P	.999.	-666-	-996-	-666-	
Transverse dispersivity	E		.999.	-666-	0000-	-999-	
Vertical dispersivity	E	6	-666-	.999.	-666-	-999.	
Temperature of aquifer	U	CONSTANT	21.0	-966	0.000E+00	100.	
Ha	!	CONSTANT	7.20	-999.	6.369	14.0	
Organic carbon content (fraction)		CONSTANT	8.300E-02	-999-	9.190E-05	1.90	
Well distance from site	€ .	CONSTANT	58.6		1.00	. n.	
Angle off center	degree	CONSTANT	6.000E+00	-666-	9.000E+00	360.	
Well vertical distance	E	CONSTANT	0.000H-00	.999.	a.aao=+oa	T. 66	
ENTRATTON AFTER SATURATED ZONE MODEL 0.2242E-05	2242E-05						

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CASE10LO

ASSESSMENT MODEL MULTIMEDIA EXPOSURE

MULTIMED (Version 1.01, June 1991)

Run options

CASE10L Base Case Organic Carbon Content 0%

Location 1 Chemical simulated is DEFAULT CHEMICAL

Saturated zone model DETERMIN Infiltration input by user Option Chosen

Run was steady-state Reject runs if Y coordinate outside plume Reject runs if Z coordinate outside plume Gaussian source used in saturated zone model

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS	LIMITS	ξ
			MEAN STD DEV	ev MIN	MAX
Solid phase decay coefficient	1/yr	CONSTANT	0.000E+00 -999.	9.000E+86	0.100E+11
Dissolved phase decay coefficient	1/yr	CONSTANT	0.000E+00 -999.	0.000E+00	0.100E+11
Overall chemical decay coefficient	1/yr	CONSTANT	0.000E+80 -999.	0.000E+00	
Acid catalyzed hydrolysis rate	1/M-yr	CONSTANT	0.000E+00 -999.	0.000E+00	.999.
Neutral hydrolysis rate constant	1/yr	CONSTANT	0.000E+00 -999.	8.000E+00	-989.
Base catalyzed hydrolysis rate	1/M-yr	CONSTANT	0.888E+88 -999.	0.000E+00	-666-
Reference temperature	Ų	CONSTANT	20.0 -999.	0.000E+00	
Normalized distribution coefficient	m1/g	CONSTANT	6.000E+00 -999.	8.080E+00	.999.
Distribution coefficient	1	DERIVED	-986986	8.880E+88	0.100E+11
iodegradation coefficient (sat. zone)	1/yr	CONSTANT	0.000E+00 -999.	8.888E+86	.000
Air diffusion coefficient	cm2/s	CONSTANT	0.000E+00 -939.	8.000E+00	10.0
Reference temperature for air diffusion		CONSTANT	8.868E+88 -999.	8.080E+08	100.
Molecular weight	M/M	CONSTANT	0.000E+00 -999.	9.000E+00	-966 96-
Mole fraction of solute	; ;	CONSTANT	0.090E+00 -999.	6.160E-08	1.99
solute	mm Hg	CONSTANT	8.888E+88 -959.	8.888E+88	109.
- t-c	atm-m^3/M	CONSTANT	8.000E+08 -999.	6.1885-89	1.99

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1. 4 4. 86 86 86		S. MAX	0.100E+11	, 999.	0.100E+11	o.Tode+TI	. 0000	0.100E+11	0.100E+11	1.00		5	MAX	100.	966.9	5.68	0.100E+05	0.100E+06	0.100E+09	-866-	8.180E+09	9.180E+09	-999-	.999.	-666-	100.	14.0	1.00	, 6 66-	366.	1.00
0.0005+00 0.0005+00 0.0005+00		LIMITS MIN	0.100E-09	9.196E-61	0.100E-08	8.000E+98	0.000m+00	0.100E-08	Ø.188E-88	0.000E+00		LIMITS	MIN	0.100E-08	0.100E-08	0.100E-01	0.100E-08	0.100E-08	0.100E-05	0.100E-07	6.160E-09	1.68	.999.	-999	-999-	9.000E+00	9.390	0-100E-05	1.90	6.000E+00	0.888E+88
0.000E+00 0.000E+00 -999999. -999.		PARAMETERS AN STD DEV					- המה נספה נספה	.000	-666-	0.000E+00		PARAMETERS	STD DEV	1 -999.	-666-	.999.	.666-	-666-			-999	-956	-666-	-866	-999	-999	-666-				. 666- 6
	и	PARA MEAN	8.179E-86	8.486E+86 -999.	- 666	9.368E-01	9.8861+88	-999.	-666-	1.00	vı	PARA	MEAN	0.381E-01	0.430	1.65	10.0	-666-	130.	0.200E-02	-999.	- 99 9	-999.	-999-	.999	21.0	7.20	0.100E-05	58.0	6.000E+0B	8.889E+88
CASE1OLO DERIVED CONSTANT CONSTANT	SOURCE SPECIFIC VARIABLES	DESTRIBUTION	CONSTANT	CONSTAN	DERIVED	CONSTANT	CONSTANT	DERIVED	DERIVED	DERIVED	AQUIFER SPECIFIC VARIABLES	DISTRIBUTION		CONSTANT	CONSTANT	CONSTANT	CONSTANT	DERIVED	CONSTANT	CONSTANT	DERIVED		6		6	CONSTANT	CONSTANT	CONSTANT	CONSTANT	CONSTANT	CONSTANT
1/yr	SOURCI	UNITS	п/уг	m^Z VL	` ⊨	m/yr	1/yr	i À E	£		AQUIFE	STIM		E5	;	g/cc	8	8	m/yr		m/yr	ţ	E	E	E	U	<u>1</u>		E	degree	E
Overall 1st order decay sat. zone Not currently used Not currently used		VARIABLE NAME	•	Area of waste disposal unit Duration of pulse	Spread of contaminant source	Recharge rate	Source decay constant thitis of londfill	444	Width scale of facility	Near field dilution		VARTABLE NAME		Particle diameter	Aguifer porosity	Bulk density	Aquifer thickness	Source thickness (mixing zone depth)	Conductivity (hydraulic)	Gradient (hydraulic)	Groundwater seepage velocity	Retardation coefficient	Longitudinal dispersivity	Transverse dispersivity	Vertical dispersivity	Temperature of aquifer	- 	Organic carbon content (fraction)	Well distance from site	Angle off center	Well vertical distance

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ASSESSMENT EXPOSURE

MODEL MULTIMEDIA MULTIMED (Version 1.01, June 1991)

CASE101 Base Case Point of Compliance 2 m

Run options

Location 1 Chemical simulated is DEFAUIT CHEMICAL

Saturated zone model DETERMIN Infiltration input by user Option Chosen

Reject runs if Y coordinate outside plume Reject runs if Z coordinate outside plume Gaussian source used in saturated zone model Run was steady-state

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS	v	LIMITS	TS
			MEAN ST	STD DEV	N X	MAX
Solid phase decay coefficient	1/yr	CONSTANT	0.888E+88 -999		9.888E+88	0.100E+11
Dissolved phase decay coefficient	1/yr	CONSTANT	8.680E+88 -999.	6	0.800E+80	0.1005+11
Overall chemical decay coefficient	1/yr	CONSTANT	6.800E+80 -999.	e,	0.806E+88	8.108E+11
	I/M-yr	CONSTANT	0.980E+80 -999.	o,	9.86E+86	-666-
Neutral hydrolysis rate constant	1/yr	CONSTANT	9.880E+88 -999.	ę.	0.000E+00	-666-
Base catalyzed hydrolysis rate	1/M-yr	CONSTANT	0.800E+80 -999.	6	8.860E+88	-666
Reference temperature	' ن	CONSTANT	20.0 -999.	o.	0.000E+00	100.
Normalized distribution coefficient	m1/g	CONSTANT	6.888E+88 -999.	ō,	8.088E+88	-666-
Distribution coefficient	1	DERIVED	-666666-	ο,	0.999E+99	0.100E+11
Biodegradation coefficient (sat. zone)	1/vr	CONSTANT	0.808E+80 -999.	ģ	0.000E+00	-666
Air diffusion coefficient	CI12/5	CONSTANT	0.000E+00 -999.	9.	0.000E+00	10.0
Reference temperature for air diffusion	U	CONSTANT	8.888E+88 -999.	.6	9.668E+86	100.
Molecular weight	₩/6	CONSTANT	8.888E+88 -999.	e,	0.000E+00	-666-
Wole fraction of solute	, ¦	CONSTANT	8.888E+88 -999	9.	0.100E-08	1.99
Vapor pressure of solute	哥	CONSTANT	0.000E+00 -999	.6	9.989E+09	169.
+ue	atm-m/3/M	CONSTANT	8.888F+88 -999		0.100E-09	1.90

NIABLES ON PARAMETERS ON AND STD DEV MIN 0.179E-06 -999. 0.160E-08 0.486E+06 -999. 0.160E-08 0.999. 0.100E-08 0.999. 0.100E-08 0.999. 0.100E-08 0.999. 0.100E-08 1.90 0.000E+00 0.000E+00 1.00 0.381E-01 -999. 0.100E-08 1.65 0.999. 0.100E-08 1.65 0.999. 0.100E-08 1.06 0.999. 0.100E-08 1.06 0.999. 0.100E-08 1.099. 0.100E-09 1.00 0.381E-01 -999. 0.100E-09 1.00 0.391E-01 -999. 0.100E-09 1.00 0.391E-01 -999. 0.100E-09 1.00 0.200E-02 -999. 1.00 0.200E-03 -999. 0.							
ILINITIS DISTRIBUTION PARAMETERS LIMITIS		SOURCE	SPECIFIC VARIABLES				
It m^2 CONSTANT 0.179E-06 -999. 0.100E-09	ABLE NAME	UNITS	DISTRIBUTION	PARAMI MEAN			1
if m/yr CONSTANT 6.124-B6 -999, 6.166E-81 yr CONSTANT 9999, -999, 6.166E-81 m/yr CONSTANT 9999, -999, 6.166E-81 1andfill mg/l CONSTANT 1.060 999, 6.066E+69 1andfill mg/l CONSTANT 1.060 999, 6.066E+69 DERIVED -999, -999, 6.166E-88 m DERIVED -999, -999, 6.066E+69 1.06 6.999, 6.066E+69 1.06 6.999, 6.066E+69 1.06 6.066E+69 1.06 6.999, 6.066E+69 1.066E-88 m DERIVED -999, -999, 6.166E-88 DERIVED -999, -999, 6.166E-88 AQUIFER SPECIFIC VARIABLES CONSTANT 0.381E-01.999, 6.166E-88 CONSTANT 0.381E-01.999, 6.166E-88 E/C CONSTANT 1.65 -999, 6.166E-88 CONSTANT 1.65 -999, 6.166E-88 IITHY 0.00STANT 1.65 -999, 6.166E-88 CONSTANT 0.266E-82 CONSTANT 0.266E-82 CONSTANT 0.266E-82 CONSTANT 0.269, -999, 6.166E-88 IITHY m/yr CONSTANT 0.269, -999, 6.166E-88 IITHY 0.269, -999, 6.166E-89 IITHY 0.269, -999,							1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
	1	m/yr	CONSTANT	0.1/ye-00		U. TUBE-US	TT+BOAT A
The constraint	unit	m^2	CONSTANT	8.486E+06		6.166E-61	.000
The constraint Derived 1,000 1		<u>ځ</u>	CONSTANI	.000		0.100E-08	ייי אליייי אליייייייייייייייייייייייייי
March Marc		E	DERIVED	-999		0.100E-08	0.100E+11
Agure 1,yr CONSTANT 0.0006+00 -999. 0.0006+00		m/yr	CONSTANT	0.368E-01		6.000E+00	0.100E+11
landfill mg/l CONSTANY 1.90 -999. 6.000E+00 DERIVED -999999. 6.100E-08 OERIVED -999999. 6.100E-08 OERIVED -999999. 6.100E-08 OERIVED -999999. 6.100E-08 OERIVED OERIVED 1.00 0.000E+00 0.000E+00 OERIVED OERIVED OERIVED OERIVED OERIVED OERIVED OERIVED OERIVED -999. 0.100E-08 OERIVED -999. 0.100E-09 OERIVED OERIVED -999. 0.100E-09 OERIVED OERIVED -999. 0.100E-09 OERIVED -999. 0.100E-09 OERIVED -999. 0.100E-09 OERIVED -999. 0.100E-09 OERIVED OERIVED OERIVED -999. 0.100E-09 OERIVED OERIVED OERIVED OERIVED OERIVED -999. 0.100E-09 OERIVED O		1/yr	CONSTANT	8.090E+08		9.000E+00	-666-
DERIVED -999999. 6.100E-08 DERIVED -999999. 6.100E-08 DERIVED 1.00 0.000E+00 0.100E-08 AQUIFER SPECIFIC VARIABLES CM CONSTANT 0.381E-01 999. 0.100E-08 CM CONSTANT 1.65 -999. 0.100E-08 CONSTANT 1.65 -999. 0.100E-09 CONSTANT 0.200E-02 -999. 0.100E-09 Lity m/yr DERIVED -999999. 0.100E-09 Lity DERIVED -999999. 1.60 M FUNCTION OF X -999999. 0.100E-09 THORITON OF X -999999. 0.100E-09 C CONSTANT 21.0 -999999. 0.100E-09 THORITON OF X -999999. 0.100E-09 C CONSTANT 21.0 -999999. 0.100E-09 THORITON OF X -999999. 0.100E-09 C CONSTANT 21.0 -999999. 0.100E-09	landfill	mg/1	CONSTANT	1.90	.999.	8.880E+88	-666-
DERIVED -999, -999, 6.100E-08 AQUIFER SPECIFIC VARIABLES		. =	DERIVED	-666-	- 656	9.188E-88	0.100E+11
AQUIFER SPECIFIC VARIABLES AQUIFER SPECIFIC VARIABLES	44 0/2 0 0f 4201 145	. £	DEPTVED	500	000	9 188E-88	0 100E+11
AQUIFER SPECIFIC VARIABLES UNITS DISTRIBUTION PARAMETERS LIMIN CM CONSTANT 0.381E-01 -999. 0.100E-08 CONSTANT 1.65 -999. 0.100E-08 CONSTANT 1.65 -999. 0.100E-08 CONSTANT 1.65 -999. 0.100E-08 CONSTANT 1.65 -999. 0.100E-08 CONSTANT 0.200E-02 -999. 0.100E-09 IITY 0.7 DERIVED -999. 0.100E-09 CONSTANT 0.200E-02 -999. 0.100E-09 LITY 0.7 DERIVED -999999. 0.100E-09 M FUNCTION OF X -999999999. M FUNCTION OF X -999999999. C CONSTANT 21.0 -999999. C CONSTANT 21.0 -999999.	ar field dilution	i .	DERIVED	1.90	0.000E+00	9.880E+08	1.00
CONSTANT 0.381E-01 -999. MIN CONSTANT 0.381E-01 -999. 0.100E-08 0.005TANT 0.430 -999. 0.100E-08 0.100E-08 0.005TANT 1.65 -999. 0.100E-08 0.100E-08 0.005TANT 1.65 -999. 0.100E-08 0.100E-08 0.005TANT 1.30999. 0.100E-08 0.100E-08 0.100E-08 0.100E-08 0.100E-08 0.100E-08 0.100E-09 0.100E	3 4 1 1 1 1 1 1		170 170 170 170 170 170		; ; ; ; ; ; ; ; ; ; ; ; ; ; ; ; ; ; ;		
CONSTANT 0.381E-01 -999. 0.100E-08		SLINO	DISTRIBUTION	PARAM MEAN			
CONSTANT 0.364E-01-559. 0.100E-08 g/cc CONSTANT 1.65 -999. 0.100E-08 zone depth) m DERIVED -999. 0.100E-08 m/yr CONSTANT 130999. 0.100E-08 constant 0.200E-02-999. 0.100E-08 constant 0.200E-02-999. 0.100E-09				100 BOC 6	1	00 100 4 0	000
CONSTANT 0.430 -999. 0.100E-08 g/cc CONSTANT 1.65 -999. 0.100E-08 cone depth) m DERIVED -999. 0.100E-08 m/yr CONSTANT 0.200E-02-999. 0.100E-06 constant 0.200E-02-999. 0.100E-06 DERIVED -999999. 0.100E-06 DERIVED -999999. 1.000 DERIVED -999999999 DERIVED -999999999 DERIVED -999999999 DERIVED -999999999999 TONCTION OF X -999999999 TONCTION OF X -999999999999.	rticle alameter	5	ENT SOLO	0.30te-01		00-100T-0	100.
g/cc CONSTANT 1.65 -999. 0.100E-01 constant 10.0 -999. 0.100E-01 constant 10.0 -999. 0.100E-08 constant 13.0 -999. 0.100E-08 constant 0.200E-02 -999. 0.100E-08 constant 0.200E-02 -999. 0.100E-09 DERIVED -999999. 1.00 DERIVED -999999. 1.00 DERIVED -999999999. DERIVED -999999999. DERIVED -999999999. CONSTANT 21.0 -999999.	uífer porosity	;	CONSTANT	6.436		9.100E-08	988.0
zone depth) m CONSTANT 10.0 -999. 0.100E-08 zone depth) m DERIVED -999. 0.100E-08 m/yr CONSTANT 0.200E-02-999. 0.100E-06 constant 0.200E-03-999. 0.100E-07 ity m/yr DERIVED -999999. 0.100E-09 DERIVED -999999. 1.00 m FUNCTION OF X -999999999. m FUNCTION OF X -999999999. C CONSTANT 21.0 -999999.	1k density	ಶ ್/೮ ೮	CONSTANT	1.65	, 000 1	0.100E-01	5.00
zone depth) m DERIVED -999, -999, 0.100E-08 m/yr CONSTANT 130, -999, 0.100E-08 CONSTANT 130, -999, 0.100E-08 CONSTANT 0.200E-02 -999, 0.100E-05 -999, 0.100E-07 -999, -999, -999, 0.100E-09 DERIVED -999, -999, -999, -999, -999, -999, 0.00STANT 21.0 -999, 0.000E+00	juifer thickness	E	CONSTANT	10.0	.999	0.100E-08	0.100E+06
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tance in CONSTANT 0.000E+00 -999. 0.000E+00	stance	, ==	CONSTANT	0.888E+88		0.000E+00	1.69

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PROTECTION NVIRONMENTAL

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ASSESSMENT EXPOSURE

MODE

MULTIMEDIA

MULTIMED (Version 1.01, June 1991)

Run options

CASE101 Base Case Point of Compliance 150 m

Location 1 Chemical simulated is DEFAULT CHEMICAL

Saturated zone model DETERMIN Option Chosen

Infiltration input by user Run was steady-state

Reject runs if Y coordinate outside plume Reject runs if Z coordinate outside plume Gaussian source used in saturated zone model

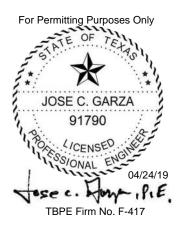
Part III, Attachment 5, Appendix H.3, p.g.-31

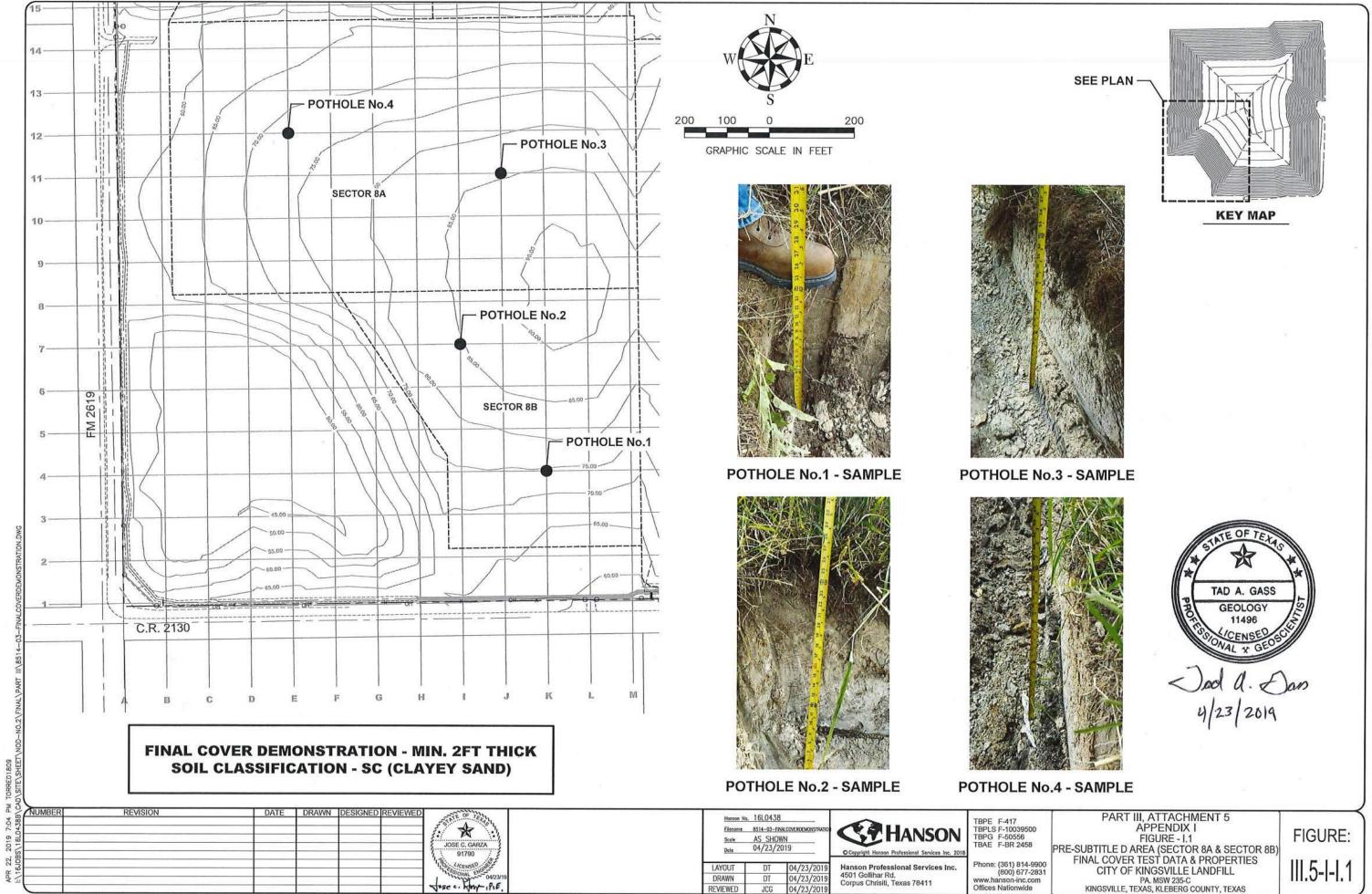
VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN STD	TERS STD DEV	LIMITS MIN	TS MAX
Solid phase decay coefficient	1/yr	CONSTANT	6.888E+88 -999.	-999.	9.898E+89	0.100E+11
Dissolved phase decay coefficient	1/yr	CONSTANT	0.000E+00 -999.	-666	9.000E+00	
Overall chemical decay coefficient	1/yr	CONSTANT	8.000E+08 -999.	-666-	9.000E+09	
Acid catalyzed hydrolysis rate	1/M-yr	CONSTANT	8.666E+66 -999.	-999.	8.880E+08	-666-
Neutral hydrolysis rate constant	1/yr	CONSTANT	6.668E+86 -359.	.999.	9-860E+66	-666-
Base catalyzed hydrolysis rate	1/M-yr	CONSTANT	0.000E+00 -999.	-959.	9.880E+08	-666-
Reference temperature	Ų	CONSTANT	20.0	-666-	9.880E+98	169.
Normalized distribution coefficient	m1/g	CONSTANT	6.666E+66 -999.	-999,	0-6005+60	- 666-
Distribution coefficient	·	DERIVED	.999	-666-	0-600E+00	0.100E+11
Biodegradation coefficient (sat. zone)	1/yr	CONSTANT	8.888E+88 -999.	-999.	9.880E+88	-666-
Air diffusion coefficient		CONSTANT	8.888E+88 -999.	-666-	0.800E+00	16.0
Reference temperature for air diffusion		CONSTANT	6.800E+88 -999.	-666-	0.666E+66	199.
Molecular weight		CONSTANT	6.880E+88 -999.	-666-	9-880E+88	.666 - 98
Mole fraction of solute		CONSTANT	8.800E+88 -999.	-999.	8.100E-08	1.00
solute	mu Hg	CONSTANT	9.800E+80 -999.	-999.	0.808E+80	196.
wat	atm-m^3/M	CONSTANT	0.000E+00 -999,	-666-	0.100E-09	1.00

E UNITS DISTRIBUTION PARAME mi/yr CONSTANT 0.179E-06 nit nit 0.486E+06 yr CONSTANT 0.368E-01 1/yr CONSTANT 0.368E-01 1/yr CONSTANT 0.368E-01 1/yr CONSTANT 0.368E-01 1/yr CONSTANT 0.3699. m DERIVED -999. m DERIVED -999. AQUIFER SPECIFIC VARIABLES	PARAME MEAN 6-179E-86 9-486E+86 -999. 1-999. 1-99 1-999. 1-80 1-80 1-80 1-80 1-80 1-80 1-80 1-80	LIMITS LIMITS 0.100E-09 0.100E-09 0.100E+09 0.100E+08	7.5 MAX 0.180E+11 -939. 0.100E+11 0.100E+11 0.100E+11 1.90 1.00
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	130.	0.100E-08	0.100E+06
m/yr CONSTANT 130.		0.100E-06	0.100E+09
CONSTANT 0.200E-02	0.200E-02	0.100E-07	-666-
velocity m/yr	·666-	9.188E-89	0.100E+09
DERIVED -999.	-666-	1.00	0.1005+09
ty m FUNCTION OF	OF X -999.	-666-	-666-
m FUNCTION OF	0F X -999.	-666-	-666-
Vertical dispersivity m FUNCTION OF X -999999.	OF X -999.	-666	-666
C CONSTANT 21.8	21.9	0.868E+86	198.
CONSTANT 7.28	7.28	9.388	14.0
0.309E-02	0.309E-02	0.180E-05	1.66
e constant	150.	1.00	.666-
Angle off center degree CONSTANT 0.000E+00 -999.	0.000E+00	0.000E+00	360.
CC LCCC C STREET			1.60

APPENDIX I

PRE-SUBTITLE D AREA (SECTOR 8A AND SECTOR 8B) FINAL COVER TEST DATA & PROPERTIES FIGURE





THE CITY OF KINGSVILLE LANDFILL TCEQ PERMIT MSW 235C

PERMIT AMENDMENT APPLICATION Volume 5 of 6



CITY OF KINGSVILLE, KLEBERG COUNTY, TEXAS

September 2018

Revision 1 – November 2018

Revision 2 – February 2019

Revision 3 – April 2019

Prepared by



TBPE Firm No. F-417



TBPE F-417

HANSON PROJECT NO. 16L0438-0003

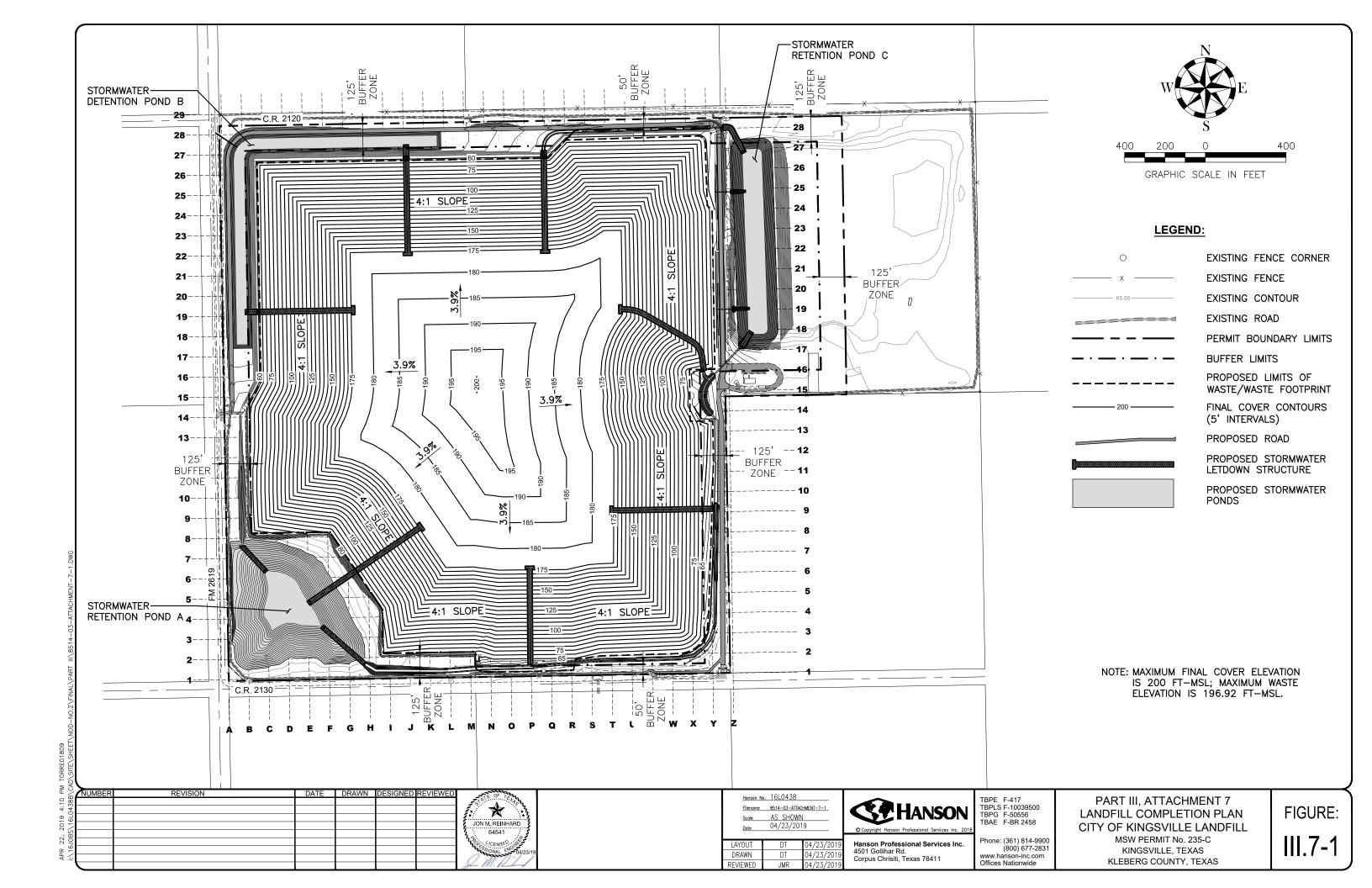
CITY OF KINGSVILLE LANDFILL PART III ATTACHMENT 7 LANDFILL COMPLETION PLAN

JON M. REINHARD
64541

CENSE
04/25/19

For Permitting Purposes Only

TBPE Firm No. F-417



CITY OF KINGSVILLE LANDFILL PART III ATTACHMENT 10 LINER QUALITY CONTROL PLAN

For Permitting Purposes Only

JON M. REINHARD

64541

CENSE

04/25/19

TBPE Firm No. F-417

THE CITY OF KINGSVILLE LANDFILL TCEQ PERMIT MSW 235C

PERMIT AMENDMENT APPLICATION Part III

Attachment 10 Liner Quality Control Plan



CITY OF KINGSVILLE, KLEBERG COUNTY, TEXAS

September 2018

Revision 1 – November 2018

Revision 2 - February 2019

Revision 3 - April 2019

Prepared by



JON M. REINHARD

64541

TBPE F-417

HANSON PROJECT NO. 16L0438-0003

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	ENDI		

1. **GENERAL**

1.1. Scope and Purpose

This Liner Quality Control Plan (LQCP) is applicable to the construction of all landfill liner systems at the City of Kingsville Landfill, a Municipal Solid Waste (MSW) disposal facility in Kleberg County, Texas. This LQCP shall govern the material characteristics, installation and testing for the various construction components for the landfill liners at the facility. Qualifications for quality control personnel are also identified in this LQCP. The provisions of this LCQP were developed based on the latest technical guidelines of the TCEQ, including quality control of construction, testing frequencies and procedures, and quality assurance of sampling and testing procedures.

1.2. Lining and Cover Systems Used for the Landfill

The lining and cover systems that will be used at this facility will be alternative liner designs. Alternative liner design demonstrations can be found in Part III, Attachment 5. The following lining and/or cover systems will be used at the facility:

1.2.1. Landfill Lining System

The landfill lining system to be used in Sectors 4C, 5, 6 and 7 will consist of (from bottom to top):

- A prepared subgrade;
- A geosynthetic clay liner (GCL);
- A geomembrane liner consisting of sixty mil (0.06 inch) thick HDPE;
- A leachate collection layer consisting of a drainage geocomposite (a synthetic drainage net with geotextile fabric on one or both sides), gravel, collection piping, and geotextile separation fabric;
- A two (2) foot protective cover soil layer.

1.2.2. Landfill Cover System

The landfill cover system will consist of (from bottom to top):

- A prepared soil subgrade;
- A geosynthetic clay liner (GCL) layer;
- A forty mil (0.04 inch) thick LLDPE geomembrane layer;
- A geocomposite drainage layer consisting of a synthetic drainage net and geotextile fabric;
- A twenty five (25) inch thick protective cover soil layer, the top seven (7) inches of which must be capable of supporting vegetation.

1.2.3. Piggyback Liner System

This liner system will be used in areas of the landfill where disposal development will occur over existing unlined MSW fill locations and will include components that will provide additional geotechnical stability. The piggyback lining system will consist of (from bottom to top):

D 5261	Standard Test Method for Measuring Mass per Unit Area of Geotextiles
D 5321	Standard Test Method for Determining the Shear Strength of Soil-
	Geosynthetic and Geosynthetic-Geosynthetic Interfaces by Direct Shear
D 5596	Standard Test Method for Microscopic Evaluation of the Dispersion of
	Carbon Black in Polyolefin Geosynthetics
D 5887	Standard Test Method for Measurement of Index Flux Through Saturated
	Geosynthetic Clay Liner Specimens Using a Flexible Wall Permeameter
D 5890	Standard Test Method for Swell Index of Clay Mineral Component of
	Geosynthetic Clay Liners
D 5891	Standard Test Method for Fluid Loss of Clay Component of Geosynthetic
	Clay Liners
D 5993	Standard Test Method for Measuring Mass Per Unit of Geosynthetic Clay
	Liners
D 5994	Standard Test Method for Measuring Core Thickness of Textured
	Geomembranes
D 6392	Standard Test Method for Determining the Integrity of Nonreinforced
	Geomembrane Seams Produced Using Thermo-Fusion Methods
D 6241	Standard Test Method for Static Puncture Strength of Geotextiles and
	Geotextile-Related Products Using a 50-mm Probe
D 6243	Standard Test Method for Determining the Internal and Interface Shear
	Strength of Geosynthetic Clay Liner by the Direct Shear Method
D 6496	Standard Test Method for Determining Average Bonding Peel Strength
	Between Top and Bottom Layers of Needle-Punched Geosynthetic Clay
	Liners
D 6768	Standard Test Method for Tensile Strength of Geosynthetic Clay Liners
D 7176	Standard Specification for Non-Reinforced Polyvinyl Chloride (PVC)
	Geomembranes Used in Buried Applications
D 7179	Standard Test Method for Determining Geonet Breaking Force
F 480	Standard Specification for Thermoplastic Well Casing Pipe and Couplings
	Made in Standard Dimension Ratios (SDR), SCH 40 and SCH 80
F 714	Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based or
	Outside Diameter

1.7.2. Geosynthetics Research Institute

- GM13 Standard Specification for Test Methods, Test Properties and Testing Frequency for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes
- GM17 Test Methods, Test Properties and Testing Frequency for Linear Low Density Polyethylene (LLDPE) Smooth and Textured Geomembranes
- GM19 Seam Strength and Related Properties of Thermally Bonded Polyolefin Geomembranes

1.8. Material Conformance Tests for Soils and Gravel

Soil materials used for construction at the facility shall be subjected to the following conformance tests to demonstrate compliance with the LQCP. Unless otherwise specified, one

set of tests shall be performed for each material type. If there is a visually distinguishable change in the soil characteristics or a change in the soils Liquid Limit (LL) or Plasticity Index (PI) by more than 10 points, the soil shall be considered a separate borrow source and shall require an additional set of tests. In any condition, a minimum of one (1) complete set of tests must be performed for each type of soil material used. Conformance testing will be conducted by the party identified in sections 2.4. The results of these tests shall be used for field quality control. The Contractor shall ensure that the required samples are collected and tested in a timely manner to be available for field quality control. Not all tests will be required for all soils; only those tests for which the individual components specify a required material property.

1.8.1. Soil Classification

All soil materials used shall be classified in accordance with the Unified Soil Classification System (USCS - ASTM D 2487).

1.8.2. Gradation

All soil materials used shall be tested to determine the particle size gradation, including the percentage passing the #200 sieve. Gradation shall be determined in accordance with ASTM D 1140. Gravel materials used shall be tested to determine the gradation in accordance with ASTM C 136 or ASTM D 422.

1.8.3. Atterberg Limits

All soil materials used shall be tested to determine the Atterberg Limits (Liquid Limit and Plastic Limit) and the Plasticity Index (ASTM D 4318).

1.8.4. Soil Moisture-Density

The soil moisture/density relationship shall be determined using the Standard Proctor method (ASTM D 698).

1.8.5. Coefficient of Permeability/Hydraulic Conductivity

Where the LQCP indicates to determine the coefficient of permeability or the hydraulic conductivity (in centimeters per second [cm/sec]), use one of the following test procedures:

Constant Head Permeability

Permeability of Granular Soils (Constant Head) – ASTM D 2434

Hydraulic Conductivity

Flexible Wall Permeameter (back pressure saturation) ASTM D 5084.

1.8.6. Calcium Carbonate Content

All gravel materials used shall be tested to determine the calcium carbonate content in accordance with ASTM D 3042.

1.9.5. Thickness

Smooth HDPE geomembrane sheet and HDPE drainage net shall be tested for thickness in accordance with ASTM D 5199. Textured HDPE geomembrane sheet shall be tested for thickness in accordance with ASTM D 5994.

1.9.6. Tear Resistance

The geomembrane sheet shall be tested for tear resistance in accordance with ASTM D 1004.

1.9.7. Puncture Resistance

The geomembrane and geotextile materials shall be tested for puncture resistance in accordance with ASTM D 4833 and ASTM D 6241, respectively.

1.9.8. Apparent Opening Size

Geotextile shall be tested for apparent opening size (AOS) in accordance with ASTM D 4751.

2. SUBGRADE PREPARATION AND CONTROLLED FILL

The following requirements govern the subgrade preparation for liners and covers used at the facility:

2.1. Subgrade Description

Subgrade materials shall not exhibit excessive cohesion and shall be free of large particles, rocks or other foreign material. The finished subgrade should be smooth, with no large or protruding items that may damage liner materials placed on the subgrade. Soil materials used as fill to finish the subgrade shall be obtained either from on-site or off-site sources.

2.2. Required Material Properties

Soil materials used for fill to construct subgrade shall be free of sod, trash, roots, and organic matter. The materials shall meet the following minimum requirements which are also summarized in Table 10-1:

2.2.1. Soil Materials

2.2.1.1. Classification

Soil materials shall be classified using the USCS. Acceptable classifications are CH CL, ML, SW, SP, SM, or SC.

2.2.1.2.Gradation:

The soil material shall be composed of particles of which no more than ninety six percent (96%) pass the #200 sieve.

2.2.1.3. Atterberg Limits

The soil material used shall have a Liquid Limit of no greater than seventy five percent (75%) and a Plasticity Index (Liquid Limit minus Plastic Limit) of no greater than forty five percent (45%).

2.2.2. Moisture Density for Subgrade Materials Placed as Fill

Subgrade materials placed as fill shall be compacted to at least ninety five percent (95%) of the maximum dry density, Standard Proctor Basis, as per ASTM D698. The moisture content shall range from optimum moisture to five percent (5%) above the optimum moisture content.

Table 10-1
Required Testing for Subgrade Soil Materials Used as Fill

Property	Frequency	Test Method	Value
Sieve Analysis	1 test per each 100,000 s.f. per lift, minimum of 1 test/lift	ASTM D 1140	96% maximum
Atterberg Limits	1 test per each 100,000 s.f. per lift, minimum of 1 test/lift	ASTM D 4618	LL = 75% maximum PI = 45% maximum
Field Density and Moisture Content	1 test per each 10,000 s.f. per lift	ASTM D 698	95% maximum dry density; optimum to optimum plus 5% above moisture content

2.3.Installation Procedures

The subgrade installation procedures shall be conducted by the Earthwork Contractor and observed by QAO. The installation procedures shall conform to the following requirements:

2.3.1. Excavation

Overlying materials shall be excavated and removed to achieve the required subgrade lines and grades as indicated in the project plans and specifications. The Earthwork Contractor shall exercise care and provide sufficient grade control during the excavation process to minimize or eliminate the placement of fill to meet the required subgrade lines and grades. Soil overburden shall be excavated using standard mobile construction equipment. Where the bedrock is encountered within the planned excavation and cannot be removed using this equipment, it will be removed either through rock saw or blasting. For areas requiring rock removal, the rock will be removed at least 1 foot beyond the lines and grades shown

to accommodate the construction of a soil subgrade layer. In the event voids in bedrock are discovered intersecting the limits of the planned excavation, these voids will be hydro or vacuum excavated to remove any loose material and will be filled with cement grout or concrete to align with the limits of the planned excavation. Once allowed to properly cure and set, these filled voids will be covered with subgrade material.

2.3.2. Subgrade Preparation

The subgrade shall be excavated and/or graded to the appropriate lines and grades as shown in the project contract documents. Where subgrade materials are placed as fill, the in-situ material shall be properly scarified and prepared to receive the subgrade material. Any soft areas shall be excavated and replaced with compacted materials to provide a solid working base. In areas where bedrock has been removed to accommodate a subgrade layer, the subgrade may be constructed from on-site soils, off-site soils, millings from the rock saw process or a combination of these sources, with the subgrade material meeting the requirements of this section.

2.3.3. Placement

The subgrade soil materials shall be broken down such that all material is uniformly hydrated. The finished material shall not contain clods that exceed one (1) inch in diameter or that total more than ten percent (10%) by weight. Any gravel size particles shall not be of sufficient number or size to be a detriment to the integrity of the overlying component. When placed as fill, the subgrade material shall be placed in loose lifts as required to obtain compacted lift thickness of six (6) to eight (8) inches, or the pad or prong length of the compactor feet, whichever is less.

2.3.4. Hydration

Prior to compaction, the soil material shall be hydrated so that proper moisture can be maintained during the compaction process. Once water has been added, the soil material shall be worked to provide proper mixing. Soil hydration is allowed either on a stockpile or in-place. The soil material shall be hydrated to a moisture content wet of optimum.

2.3.5. Compaction

The soil material shall be compacted using a pad or tamping foot roller or a prong foot ("sheepsfoot") roller. Bulldozers and/or pneumatic tired compactors will not be used. The lift thickness shall be controlled, as outlined above, such that the compactor feet penetrate through the entire lift under compaction into the top of the previously compacted lift. Therefore, the compacted lift thickness must not be greater than the pad or prong length of the compactor feet. Adequate cleaning devices shall be used to prevent clogging of the compactor from excess soil material. Sections of re-compacted subgrade that do not pass both the density and moisture requirements shall be re-worked and re-tested until the section in question does pass, and to the extent that the re-worked area(s) tie-in to an area which passed the testing. The re-worked area shall be re-worked and re-tested until passing tests are achieved.

2.3.6. Finishing

The subgrade shall be prepared and finished in a manner consistent with proper subgrade preparation techniques for the installation of geosynthetics materials and as recommended by the GCL manufacturer. The subgrade shall be properly compacted to a minimum of 95% Standard Proctor Density per ASTM D698, so as not to settle and cause excessive strains in the GCL or other synthetic liner materials. Prior to installation, ensure a surface free of debris, roots, or angular stones larger than 0.5-inch. The subgrade must be rolled with a smooth-wheeled roller. During installation, ensure rutting or raveling is not caused by installation equipment.

2.3.7. Proof rolling

The top surface of the completed subgrade must be proof rolled with a smooth-wheel roller prior to final grade/thickness surveying and placement of overlying layers. Additional proof-rolling may be employed if it is necessary to minimize desiccation and cracking of the subgrade.

2.3.8. Protection of Subgrade Surface

Prior to and during the installation of overlying components, the Earthwork Contractor shall preserve and protect the exposed surface of the subgrade from desiccation and cracking, rutting, erosion, and ponding using regular watering and proof rolling.

2.4. Quality Assurance Quality Control Requirements

The Earthwork Contractor shall conduct material conformance tests and the QAO shall monitor the placement and finishing of the subgrade, and coordinate the necessary surveys with the project surveyor. Prior to placement of any overlying layers, the QAO shall coordinate with the GMI to execute a subgrade acceptance form for all areas of completed subgrade. In addition, the Earthwork Contractor shall employ testing personnel to conduct the following QC verification activities:

2.4.1. Field Density

A minimum of one (1) field density test per 10,000 square feet (ft²), or less, for each lift. A minimum of three (3) field density tests are required for each lift.

2.4.2. Sieve Analysis (Percent Passing #200)

A minimum of one (1) test for each 100,000 ft² or less, for each lift, shall be performed in accordance with ASTM D 1140. A minimum of one (1) test shall be performed for each lift regardless of the area.

2.4.3. Atterberg Limits

A minimum of one (1) test for each 100,000 ft² per lift shall be performed in accordance with ASTM D 4318. A minimum of one (1) test shall be performed for each lift regardless of the area.

2.4.4. Survey Verification

A minimum of one (1) survey verification shall be made per 5,000 ft² of surface area. Reference locations will be noted on a drawing of the area.

2.4.5. Repair of Test Holes

All holes in the subgrade created from tests and test samples shall be completely backfilled with soil and shall be tamped into place.

3. GEOGRID

The following requirements govern the geogrid used at the facility:

3.1.Geogrid Description

A geogrid is a reinforcing geosynthetic structure formed by a regular network of tensile members with appropriate apertures to allow interlocking with surrounding soil or aggregate. Geogrid materials shall be High Density Polyethylene (HDPE). Geogrid material will be placed on a prepared subgrade and will underlie the GCL layer. The geogrid shall be stored, handled and installed in accordance with the manufacturer's recommendations.

3.2. Required Material Properties

The geogrid shall have a minimum tensile strength of 2500 pounds per foot at an allowable stress of 5% or less over 50 years. Properties, test methods and minimum values are listed below and summarized in Table 10-2.

Ultimate Tensile Strength (ASTM D6637)	7810 lb/ft
Tensile Strength @ 5% Strain (ASTM D6637)	3560 lb/ft
Junction Strength (ASTM D7737)	7200 lb/ft
Maximum Allowable Strength for 120 yr Design Life (GRI-GG4)	2860 lb/ft

Table 10-2
Required Testing for Uniaxial Geogrid

Property	Frequency	Test Method	Value
Ultimate Tensile Strength	MARV based on 95% confidence level	ASTM D 6637	7810 lb/ft
Tensile Strength @ 5% Strain	MARV based on 95% confidence level	ASTM D 6637	3560 lb/ft
Junction Strength	MARV based on 95% confidence level	ASTM D 7737	7200 lb/ft
Maximum Allowable Strength for 120-yr Design Life	MARV based on 95% confidence level	GRI – GG4	2860 lb/ft

The manufacturer shall certify that the geogrid has been quality control tested during the manufacturing process and that the liner meets all strength requirements for the intended use.

3.3.Installation Procedures

The geogrid installation procedures shall be conducted by the GMI and observed by the QAO. The installation procedures shall conform to the following requirements:

3.3.1. Surface Preparation

The surface to receive the geogrid shall be prepared in accordance with the requirements specified in Section 2, Subgrade Preparation and Controlled Fill. Prior to placing geogrid materials, the GMI shall execute a subgrade acceptance form. This form shall be submitted to the QAO and signed by the QAE and the Owner. A copy of the form is included in Appendix A.

3.3.2. Delivery and Storage

All rolls of geogrid delivered to the site shall be marked with the name of the manufacturer, the product type, the manufacturing batch code, roll number, date of manufacture and roll dimensions. The QAO must inspect the delivered materials for damage and defects. Pushing, sliding, or dragging of rolls or pallets can cause damage and must be avoided. The geogrid rolls shall be dept free of dirt and debris, must be protected from soft or wet ground and rocky or rough ground and must not be stacked more than five (5) rolls high to avoid crushing the cores of the rolls. A sacrificial cover must be used to protect the geogrid if stored on site for more than six (6) months.

3.3.3. Geogrid Anchor Trench

A geosynthetic materials anchor trench shall be completed along the perimeter of the area to be lined where indicated on the project contract documents. The anchor trench may be excavated in sections, as necessary. Loose soil shall be removed from the anchor trench and shall not underlie the geosynthetic materials to be placed in the anchor trench. The excavated anchor trench shall have rounded corners in order to help protect the geosynthetic materials. The anchor trench shall conform to the dimensions and requirements shown on the project contract documents.

3.3.4. Geogrid Deployment

The geogrid shall be deployed in accordance with the procedures recommended by the manufacturer and as outlined below:

- Only those geogrid panels which can be anchored and connected in one (1) day should be deployed.
- Each geogrid panel shall be inspected for damage and manufacturing defects prior to anchoring or connecting to other panels.
- Geogrid panels shall be placed in a controlled manner, such as pulling, hoisting, or rolling and shall be pulled taut to remove slack. Geogrid shall be deployed from a top to bottom direction on slopes.
- Adjacent geomembrane panels shall not be overlapped but shall be deployed side by side. Panel end connections shall be made using a Bodkin connection.
- Geogrid panels shall be anchored in place after placement so as to remain in the deployed alignment. Anchoring can be accomplished using stakes, sandbags, or small quantities of fill soil. Sandbag anchorage must be removed as the

- subsequent GCL layer is placed. Stakes must be driven flush with the subgrade as the subsequent GCL layer is placed.
- The geogrid panels shall be placed and aligned such that endroll connections on slopes are minimized. Connections should be located as close to the bottom of the slope as possible.
- o No construction equipment traffic shall be allowed on the geogrid.
- O Personnel working on the geogrid shall not smoke, wear damaging shoes, throw equipment or engage in other activities which could damage the geogrid.

4. GEOSYNTHETIC CLAY LINER (GCL)

4.1.General

This section includes the requirements for selection, installation, and protection of GCL.

4.2.Submittals

A. Pre-installation

Submit the following to the QAO for approval prior to GCL deployment.

- 1. Supplier of the GCL manufacturer results for standard tests described in Table 10-3.
- 2. Written certification the GCL meets the properties listed in Table 10-3.
- 3. Written certification that GCL manufacturer has continuously inspected each roll of GCL for the presence of needles and other defects and found GCL defect-free.
- 4. Written certification from the GCL manufacturer the bentonite will not shift during transportation or installation thereby causing thin spots in the body of the GCL.
- 5. QC certificates signed by a responsible party of the GCL manufacturer for each roll delivered to the site. Each certificate shall include roll identification numbers and results of all QC tests. At a minimum, results shall be given for tests corresponding to Table 10-3. The bentonite and textile suppliers shall each certify the respective properties under Manufacturer's Quality Control. The GCL manufacturer shall also perform the bentonite tests described under Manufacturer's Quality Control and third party tests.

Test	Item	Type of Test	Standard Test Method	Frequency of Testing
Manufacturer's Quality	Bentonite ^(A)	Swell Index ^(A)	ASTM D5890	per 100,000-lbs and every truck or railcar
		Moisture Content ^(A)	ASTM D4643	per 100,000-lbs and every truck or railcar
		Fluid Loss ^(A)	ASTM D5891	per 100,000-lbs and every truck or railcar
	Geotextile	Grab Tensile Strength ^(B)	ASTM D4632	per 200,000-ft ²
Control		Mass/Unit Area	ASTM D5261	per 200,000-ft ²
	GCL Product	Grab Tensile Strength ^(B)	ASTM D6768 ASTM D4632	per 200,000-ft ²
		Peel Strength ^(H)	ASTM D 6496 ASTM D 4632	per 40,000-ft ²
		Clay Mass/Unit Area ^(C)	ASTM D5993	per 40,000-ft ²
		Permeability(D)	ASTM D5887	per week for each production line ^(E)
		Lap Joint Permeability ^{(D)(F)}	ASTM D5887	per each material and lap type
Conformance Testing by 3 rd Party Independent Laboratory	GCL Product	Clay Mass/Unit Area ^(C)	ASTM D5993	at least one (1) test per 100,000-ft ² and ASTM D4254 procedure A
		Permeability ^{(D)(F)}	ASTM D5084	per 100,000-ft ²
		Direct Shear(F)(G)(I)	ASTM D5321 ASTM D6243	Per GCL/adjoining material type
Notes:		•	•	•

Table 10-3 - STANDARD TESTS ON GEOSYNTHETIC CLAY LINER MATERIAL

Notes:

- A Tests performed on bentonite before incorporation into GCL. Free swell shall have a minimum test value of 24-ml. Fluid loss shall have a maximum value of 18-mil.
- B Geotextiles shall meet minimum manufacturer criteria.
- C Minimum Test value 0.75-lb/sq. ft. MARV at 0% moisture content
- D 5×10^{-9} cm/ sec max or as required by the permit.
- E Report last twenty (20) permeability values, ending on production date of supplied GCL.
- F Test at confining/consolidating pressures simulating field conditions.
- G Not applicable for slopes of 7H:IV or flatter. Testing must be on material in hydrated state unless GCL includes geomembrane on both side of GCL.
- H Peel strength for unreinforced GCL 1 lb/in (1.75 N/cm) min. Peel strength for reinforced GCL 3.5 lbs/in (6.1 N/cm) min.
- I Hydrated internal shear strength for unreinforced GCL 150 psf. Hydrated internal shear strength for reinforced GCL 500 psf.

4.3.Installation

The GCL installation Contractor shall submit to the QAI a Subgrade Surface Acceptance Form, signed by the GCL installation Contractor, for each area covered directly by GCL as installation proceeds.

4.4.Delivery, Storage, and Handling

A. Packing and Shipping

The GCL shall be supplied in rolls wrapped individually in relatively impermeable and opaque protective covers. The GCL rolls shall be marked or tagged with the following information:

- 1. Manufacturer's name.
- 2. Product identification.
- 3. Roll number.
- 4. Roll dimensions.
- 5. Roll weight.

B. Storage and Protection

An onsite storage area for GCL rolls from the time of delivery until installed as recommended by the GCL Manufacturer shall store and protect GCL from dirt, water, ultraviolet light exposure, and other sources of damage. Contractor shall preserve integrity and readability of GCL roll labels. Rolls must not be stacked higher than recommended by the manufacturer to preclude thinning of bentonite at contact points.

Use wooden pallets for above ground storage of GCL and heavy, waterproof tarpaulin for protecting unused GCL unless otherwise specified by GCL manufacturer.

4.5. Materials

The active ingredient of the GCL shall be natural sodium bentonite and encapsulated between two (2) geotextiles. The geotextile-backed GCL shall provide sufficient internal shear strength of the slopes to be lined. The GCL shall have a coefficient of permeability of 5 x 10^{-9} -centimeters/second (cm/sec) or less and an index flux of 1 x 10^{-8} - (m³/m²/sec).

The bentonite shall be continuously adhered to both geotextiles to ensure the bentonite will not be displaced during handling, transportation, storage, and installation, including cutting, patching, and fitting around penetrations. The bentonite sealing compound or bentonite granules used to seal penetrations and make repairs shall be made of the same natural sodium bentonite as the GCL and recommended by the GCL manufacturer. The permeability of the GCL seams shall be equal to or less than the permeability of the body of the GCL sheet.

4.6.Manufacturer

A. Manufacturing Experience

The GCL manufacturer shall have a minimum of two (2) years of continuous experience in the manufacture of similar CGL products. The Manufacturer must demonstrate, by submitting a list of previous projects, a minimum of 5-million sq.ft. of manufacturing experience of similar GCL products.

4.7.Warranty

The Manufacturer shall provide a 5-year warranty to the Owner against manufacturing defects. The warranty shall include the supply of the replacement GCL material and

shall not include the cost of re-installation, defects, or failures due to improper installation.

4.8.Execution

A. Examination

The QAE or his representative will collect samples of material delivered to the site for conformance testing. Alternatively, the QAE may coordinate the collection and shipping of samples collected by the manufacturer and shipped directly to the QAL.

B. Installation

i. GCL Deployment

Handle GCL in a manner to ensure it is not damaged as recommended by the GCL Manufacturer. At a minimum, comply with the following:

- 1. On slopes, anchor the GCL securely and deploy it down the slope in controlled manner.
- 2. Weight the GCL with sandbags or equivalent in the present of wind.
- 3. Cut GCL with a cutter (hook blade), scissors, or other approved device.
- 4. Prevent damage to underlying layers during placement of GCL.
- 5. During GCL deployment, do not entrap in or beneath GCL stones, trash, or moisture that could damage GCL.
- 6. Visually examine entire GCL surface. Ensure no potentially harmful foreign objects such as needles are present.
- 7. Do not place GCL in the rain or a times of impending rain.
- 8. Do not place GCL in areas of ponded water.
- 9. Replace GCL that is hydrated before placement of overlying geomembrane and cover soil.
- 10. In general, only deploy GCL that can be covered during the day by geomembrane.
- 11. Prepare seam overlap areas as specified by the manufacturer.
- 12. Protective soil cover (including leachate collection media) shall be placed over the liner as soon as practicable.
- 13. Avoid dragging GCL on the subgrade.
- 14. Vehicular traffic other than low contact pressure vehicles such as UTV/ATV's or golf carts are not allowed on deployed GCL.
- 15. Installation personnel shall not smoke or wear damaging shoes when working on GCL.

ii. Overlaps

Overlap GCL to the manufacturer's recommendations that will vary according to seam location and climatic conditions. Prepare the overlap area as required by the manufacturer. At sumps, overlapped GCL shall be a minimum of 1-foot. At bottom of collection and leak detection sumps, unroll an extra layer of GCL on top of

previously installed GCL. Avoid placing seams on top of underlying seams. Horizontal seams and mid-slope anchor trenches are not allowed on side slopes.

iii Defects and Repairs

Repair all flaws or damaged areas by placing a patch of the same material extending at least 1-foot beyond the flaw or damaged area. Add granular bentonite to the overlapped edges of the patch at the manufacturer's specified rate.

iv Interface with Other Products

Ensure the following when deploying overlying material:

- 1. GCL and underlying materials are not damaged.
- 2. Minimal slippage of GCL on underlying layers occurs.
- 3. No excess tensile stresses occur in GCL.
- 4. If necessary, bond overlap seams and patches in place prior to placement of overlying materials to prevent dislocating the GCL seam or patch.

4.9.Equipment

A. Installation

- 1. Use front-end loader, crane, or similar equipment for GCL deployment with a spreader bar and spindle to prevent slings from damaging edges.
- 2. Use 3-inch wide grips for moving GCL panels into place for each installation technician.
- 3. Use sealing and securing materials as required by specifications and drawings at attachment or penetration locations.
- 4. Use sand bags for securing tarpaulin when being stored and to secure GCL prior to placement of GML.

5. GEOMEMBRANE LINERS

The following requirements govern the geomembrane liners used at the facility:

5.1. Geomembrane Description

Geomembrane materials shall be High Density Polyethylene (HDPE) or Linear Low Density Polyethylene (LLDPE). The thicknesses of these geomembrane materials will vary based on project documents. Geomembrane sheets will be placed on a prepared subgrade and will be continuously seamed in accordance with the manufacturer's instructions to provide a water-tight seam.

5.2.Required Material Properties

The geomembrane shall be made of new, first quality materials with no more that 10% re-grind manufactured specifically for the purpose of liquid containment.

5.2.1. All HDPE Geomembrane Materials

Minimum specifications for all HDPE materials, including geomembrane and extrudate (welding rods):

Density (ASTM D 1505) 0.94 gm/cm³ Percent Carbon Black (ASTM D 1603 or 2.0% to 3.0%

ASTM D 4218)

Minimum specifications for all HDPE geomembrane sheet:

Carbon Black Dispersion (ASTM D 5596) Only near spherical agglomerates, for 10

different view: 9 in Categories 1 or 2 and

1 in Category 3

5.2.2. Smooth HDPE Geomembrane

Thickness (ASTM D 5199) 60 mils (average of all measurements)

54 mils (lowest of any 10 measurements)

Tensile strength @ yield (ASTM D 6693) 126 pounds per inch (ppi)

Tensile strength @ break (ASTM D 6693)

Elongation @ yield (ASTM D 6693)

Elongation @ break (ASTM D 6693)

Tear resistance (ASTM D 1004)

Puncture resistance (ASTM D 4833)

228 ppi

12%

700%

42 pounds

108 pounds

5.2.3. Textured HDPE Geomembrane

Thickness (ASTM D 5994) 60 mils (average of all measurements)

54 mils (lowest for 8 out of 10)

51 mils (lowest of any 10)

Tensile strength @ yield (ASTM D 6693)

Tensile strength @ break (ASTM D 6693)

Elongation @ yield (ASTM D 6693)

Elongation @ break (ASTM D 6693)

Tear resistance (ASTM D 1004)

Puncture resistance (ASTM D 4833)

120 ppi
90 ppi
12%
100%
42 pounds
90 pounds

5.2.4. All LLDPE Geomembrane Materials

Minimum specifications for all LLDPE materials, including geomembrane and extrudate (welding rods):

Density (ASTM D 1505) 0.939 gm/cm³ Percent Carbon Black (ASTM D 1603 or 2.0% to 3.0%

ASTM D 4218)

Minimum specifications for all LLDPE geomembrane sheet:

Carbon Black Dispersion (ASTM D 5596) Only near spherical agglomerates, for 10

different view: 9 in Categories 1 or 2 and

1 in Category 3

5.2.5. Smooth LLDPE Geomembrane

Thickness (ASTM D 5199) 40 mils (average of all measurements)

36 mils (lowest of any 10 measurements)

Tensile strength @ break (ASTM D 6693) 152 pounds per inch (ppi)

Elongation @ break (ASTM D 6693) 800%
Tear resistance (ASTM D 1004) 22 pounds
Puncture resistance (ASTM D 4833) 56 pounds

5.2.6. Textured LLDPE Geomembrane

Thickness (ASTM D 5994) 40 mils (average of all measurements)

36 mils (lowest for 8 out of 10)

Tensile strength @ break (ASTM D 6693) 60 ppi Elongation @ break (ASTM D 6693) 250% Tear resistance (ASTM D 1004) 22 pounds Puncture resistance (ASTM D 4833) 44 pounds

The manufacturer shall certify that the geomembrane has been quality control tested during the manufacturing process and that the materials are first quality and free of holes, blisters, undispersed raw materials, and contamination by foreign materials. In addition, the manufacturer shall certify that the liner meets all strength and resistance requirements for the intended use.

Properties, test methods, testing frequencies, and required values are summarized in Tables 10-4 and 10-5 for HDPE geomembranes, and Tables 10-6 and 10-7 for LLDPE geomembranes.

Table 10-4
Required Testing for 60-mil HDPE Geomembrane (Smooth and Textured)¹

Test	Property	Frequency	Test Method
Resin	Specific Gravity/Density	Per 200,000 lbs and	ASTM D 1505 or ASTM D 792
	Melt Flow Index	every resin lot Per 100,000 ft ² and every resin lot	ASTM D 1238
Manufacturer's	Thickness	Per roll of geomembrane	ASTM D 5199 (smooth), and ASTM D 5994 (textured)
Quality Control	Specific Gravity/Density	Per 200,000 lbs and every resin lot	ASTM D 1505 or ASTM D 792
	Carbon Black Content	Per 20,000 lbs	ASTM D 4218 or ASTM D 1603
	Carbon Black Dispersion	Per 45,000 lbs	ASTM D 5596
	Tensile Properties	Per 20,000 lbs	ASTM D 6693
	Tear Resistance	Per 45,000 lbs	ASTM D 1004
	Puncture Resistance	Per 45,000 lbs	ASTM D 4833
	Stress Crack Resistance	Per GRI-GM10	ASTM D 5397
	Oxidative Induction Time	Per 200,000 lbs	ASTM D 3895 or ASTM D 5885
	Oven Aging @ 85°C (a) Standard OIT, or (b) High Pressure OIT	Per each formulation	ASTM D 5721 ASTM D 3895 ASTM D 5885
	UV Resistance High Pressure OIT Asperity Height ²	Per each formulation Every second roll of geomembrane	ASTM D 7238 ASTM D 5885 ASTM D 7466
Conformance Testing by 3 rd Party	Thickness Specific Gravity/Density	Per 100,000 ft ² and every resin lot	ASTM D ASTM D 5199 (smooth), and ASTM D 5994 (textured) ASTM D 1505 or ASTM D 792
Independent Laboratory	Carbon Black Content		ASTM D 4218 or ASTM D 1603
	Carbon Black Dispersion		ASTM D 5596
	Tensile Properties		ASTM D 6693
Destructive Seam Field Testing	Shear & Peel	Various for field, lab & archive	ASTM D 6392
Non- Destructive	Air Pressure	All dual-track fusion weld seams	ASTM D 5820
Seam Field Testing	Vacuum	All non-air pressure tested seams when possible	ASTM D 4437

¹ All tests will conform to the minimum requirements set forth by GRI testing standard GM13. Required values for the properties are listed in Table 10.5

²This testing is for textured geomembrane only. Measurement side will be alternated for double-sided textured sheet.

Table 10-5

Minimum Required Property Values for 60-mil HDPE Geomembrane (Smooth and Textured)¹

Dranarty	Took Makhad	Minimum Required Value	
Property	Test Method	Smooth	Textured
Thickness, mils	ASTM D 5199		
Minimum average	ASTM D 5994 (textured)	60	57
Lowest individual reading		54	51
Lowest individual of 8 of 10 readings		NA	54
Density, g/cc	ASTM D 1505/ D 792	0.94	0.94
Asperity Height, mils	ASTM D 7466	NA	10
Tensile Properties ¹	ASTM D 6693		
 Yield Strength, lb/in 		126	126
2. Break Strength, lb/in		228	90
3. Yield Elongation, %		12	12
4. Break Elongation, %		700	100
Tear Resistance, lb	ASTM D 1004	42	42
Puncture Resistance, lb	ASTM D 4833	108	90
Stress Crack Resistance ² , hrs	ASTM D 5397	300	300
Carbon Black Content, %	ASTM D 4218 or ASTM D 1603	2.0 – 3.0	2.0 – 3.0
Carbon Black Dispersion ³ , Category	ASTM D 5596	1 or 2 and 3	1 or 2 and 3
Oxidative Induction Time (OIT) ⁴ (min.			
avg)	ASTM D 3895	100	100
Standard OIT, minutes	ASTM D 5885	400	400
High Pressure OIT, minutes			
Oven Aging @ 85°C	ASTM D 5721		
Standard OIT, % retained after 90 days	ASTM D 3895	55	55
High Pressure OIT, % retained after 90	ASTM D 5885	80	80
days			
UV Resistance ⁵	ASTM D 7238		
High Pressure OIT ⁶ , % retained after	ASTM D 5885	50	50
1600 hrs			
Seam Properties (4 out of 5 specimens,	ASTM D 6392		
5 th specimen can be as low as 80%)			
 Shear Strength, Ib/in 		120	120
2. Peel Strength, lb/in		91 & FTB	91 & FTB
		(78, ext. weld)	(78, ext. weld)

¹Machine direction (MD) and cross machine direction (XMD) average values will be on the basis of 5 test specimens each direction. Yield elongation is calculated using a gauge length of 1.3 inches; break elongation is calculated using a gauge length of 2.0 inches.

²The yield stress used to calculate the applied load for the Single Point Notched Constant Tensile Load (SP-NCTL) test will be the mean value via MQC testing

³ Carbon Black Dispersion for 10 different views; 9 in Categories 1 and 2 and 1 in Category 3.

⁴The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.

⁵The condition of the test will be 20 hr UV cycle at 75°C followed by 4 hr condensation at 60°C.

⁶ UV resistance is based on percent retained value regardless of the original HP-OIT value.

⁷Required values are based on GRI GM13, except for the seam properties which are based on GRI GM19.

 $\label{thm:continuous} Table~10\text{--}6$ Required Testing for 40-mil LLDPE Geomembrane (Textured) 1

Test	Property	Frequency	Test Method
Resin	Specific Gravity/Density	Per 200,000 lbs and	ASTM D 1505 or ASTM D 792
	Melt Flow Index	every resin lot Per 100,000 ft ² and every resin lot	ASTM D 1238
Manufacturer's	Thickness	Per roll of geomembrane	ASTM D 5994
Quality Control	Specific Gravity/Density	Per 200,000 lbs and every resin lot	ASTM D 1505 or ASTM D 792
	Carbon Black Content	Per 20,000 lbs	ASTM D 4218 or ASTM D 1603
	Carbon Black Dispersion	Per 45,000 lbs	ASTM D 5596
	Tensile Properties	Per 20,000 lbs	ASTM D 6693 Type IV
	Tear Resistance	Per 45,000 lbs	ASTM D 1004
	Puncture Resistance	Per 45,000 lbs	ASTM D 4833
	Axi-Symmetric Break Resistance Strain	Per each formulation	ASTM D 5617
	Oxidative Induction Time	Per 200,000 lbs	ASTM D 3895 or ASTM D 5885
	Oven Aging @ 85°C (a) Standard OIT, or (b) High Pressure OIT	Per each formulation	ASTM D 5721 ASTM D 3895 ASTM D 5885
	UV Resistance High Pressure OIT Asperity Height ²	Per each formulation Every second roll of	ASTM D 7238 ASTM D 5885 ASTM D 7466
		geomembrane	
Conformance	Thickness ²	Per 100,000 ft ² and every	ASTM D 5994
Testing by 3 rd Party	Specific Gravity/Density	resin lot	ASTM D 1505 or ASTM D 792
Independent	Carbon Black Content		ASTM D 4218 or ASTM D 1603
Laboratory	Carbon Black Dispersion		ASTM D 5596
	Tensile Properties		ASTM D 6693 Type IV
Destructive Seam Field Testing ³	Shear & Peel	Various for field, lab & archive	ASTM D 6392
Non- Destructive Seam Field	Air Pressure Vacuum	All dual-track fusion weld seams All non-air pressure	ASTM D 5820 ASTM D 4437
Testing		tested seams when possible	

 $^{^{1}}$ All tests will conform to the minimum requirements set forth by GRI testing standard GM17. Required values for the properties are listed in Table 10-7.

² Field thickness measurements for each roll must be conducted. The lowest 8 out of 10 values will not be less than 10% below the nominal thickness and no single measurement will be less than 15% below the nominal thickness for the roll to be acceptable.

³ Passing criteria for the geomembrane materials are listed in Table 10-7. Passing criteria for seams are listed in Section 5.4.8.3.3

Table 10-7

Minimum Required Property Values for 40-mil LLDPE Geomembrane (Textured)¹

Property	Test Method	Minimum Required Value
Thickness, mils	ASTM D 5994	
Minimum average		38
Lowest individual reading		34
Lowest individual of 8 of 10 readings		36
Density, g/cc (max.)	ASTM D 1505/ D 792	0.939
Asperity Height, mils ¹	ASTM D 7466	10
Tensile Properties ²	ASTM D 6693 Type IV	
 Break Strength, Ib/in 		60
2. Break Elongation, %		250
Tear Resistance, lb	ASTM D 1004	22
Puncture Resistance, lb	ASTM D 4833	44
Break Resistance Strain, % (min.)	ASTM D 5617	30
Carbon Black Content, %	ASTM D 4218 or ASTM D 1603	2.0 – 3.0
Carbon Black Dispersion ³ , Category	ASTM D 5596	1 or 2 and 3
Oxidative Induction Time (OIT) ⁴ (min. avg)		
Standard OIT, minutes	ASTM D 3895	100
High Pressure OIT, minutes	ASTM D 5885	400
Oven Aging @ 85°C	ASTM D 5721	
Standard OIT, % retained after 90 days	ASTM D 3895	35
High Pressure OIT, % retained after 90 days	ASTM D 5885	60
UV Resistance ⁵	ASTM D 7238	
High Pressure OIT ⁶ , % retained after 1600 hrs	ASTM D 5885	35
Seam Properties (4 out of 5 specimens, 5 th		
specimen can be as low as 80%)		
Shear Strength, Ib/in	ASTM D 6392	60
Peel Strength, lb/in		50 & FTB
		(44, ext. weld)

¹ Measurement side will be alternated for double-sided textured sheet.

5.3.Installation Procedures

The geomembrane liner installation procedures shall be conducted by the GMI and observed by QAO. The installation procedures shall conform to the following requirements:

² Machine direction (MD) and cross machine direction (XMD) average values will be on the basis of 5 test specimens each direction. Break elongation is calculated using a gauge length of 2.0 inches.

³ Carbon Black Dispersion for 10 different views; 9 in Categories 1 and 2 and 1 in Category 3.

⁴The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.

⁵The condition of the test will be 20 hr UV cycle at 75°C followed by 4 hr condensation at 60°C.

⁶ UV resistance is based on percent retained value regardless of the original HP-OIT value.

⁷Required values are based on GRI GM17, except for the seam properties which are based on GRI GM19.

5.3.1. Surface Preparation

The surface to be lined shall be prepared so as to provide a surface which is relatively free of irregularities, loose earth, desiccation cracks, and abrupt changes in grade. This preparation shall consist of the removal of loose scale materials which might damage the geomembrane. Prior to placing geomembrane materials, the GMI shall execute a subgrade acceptance form unless installed over a GCL. This form shall be submitted to the QAO and signed by the QAE and the Owner. A copy of this form has been included in Appendix A.

5.3.2. Delivery and Storage

All rolls of geomembrane delivered to the site shall be marked with the name of the manufacturer, the product type, the nominal thickness, the manufacturing batch code, roll number, date of manufacture, and roll dimensions. The QAO must inspect the delivered materials for damage and defects. Pushing, sliding or dragging or rolls or pallets can cause damage and must be avoided. The geomembrane rolls shall be kept free of dirt and debris, must be protected from soft or wet ground and rocky or rough ground, and must not be stacked more than five (5) rolls high to avoid crushing the cores of the rolls. A sacrificial cover must be used to protect the geomembrane if stored on site for more than six (6) months. The rolls shall be stored on level ground in such a manner as to avoid shifting, abrasion, or other adverse movements that can damage the geomembrane materials.

5.3.3. Geosynthetic Materials Anchor Trench

A geosynthetic materials anchor trench shall be completed along the perimeter of the area to be lined where indicated on the project contract documents. The anchor trench may be excavated in sections, as necessary. Loose soil shall be removed from the anchor trench and shall not underlie the geosynthetic materials to be placed in the anchor trench. The excavated anchor trench shall have rounded corners in order to help protect the geosynthetic materials. The anchor trench shall conform to the dimensions and requirements shown on the project contract documents.

5.3.4. Geomembrane Deployment

5.3.4.1.Weather Conditions

Geomembrane deployment shall not proceed:

- During precipitation events;
- o In the presence of excessive moisture (humidity);
- o In areas of ponded water; or,
- o In the presence of excessive wind.

5.3.4.2. Temporary Geomembrane Anchoring

All unseamed edges of geomembrane panels shall be temporarily anchored each day using sand bags, rubber tires or a comparable means that does not damage the material, and does

not degrade during the time it is in use. Similar procedures may be used to temporarily anchor the geomembrane in the anchor trench. Penetrating anchors shall not be used for temporary anchorage unless the penetrations will be beyond the inside wall of the anchor trench and will not require repair. Anchorage shall be sufficient to prevent loss or damage.

5.3.4.3. Panel Placement and Alignment

The geomembrane shall be deployed in accordance with the procedures outlined below:

- Only those geomembrane panels which can be seamed in one (1) day should be deployed.
- Each geomembrane panel shall be inspected for damage and manufacturing defects prior to seaming.
- Geomembrane panels shall be placed in a controlled manner, such as pulling, hoisting, or rolling. The geomembrane panels shall be installed such that there will be neither excessive tension nor wrinkles that could cause creasing in the final use condition. Wrinkles shall be walked out or removed as much as possible prior to field seaming.
- o Panels shall be placed in such a manner that the geomembrane is not scratched or crimped. Any such damage shall be repaired or removed and replaced in accordance with the procedures described in Section 5.3.7.
- Adjacent geomembrane panels shall be overlapped a minimum of three (3) inches (HDPE) after seaming is completed. The QAI shall visually inspect the placement and overlap of the geomembrane to verify that the material is placed with sufficient overlap. Geomembrane seams with insufficient overlap shall be repaired or replaced.
- o Geomembrane panels shall be placed such that there are no horizontal or crosspanel seams on the side slopes unless approved by the QAE and the owner. In addition, geomembrane panels placed on the bottom shall be overlapped from top to bottom in the downslope direction. In this configuration the upslope geomembrane panel will overlie the immediately adjacent downslope panel. This overlap shall be a minimum of three (3) inches.
- The geomembrane panels shall be placed and aligned such that seam joining of the sidewalls and bottom sections must be located in the bottom and at least five (5) feet from the sidewall. In corners and odd-shaped geometric locations, the number of field seams should be minimized.
- No vehicular traffic shall be allowed on the geomembrane. Only low-ground pressure supporting equipment may be allowed to traverse the geomembrane. The equipment used for placement and seaming shall not damage the geomembrane by leaking fluids or other means. Areas which are damaged in this manner shall be removed or repaired.
- Personnel working on the geomembrane shall not smoke, wear damaging shoes, throw equipment or engage in other activities which could damage the geomembrane.

5.3.4.4.Panel Identification

As each geomembrane panel is placed, it shall be labeled in bold print visible from a distance of approximately thirty (30) feet. In general, these markings shall be placed in an area which will remain un-obscured until subsequent layers are placed. Panel numbers shall be sequential based on the placement order. The roll number from which the panel is from shall be included with the panel number.

5.3.5. Field Seaming

All field seaming shall be performed using method(s) approved by the manufacturer of the geomembrane sheet. For HDPE geomembrane, this will include fusion and extrusion welding.

5.3.5.1. Weather Conditions

Field seaming of the geomembrane shall not be performed at ambient temperatures below 40° Fahrenheit (F) [5° Celsius (C)] unless the geomembrane seam area is preheated, by sun or hot air device, to a temperature in excess of 50°F (5°C). However, in any case, field seaming of the geomembrane shall not be performed at ambient temperatures below 34°F (1°C). The GMI shall consult with the QAE if it is anticipated that seaming will be attempted or performed above 113°F (45°C) ambient air temperature. The QAE shall establish and the GMI shall implement agreed-upon measures to prevent liner stretching and thickness reduction or no seaming shall be performed above 113°F (45°C) ambient air temperature. The temperature shall be recorded at regular, periodic intervals by the GMI.

5.3.5.2.Trial Seams

All personnel responsible for seaming shall perform a trial seam prior to the start of seaming with each apparatus used that day. The beginning of each seaming period is considered to be the morning, and immediately after a break. Whenever seaming with a particular apparatus is discontinued for more than one hour or turned off more than ten (10) minutes, a new trial seam shall be performed. An additional trial seam shall be performed for each seaming period for each apparatus used that day, and for each six (6) hours if a break is not taken. In any instance, a minimum of one (1) trial seam shall be performed for each six (6) hours of operation for each seaming apparatus used.

An additional trial seam shall also be performed for each occurrence of significantly different environmental conditions (i.e., temperature, humidity, dust, etc.), and when fusion seaming different geomembranes (tie-ins and smooth to textured). Both the welder and the machine must be tested for each trial seam when extrusion welding. Only the machine needs to be tested for each new trial seam when fusion welding, since the machine is not as operator dependent. Each individual seaming shall make at least one (1) trial seam each day they actually perform seaming.

Trial seams shall be performed on "fragment" pieces of geomembrane and shall be a minimum of twelve (12) inches in width by three (3) feet in length. A minimum three (3) inch overlap shall be provided and the seam shall be approximately centered throughout the length of the geomembrane fragment used. All trial seams shall be performed under the same conditions as production seaming. Trial seams shall be tested in the field by the GMI for peel and shear performance, as outlined in Sections 5.4.6 and 4.4.7.

5.3.5.3.General Seaming Requirements

All geomembrane seams shall extend to the end of each panel to be anchored. All geomembrane seams shall be clean and free of moisture, oil, dust, dirt, debris of any kind, and foreign matter at the time of welding. No folds, large wrinkles, or fish mouths shall be allowed in the seam. Only normal factory-induced creasing from the blown film process may be acceptable. Where wrinkles or folds occur, the material shall be cut and overlapped, and an extrusion weld applied, in accordance with the procedures outlined in this LQCP. Areas of insufficient overlap shall be repaired in accordance with the procedures detailed in Section 5.3.7. All complete seams shall be tightly bonded and sealed.

If geomembrane seaming operations are performed at night, adequate lighting shall be provided for seaming as well as for inspection of the seaming conditions and the seams.

5.3.5.4. Extrusion Seaming Requirements

The extrusion welding apparatus shall have a temperature gauge which indicates the temperature of the extrudate. Additionally, the temperature of the extrudate at the nozzle will be monitored at the time of trial seaming using a probe (pyrometer). A significant difference (greater than 15°C) in the indicated vs. monitored temperature shall result in investigation and repair of the seaming apparatus. The QAI may request that the GMI check extrudate temperatures at other times as well.

The extruder shall be purged to remove heat-degraded material prior to the beginning of seaming and whenever the extruder is stopped for an appreciable length of time.

Grinding in preparation for extrusion welding should be done carefully. Grinding beyond the area to be covered with extrudate is unnecessary, and will be minimized. Grinding shall not extend more than one-eighth (1/8) inch beyond the edge of the seam.

5.3.5.5. Fusion Seaming Requirements

The fusion welding apparatus shall be a vehicular mounted, automated device. The temperature, pressure and welding speed shall be independently adjustable and the apparatus shall be equipped with a gauge which displays the actual internal temperature.

5.3.6. Nondestructive Seam Continuity Testing

The GMI shall conduct the following nondestructive seam continuity testing:

5.3.6.1.General

Continuous non-destructive testing shall be performed on all seams by the GMI. Air pressure testing shall be performed on all dual track fusion welds and vacuum-box testing for extrusion welds are the only acceptable methods for geomembrane seams. All leaks identified during testing must be isolated and repaired by the following procedures described in this LQCP.

Areas thought to be potentially inaccessible to nondestructive continuity testing equipment shall be brought to the QAE's attention prior to the start of work.

Nondestructive continuity testing of field seams, including repairs, shall be performed by the GMI as the work progresses to provide the opportunity for immediate rewelding and retesting as necessary. All defects discovered shall be marked, repaired and retested.

5.3.6.2. Testing Procedures

The GMI shall submit the proposed specific nondestructive testing procedures to be employed on this project to the QAE. The testing procedures shall be consistent with the requirements of this specification. The testing procedures must be approved by the QAE.

For vacuum box testing, a suction value of approximately three (3) to five (5) inches of gauge vacuum shall be applied to all extrusion seams that can be tested in this manner. The seam that has been wetted with soapy water must be observed for leaks a minimum of five (5) seconds while subjected to this vacuum. Areas where soap bubbles appear shall be marked, repaired and re-tested. The GMI shall record the test results, including technician ID, date, time and pass/fail condition on the geomembrane near the test location.

For air pressure testing, the air space created by the fusion weld shall be tested for continuity. The ends of the air channel of the dual track fusion weld must be sealed and pressured to a minimum of 30 psi. The air pump must then be shut off and the air pressure observed after five minutes. A loss of less than four (4) psi is acceptable, if it is determined that the air channel is not blocked between the sealed ends. A loss of more than four (4) psi indicates the presence of a seam leak which must then be marked, isolated, repaired and re-tested. The GMI shall record the test results, including technician ID, date, the before and after times and pressures and pass/fail condition at a minimum on the geomembrane near the test location. All openings in air channels must be sealed subsequent to testing.

5.3.7. Defects and Repairs

5.3.7.1.General

All seam and non-seam areas of the geomembrane shall be visually inspected for signs of defective seams, blisters, punctures, undispersed raw materials, and any sign of contamination by foreign matter. Any problems discovered shall be marked, repaired and

retested or reevaluated in accordance with this document. The geomembrane surface shall be clean at the time of these inspections.

Any sheets which become seriously damaged (torn or twisted permanently) shall be replaced. Less serious damage (inadvertent punctures during installation) shall be repaired by welding a piece of geomembrane over the damaged area. The repairs must comply with the LQCP to be considered adequate.

5.3.7.2.Evaluation

Each suspect location in both seam and non-seam areas shall be inspected and, where appropriate, tested using the methods described in this document. Work shall not proceed with any materials which will cover the locations which require repair or which have been repaired but require testing with passing results.

5.3.7.3.Procedures for Repair

Grinding and welding procedures may be used to repair small sections of deficient extrusion seams and small surface blemishes which do not penetrate the entire thickness of the geomembrane. The geomembrane surfaces requiring repair shall be abraded no more than one hour prior to the repair being made. The allowable time between abrading the surface and making the repair may be reduced if determined necessary by the QAI. Grinding shall be performed only within the area requiring repair and shall not significantly damage the liner.

Defects which do not require replacement of the sheet shall be repaired and covered with a patch or a cap (a patch with an extended length). Patches and caps shall extend a minimum of six (6) inches beyond the limits of the defect and all corners of patches and caps shall be rounded with a radius of approximately two inches. All seaming for patches and caps shall be accomplished by extrusion welding.

The GMI shall record repair information, including technician and seaming apparatus ID, date, and time on the repair or on the geomembrane near the repair.

5.3.8. Permanent Anchorage in Anchor Trench

Following completion of the seaming activities as determined by the GMI, the geomembrane (and any other geosynthetic materials) shall be permanently anchored in the anchor trench. A detail indicating proper anchoring procedures is included in the project contract documents. The anchor trench shall be backfilled and compacted using hand-operated or rubber-tired equipment. Care should be used when backfilling and compacting the anchor trench to prevent damage to the geosynthetic materials. The final configuration of the anchor trench shall conform to the dimensions and requirements shown on the project contract documents.

5.4. Quality Assurance Requirements

The QAO shall review quality control documents, conduct material conformance tests and inspect the placement and installation of the geomembrane, and coordinate necessary surveys. In addition, the QAI shall ensure the following QA verification activities are performed:

5.4.1. Inspection Upon Delivery

The QAI shall inspect the geomembrane material delivered to the site. All rolls of geomembrane shall be marked with the name of the manufacturer, the product type, the nominal thickness, the manufacturing batch code and/or roll number, date of manufacture, and roll dimensions. The QAI shall document that the quality control and conformance data has been received and is acceptable for each roll. The QAI shall also verify that the geomembrane rolls are being stored in a manner to protect them from the elements.

5.4.2. Thickness Determination

The QAI shall check the thickness of each roll of geomembrane delivered to the site. Thickness shall be checked with a micrometer on the leading edge at five (5) locations. The geomembrane shall meet the required material properties. See Section 5.2, except that thickness criteria are for five (5) measurements or four of five as appropriate. Geomembrane rolls which fail this thickness determination shall be removed from the site. The QAI shall document the thickness determinations taken for each roll.

5.4.3. Inspection During Deployment

The QAI shall visually inspect the deployment of the geomembrane to ensure that the panels are properly placed and that each seam will have sufficient overlap.

5.4.4. Observation of Non-Destructive Testing

The GMI shall coordinate the non-destructive testing with the QAE to ensure that a QAI is present for non-destructive testing. The QAE or QAI will verify that all non-destructive testing is successfully completed and will document the testing on data forms.

5.4.5. Survey Documentation

The QAE shall locate all seams, destructive test locations and patches for the geomembrane and may coordinate a survey for such purposes if appropriate. Reference locations will be noted on a drawing of the area.

5.4.6. Trial Seam Testing

Each trial test seam shall be at least three (3) feet long by one (1) foot wide. Four (six when possible if using dual track fusion welding) adjoining one (1) inch wide specimens shall be cut in a controlled manner, by die or template from the test seam sample. Two (2) specimens shall be tested in the field for shear, and two (2) for peel (four [4] when possible

if testing both inner and outer welds for dual track fusion welding) using testing procedures outlined in the following paragraph. Specimens cut in an uncontrolled fashion to a random width shall not be used.

All trial seam specimens shall be tested by the GMI and observed by a QAI in the field for shear and peel using an electrically operated tensiometer, with the capability of registering the force imparted on a geomembrane test specimen. Hand operated tensiometers shall not be used. The trial seam specimens shall be tested at a cross-head rate of two (2) inches per minute. The GMI shall provide a calibration certificate for each load cell within the tensiometer. Calibration shall have been conducted within 90 days of the start of installation.

The GMI's seaming and testing technician(s) shall record the following information on a remnant portion of the trial seam sample. The remnant portion will be retained until project completion and may then be stored by the Owner. The QAI will log the information on a data form and assign each sample a number.

- Date and time of test;
- The name of the welder and identification of the apparatus used in performing the test;
- The failure mode: either "Pass" indicating a film-tear bond not in the weld or "Fail" for each specimen; and,
- The peak yield load in pounds per inch for each specimen.

5.4.7. Trial Seam Evaluation Criteria

The criteria for evaluating trial seams is as follows:

5.4.7.1.Shear

Two (2) trial seam specimens shall be tested in shear. Each must fail at a strength equal to or greater than ninety five percent (95%) of the rated yield strength of the parent sheet material as indicated on the manufacturer's quality control certifications, but in no instance at less than the specified yield strength for sheet material. Neither trial seam test shall fail in the weld. If both of these criteria are not met, the entire trial seam shall be considered failing.

5.4.7.2.Peel

Two (2) trial seam specimens (four if necessary to test both inner and outer welds) shall be tested in peel and neither shall fail in the weld area. If this criteria is not met, the entire trial seam shall be considered failing. The peel strength of the geomembrane outside of the weld shall be equal to or greater than sixty two percent (62%) of the rated yield strength of the parent sheet material as indicated on the manufacturer's quality control certifications, but in no instance less than 90 ppi for fusion seams and 78 ppi for extrusion seams. Peel seams must exhibit a Film Tear Bond (FTB) failure.

If a trial seam fails, the entire procedure shall be repeated after the appropriate adjustments to the welding apparatus or procedures have been made. This process shall be repeated until two (2) consecutive successful trial seam tests have been achieved. Alternatively, if a successful trial seam is not achieved, the welding apparatus and/or the operator shall not be used for seaming until such time as the deficiencies are resolved.

5.4.8. Destructive Seam Testing

5.4.8.1.Testing Location and Frequency

Destructive seam samples will be obtained at an average minimum frequency of one (1) per five hundred (500) lineal feet of weld. Destructive seam-testing locations shall be cap-stripped and the cap completely seamed by extrusion welding to the geomembrane. Capped sections shall be non-destructively tested. The seam destructive test sampling frequency may be increased by the QAE beyond the specified minimum based upon actual welding conditions and the results of other samples obtained.

The sample locations will be selected by the QAI as welding progresses. Additional sample locations may be prompted by suspicion of a poor quality weld.

The GMI will not be informed in advance of seam destructive test locations but will be required to physically obtain the samples from the geomembrane no later than twenty four (24) hours after the location has been selected.

The total footage of individual repairs of leaks of more than ten (10) feet and individual repairs of more than ten (10) feet for failed seams must also be counted and destructively tested using the same frequency of testing described above.

5.4.8.2. Sample Size

The location for the destructive samples shall be marked by the QAI. The dimensions for the destructive samples shall, as a minimum, be twelve (12) inches wide by thirty six (36) inches long with the seam centered widthwise. Sample lengths may be increased at the request of the QAL. The GMI shall obtain two specimens from each end of the marked seam destructive sample, each a minimum of one inch in width for preliminary field testing as described in Section 5.4.8.3.1. If the preliminary field testing exceeds the pass/fail criteria, the sample shall be cut and divided into two parts as described below:

- o One portion of the sample, measuring twelve (12) inches by fifteen (15) inches, to be sent by the QAO to the QAL for testing.
- One portion of the sample, measuring twelve (12) inches by twelve (12) inches to be retained by the owner for archiving.
- The sample length shall be increased to accommodate the additional length required by the GMI for laboratory testing or archiving.

5.4.8.3. Testing Procedure

5.4.8.3.1.Preliminary Field Testing

Four (4) specimens, two (2) from each end of the destructive sample seam, are to be removed and tested by the GMI while in the field. One (1) specimen from each end of the original sample is to be tested in shear and the other in peel. Specimen and test procedures shall be the same as described for trial seams in Section 5.4.6. Field testing shall include testing on both tracks on dual track fusion welded seams for each specimen tested for peel.

5.4.8.3.2. Laboratory Seam Destructive Testing

The destructive seam testing will be performed by QAO in an off-site laboratory. This testing is to be completed within seventy two (72) hours of the time the samples are removed from the geomembrane installation. The Contractor may test samples in the field with observation by the QAI.

The testing shall be performed on a total of ten (10) specimens obtained from the field sample described in Section 5.4.8.2. Five (5) specimens shall be tested in each of the shear and peel modes. For the dual-tracked fusion welds, five (5) peel tests shall be performed for each track of weld. These shear and peel specimens shall be selected from the sample alternately so that no two (2) immediately adjacent specimens are tested in the same mode.

The specimens shall be tested in accordance with ASTM D 6392.

5.4.8.3.3. Seam Evaluation Criteria

Each seam sample must meet both the shear and peel criteria before being considered passing. Field tested specimens are determined as passing if the specimen tested in peel fails in FTB and all test specimens meet the criteria listed in this LQCP. The QAL testing must confirm these field results.

5.4.8.3.3.1.Shear

The shear strength must be at least 120 lb/in for HDPE geomembrane and 60 lb/in for LLDPE geomembrane. The minimum passing criteria for independent laboratory testing are all of the following: (1) at least four of the five specimens shall not fail in the weld, (2) at least four of the five specimens must meet the minimum specified value, and (3) the average value from all the specimens must meet the minimum specified value. The above criteria apply to both tracks from each dual track fusion welded seam before it is considered passing. If these criteria are not met then the entire seam destructive sample is considered failing.

5.4.8.3.3.2.Peel

The peel strength must be at least 91 lb/in for HDPE geomembrane (78 lb/in for extrusion welds) and 50 lb/in for LLDPE geomembrane (44 lb/in for extrusion welds). The minimum passing criteria for laboratory testing are all of the following: (1) at least four of the five specimens shall not fail in the weld, (2) at least four of the five specimens must meet the minimum specified value, and (3) the average value from all five specimens must meet the minimum specified value. The above criteria apply to both tracks from each dual track fusion welded seam before it is considered as passing. If these criteria are not met, then the entire seam destructive sample is considered failing.

5.4.8.3.4.Seam Destructive Test Failure Procedures

In the instance of the dual-tracked fusion weld, both tracks of the weld will be tested in peel. If either peel test performed on specimens of this weld type fails, the entire specimen is considered failing.

The GMI shall reconstruct the failing seam bound by two passing seam destructive tests. The GMI shall have the option of obtaining additional destructive test samples at a minimum of ten (10) foot intervals in both directions along the failing seam from the failure location. The minimum interval may be increased by the QAE if test failures become excessive.

If both of these samples pass the laboratory seam destructive test then the seam can be reconstructed between them. If one (1) or both of these samples fail the laboratory seam destructive test, then the procedure is repeated until passing laboratory results are obtained. (Note: The tracking procedure described may be extended beyond the limits of an individual seam.)

If a seam is reconstructed to a length in excess of fifty (50) feet, a seam destructive sample may be obtained from the reconstruction zone which must meet the requirements described above.

6. LEACHATE COLLECTION SYSTEM

The following requirements govern the leachate collection system used in the landfill units:

6.1.Leachate Collection System Description

The leachate collection system (LCS) used consists of layers of geotextile fabric, HDPE drainage net, gravel and piping, as described in conjunction with the lining systems in Section 1.2. In general, the LCSs will be sloped to drain to one or more collector pipes running through each landfill unit. The underlying lining system will be sloped to the collector pipe, and along the line of the collector pipe toward the sump. The sump will have a riser pipe for the removal of collected liquids. Detailed design descriptions and drawings of the leachate collection system and geocomposite drainage layer are provided in the project construction documents.

6.2. Required Material Properties

The LCS and geocomposite drainage layer materials shall be new, first quality materials manufactured specifically for the purpose of liquid conveyance and collection. All LCS and geocomposite drainage layer materials shall have sufficient strength and resistance to chemical or ultraviolet radiation attack for the intended use. Properties, test methods, testing frequencies, and required values are summarized in Table 10-8 below for geotextiles, drainage nets and drainage geocomposites.

Table 10-8
Required Testing for Geotextile and Drainage Geocomposite¹

Responsible	ricquired resting	Geotextile and Draina	Be december	
Party	Material	Property	Test Method	Value
Manufacturer	Geotextile for Drainage Geocomposite	Unit Weight	ASTM D 5261	8 oz/sy
		Apparent Opening Size	ASTM D 4751	0.15 mm
		Grab Strength	ASTM D 4632	220 lb
		Grab Elongation	ASTM D 4632	50%
		CBR Puncture Strength	ASTM D 6241	575 lb
		Permittivity	ASTM D 4491	1.3 sec ⁻¹
	Geotextile for leak detection trench wrap	Unit Weight	ASTM D 5261	12 oz/sy
		Apparent Opening Size	ASTM D 4751	0.15 mm
Manufacturer		Grab Strength	ASTM D 4632	320 lb
		Grab Elongation	ASTM D 4632	50%
		CBR Puncture Strength	ASTM D 6241	925 lb
		Permittivity	ASTM D 4491	0.8 sec ⁻¹
	HDPE Geonet	Specific Gravity/Density	ASTM D 1505	0.94 gm/cm ³
		Thickness	ASTM D 5199	250 mils
		Peak Tensile Strength	ASTM D 5035 or	45 lb/in
Manufacturer			ASTM D 7179	
		Percent Carbon Black	ASTM D 1603 or	2.0 %
			ASTM D 4218	
		Transmissivity ²	ASTM D 4716	2 x 10 ⁻³ m ² /sec
Manufacturer		Ply Adhesion	ASTM D 7005	1.0 lb/in
Manufacturer/ Third Party Lab	Drainage Geocomposite	Transmissivity ²	ASTM D 4716	5 x 10 ⁻⁴ m ² /sec
				(double sided)
				1.5 x 10 ⁻³ m ² /sec
				(single sided)

¹ The minimum testing frequency for materials in this table will be one test sample per 100,000 square feet.

6.2.1. Geotextile

All geotextile fabric shall be non-woven polypropylene, meeting the following minimum specifications:

² Gradient of O.1, normal load of 10,000 psf, between steel plates for 15 minutes.

Geotextile fabric for use in drainage geocomposite:

Mass per Unit Areas (ASTM D 5261) 8 ounces per square yard

CBR Puncture Strength (ASTM D 6241) 575 pounds Grab Tensile Strength/Elongation (ASTM D 220 pounds/50%

4632)

Apparent Opening Size (ASTM D 4751) 0.15 mm

Permittivity (ASTM D4491) 1.3 per second (sec⁻¹)

Geotextile fabric for use in leachate collection/leak detection trench:

Mass per Unit Areas (ASTM D 5261) 12 ounces per square yard

CBR Puncture Strength (ASTM D 6241) 925 pounds
Grab Tensile Strength/Elongation (ASTM D 320 pounds/50%

4632)

Apparent Opening Size (ASTM D 4751) 0.15 mm

Permittivity (ASTM D4491) 0.8 per second (sec⁻¹)

6.2.2. HDPE Drainage Net

Minimum specifications for HDPE Drainage Net:

Thickness (ASTM D 5199) 250 mils (average of all measurements)

Density (ASTM D 1505) 0.94 gm/cm³ Peak Tensile strength (ASTM D 5035 or 45 ppi

ASTM D 7179)

Percent Carbon Black (ASTM D 1603 or 2.0% to 3.0%

ASTM D 4218)

Transmissivity (ASTM D4716) 2 x 10⁻³ square meters per second (m²/sec)

at a gradient of 0.1 and a loading of 478.8 kilo-newtons per square meter (kN/ m²)

[10,000 pounds per square foot]

6.2.3. Piping

Minimum specifications for Liquids Collection Piping:

Material HDPE or PVC, single wall Specifications HDPE – ASTM F714

PVC - ASTM D1785, D2241 or D3034

Standard Dimension Ratio (SDR) [Outside 21 Maximum

Diameter to Wall Thickness]

Joint Type HDPE - Fusion Welded

PVC – Fusion or Solvent-Cement Welded

Perforation Type (Where required)

Perforation Size (Where required)

Round

'2" Max.

Perforation Area (Where required) 1-1/2 square inches (in²) per foot

6.2.4. Gravel

Minimum specifications for LCS gravel:

Material Source Washed, rounded river gravel

Maximum particle size (100% Passing – 2"

ASTM C136 or D422)

At least 90% of Material Smaller Than 1-1/2"

(ASTM C136 or D422)

No more than 10% of Material Smaller Than ½"

(ASTM C136 or D422)

Calcium Carbonate Content (ASTM D3042) Less than 15%

Coefficient of Permeability (ASTM D2434) Greater than 0.2 cm/sec

6.3.Installation Procedures

The LCS and GDL material installation procedures shall be conducted by the GMI and observed by QAO. The installation procedures shall conform to the following requirements:

6.3.1. Geotextile

6.3.1.1.Delivery and Storage

All rolls of geotextile delivered to the site shall be marked with the name of the manufacturer, the product type, the manufacturing batch code, roll number, date of manufacture, and roll dimensions. The QAE or QAI must inspect the delivered materials for damage and defects. Damage during unloading must be avoided. The rolls shall be kept free of dirt and debris, must be protected from soft or wet ground and rocky or rough ground, and must not be stacked more than five (5) rolls high to avoid crushing the cores of the rolls. A sacrificial cover must be used to protect the rolls if stored on site for more than six (6) months. The rolls shall be stored in such a manner as to avoid shifting, abrasion, or other adverse movements that can damage the materials.

6.3.1.2.Deployment

Geotextile shall not be deployed in the presence of excessive wind. On slopes, the geotextile shall be secured and rolled down the slope so that it is kept continuously in tension. Geotextile shall be placed parallel to sideslopes, except in special locations approved by the QAI. It shall be anchored in the synthetic materials anchor trench. All unseamed edges shall be temporarily anchored each day using sand bags, rubber tires or a comparable means that does not damage the material, and does not degrade during the time it is in use. During placement of the geotextile, the GMI shall ensure that it is not clogged with dirt or foreign materials. Geotextile shall be cut only with devices that are recommended by the manufacturer.

6.3.1.3. Panel Placement and Alignment

Geotextile panels shall be deployed in accordance with procedures approved by the QAE. As a minimum, the procedures outlined below shall be followed.

- Only those panels which can be seamed in one (1) day should be deployed.
- o Each panel shall be inspected for damage prior to seaming.
- Panels shall be placed in a controlled manner, such as pulling, hoisting, or rolling. The panels shall be installed such that there will be neither excessive tension nor wrinkles that could cause creasing in the final use condition. Wrinkles shall be walked out or removed as much as possible prior to field seaming.
- Adjacent panels shall be overlapped a minimum of three (3) inches (or as sufficient for seaming.) The QAE or QAI shall visually inspect the placement and overlap of the panels to verify that the material is placed with sufficient overlap.
- No vehicular traffic shall be allowed on the geotextile.

6.3.1.4. Field Seaming

All field seaming shall be performed by sewing using polymeric thread having chemical and ultraviolet light resistance properties equal to or exceeding those of the geotextile. Thread shall be supplied by the geotextile manufacturer or shall be as recommended by the manufacturer. Provide documentation of the source or recommendation by the manufacturer. Glues and heat bonding are strictly prohibited. In general, horizontal seams or splices should be avoided on side slopes. No two adjacent slope pulls may have a horizontal seam.

6.3.1.5. Procedures for Repair

Holes or tears in the geotextile shall be repaired by placing a patch extending at least six (6) inches beyond the edges of the hole or tear. The patch shall be seamed to the panel. Care shall be taken to remove any soil or other material which may have penetrated the damaged geotextile.

6.3.2. HDPE Drainage Net

6.3.2.1.Delivery and Storage

All rolls of HDPE drainage net delivered to the site shall be marked with the name of the manufacturer, the product type, the manufacturing batch code, roll number, date of manufacture, and roll dimensions. The QAE or QAI must inspect the delivered materials for damage and defects. Pushing, sliding or dragging of rolls or pallets can cause damage and must be avoided. The rolls shall be kept free of dirt and debris, must be protected from soft or wet ground and rocky or rough ground, and must not be stacked more than five (5) rolls high to avoid crushing the cores of the rolls. A sacrificial cover must be used to protect the rolls if stored on site for more than six (6) months. The rolls shall be stored in such a manner as to avoid shifting, abrasion, or other adverse movements that can damage the materials.

6.3.2.2.Deployment

HDPE Drainage net shall not be deployed in the presence of excessive wind. On slopes, the net shall be secured and rolled down the slope so that it is kept continuously in tension. Drainage net shall be placed parallel to sideslopes, except in special locations approved by the QAI. The drainage net shall be anchored in the synthetic materials anchor trench. All unseamed edges shall be temporarily anchored each day using sand bags, rubber tires or a comparable means that does not damage the material, and does not degrade during the time it is in use. During placement of the net, the GMI shall ensure that the net is not clogged with dirt or foreign materials.

6.3.2.3. Panel Placement and Alignment

Drainage net panels shall be deployed in accordance with procedures approved by the QAE. As a minimum, the procedures outlined below shall be followed.

- Only those panels which can be seamed in one (1) day should be deployed.
- o Each panel shall be inspected for damage prior to seaming.
- O Panels shall be placed in a controlled manner, such as pulling, hoisting, or rolling. The panels shall be installed such that there will be neither excessive tension nor wrinkles that could cause creasing in the final use condition. Wrinkles shall be walked out or removed as much as possible prior to field seaming.
- Adjacent panels shall be overlapped a minimum of three (3) inches. The QAE or QAI shall visually inspect the placement and overlap of the panels to verify that the material is placed with sufficient overlap.
- o No vehicular traffic shall be allowed on the drainage net.

6.3.2.4. Field Seaming

All field seaming shall be performed using method(s) approved by the manufacturer of the HDPE drainage net. Seaming can be achieved using string, plastic fasteners or ties, or polymer braid. Metallic devices are strictly prohibited. Submit the proposed seam (tiepattern) with the quality control documents. In general, no horizontal seams are allowed on side slopes.

6.3.2.5.Procedures for Repair

Holes or tears in the drainage net shall be repaired by placing a patch extending at least six (6) inches beyond the edges of the hole or tear. The patch shall be seamed to the panel.

6.3.3. Piping

6.3.3.1.Delivery and Storage

All piping delivered to the site shall be marked with the name of the manufacturer, the product type, and applicable specifications under which the material was manufactured. The QAE or QAI must inspect the delivered materials for damage and defects. Piping shall be kept free of dirt and debris, must be protected from soft or wet ground and rocky

or rough ground, and must not be stacked more than ten (10) sections high. The piping shall be stored in such a manner as to avoid shifting, abrasion, or other adverse movements that can damage the materials.

6.3.3.2.Deployment

Piping shall be placed to the lines and grades shown on the project construction documents. Piping shall be temporarily anchored using sand bags, rubber tires or a comparable means that does not damage the piping and ensures proper alignment until covered. During placement of the piping, the GMI shall ensure that dirt or foreign materials do not enter the piping.

6.3.3.5. Field Joints/Seaming

All field joints or seaming shall be performed using fittings and method(s) approved by the manufacturer of the piping. Field joints shall be butt-fusion welded. For PVC piping, joints may be solvent-cement welded with prior written approval by the QAE. If solvent cement joints are to be completed over underlying geosynthetic materials, the GMI shall ensure that a sacrificial impermeable barrier is placed underneath each joint to prevent solvent material from coming in contact with the underlying material. Gasketed joints shall not be used.

6.3.3.4. Procedures for Repair

Damaged piping shall be removed and replaced using procedures consistent with those for installing new piping.

6.3.4. Gravel

6.3.4.1.Delivery and Storage

Gravel to be used for LCS construction shall be stockpiled as near as possible to the construction area. Signage near the stockpile shall identify the source, intended use, and gradation specifications (size). Gravel shall not be placed on wet ground.

6.3.4.2.Deployment

Gravel may be placed using mobile equipment or hand tools (e.g. wheel barrows, etc.). Where gravel placement must traverse underlying geosynthetic materials, the GMI shall use only low-ground pressure supporting equipment. If such equipment is operating over the geosynthetic materials, it must be placed on a sacrificial surface or rub sheet. Areas of underlying geosynthetic materials that are damaged in this manner shall be repaired as required by this LQCP. Gravel shall be placed to the lines and grades shown on the project construction documents. Gravel materials shall not be placed in direct contact with geomembrance materials. Where this is possible to occur, the GMI shall place a layer of geotextile fabric between the gravel and the geomembrane. During placement of the gravel, the GMI shall ensure that it is not obstructed by dirt or foreign materials.

6.4. Quality Assurance Requirements

The GMS or the QAO shall conduct material conformance tests, as outlined in Section 1.9 and the QAO shall review quality control documents, inspect the placement and finishing of the LCS, and coordinate necessary surveys. In addition, the QAI shall ensure the following QA verification activities are performed:

6.4.1. Inspection Upon Delivery

The QAI shall inspect the geosynthetic, piping and gravel materials delivered to the site, and shall document that the quality control and conformance data has been received and is acceptable for each material lot. The QAI shall also verify that the materials are being stored in a manner to protect them from the elements.

6.4.2. Inspection During Deployment

The QAI shall visually inspect the deployment of the drainage net, geotextile, piping and gravel to ensure proper placement as outlined in the LQCP and in the project construction documents.

6.4.3. Sieve Analysis (Gradation) for Gravel

A minimum of one (1) test for each 5,000 cubic yards (cy³) or less of gravel shall be performed in accordance with ASTM C136 or ASTM D422. A minimum of one (1) test shall be performed regardless of the quantity.

6.4.4. Survey Verification

The QAE shall coordinate a survey to locate the piping and verify that proper grades are achieved. Where required to document grades, a minimum of one (1) survey verification shall be made per 5,000 ft² of surface area. Reference locations will be noted on a drawing of the area.

7. PROTECTIVE COVER

The following requirements govern the protective cover that will be installed on top of constructed liner materials and leachate collection systems:

7.1. Protective Cover Description

Protective cover soil material will be placed with a minimum thickness of 2 feet over the drainage layer component of the leachate collection system, including drainage aggregate where applicable.

7.2. Required Material Properties

The protective cover will consist of soils that do not contain any materials detrimental to the underlying geosynthetics. The protective cover shall be free of organics, angular rocks, foreign objects, or other deleterious materials.

7.3.Installation Procedures

The protective cover soils shall be placed using low ground pressure equipment. The protective cover shall be placed by spreading in front of the spreading equipment with a minimum of 12 inches of soil between the spreading equipment and the underlying installed geosynthetics. Under no circumstances shall the construction equipment come into direct contact with the installed geosynthetics. Unless otherwise specified by the QAE, all lifts of protective cover soil placed over geosynthetics will conform with the following equipment and lift thickness guidelines.

Equipment Ground Pressure (psi)	Minimum Lift Thickness (in)
< 5.0	12
5.1 - 8.0	18
8.1 - 16.0	24
> 16.0	36

Protective cover placed on sideslopes shall be placed from the bottom and pushed up the slope.

7.4. Quality Assurance Requirements

The protective cover soil thickness shall be verified by field surveys using a minimum of one survey point per 5,000 square feet of constructed area. Surveys shall be performed by a licensed Texas land surveyor and the survey results shall be included in the GLER submittal.

During construction the QAE shall:

- Verify that grade control is performed prior to work.
- Verify that underlying geosynthetic installations are not damaged during placement operations or by survey grade controls. Mark damaged geosynthetics and verify and document damage repairs.
- Verify that cover soil for sideslopes is pushed from the toe up the slope.
- Monitor haul road thickness over geosynthetic installations and verify that equipment hauling and materials placement meet equipment specifications.

8. FINAL COVER CONSTRUCTION

The following requirements govern the final cover system used at the facility:

8.1. Final Cover Description

The final cover system will consist of a six (6) inch thick (minimum) prepared subgrade layer, a geosynthetic clay liner (GCL) layer, a forty mil (0.04 inch) thick LLDPE geomembrane liner, a geocomposite drainage layer, and a twenty five (25) inch thick protective cover soil layer. Soil materials used for the final cover system shall be obtained either from on-site or off-site sources.

8.2. Required Material Properties

Soil materials and geosynthetic materials used for final cover construction comply with the following required material properties.

8.2.1. Soil Materials

8.2.1.1. Subgrade Soils

Soil materials shall meet the requirements of Section 2.2.

8.2.1.2.Protective Cover Vegetative Soil Layer:

The soil material for the protective cover vegetative soil layer shall consist of earthen material capable of sustaining native plant gowth and be composed of particles of which at least thirty percent (30%) but no more than ninety six percent (96%) pass the #200 sieve.

8.2.2. Geosynthetic Materials

8.2.2.1. Geosynthetic Clay Liner (GCL)

The GCL material shall meet the requirements of Section 4.2.

8.2.2.2.Geomembrane Liner

The forty mil (0.04 inch) thick LLDPE geomembrane liner shall meet the requirements of Section 5.2.

8.2.2.3. Geocomposite Drainage Layer

The HDPE drainage net and geotextile fabric used in the geocomposite drainage layer shall meet the requirements of Section 6.2.

8.3.Installation Procedures

The final cover installation procedures shall be conducted by the Earthwork Contractor and observed by QAO. The installation procedures shall conform to the following requirements:

8.3.1. Subgrade Preparation

The existing intermediate cover material shall be shaped to the appropriate lines and grades as shown in the project contract documents and should coincide with the bottom of the final cover system. Subgrade soil materials shall be installed in accordance with the procedures specified in Section 2.3.

8.3.2. GCL Installation

The GCL shall be installed in accordance with the procedures specified in Section 4.8.

8.3.3. Geomembrane Liner Installation

The forty mil (0.04 inch) thick LLDPE geomembrane liner shall be installed in accordance with the procedures specified in Section 5.3.

8.3.4. Geocomposite Drainage Layer

The geocomposite drainage layer shall be installed in accordance with the procedures specified in Section 6.3.

8.3.5. Protective Cover Vegetative Soil Layer

A minimum twenty five (25) inch thick layer of protective cover soil shall be placed above the geocomposite drainage layer on the top and side walls of the area to receive cover. Protective cover does not require compaction control; however it should be stable for construction, operations and maintenance traffic. Care shall be exercised in placement so as not to shift or wrinkle or damage the underlying geosynthetics layers. Protective cover shall be placed using low ground pressure dozers (i.e. track pressure less than 5 psi). A 12-inch thickness of protective cover shall be maintained at all times. A greater thickness will be required to support loaded hauling trucks and trailers and for turning areas. Drivers shall proceed with caution when on the overlying soil and prevent spinning of tires and sharp turns. Protective cover shall be placed in an upslope direction on sidewalls.

The required thickness of the protective cover layer will be verified by survey methods on an established grid system with not less than one verification point per 10,000 square feet of surface area.

9. GENERAL DOCUMENTATION REQUIREMENTS

The QAE shall be responsible for ensuring that adequate documentation is prepared to comply with the LQCP. Documentation may consist of daily recordkeeping, manufacturer's test reports, conformance testing and installation reports, nonconformance reports (if necessary), progress reports, and design and specification revisions (if necessary). The appropriate documentation shall be used by the QAE to develop the GCLER, GLER and BER (if required) as well as other reports that may be required by the owner.

9.1.Daily Field Reports

The QAI shall prepare a daily field report. This report shall be prepared on the form included in Appendix C or a form containing similar information and shall be submitted to the owner and the QAE. The QAE shall review and sign all daily field reports. These daily field reports shall describe the work performed during the day.

9.2.Test Results

All tests shall be documented. The QAE shall develop and implement a tracking process to discretely identify each test result, including failures and subsequent re-tests. All laboratory tests shall have a written report prepared to indicate the results. The QAE or QAI shall review all test results and determine whether the test results meet project requirements. The QAE shall track each failing test result and shall require re-work or re-testing of the failed component to ensure that the completed component meets project requirements. Written and/or tabular summaries of field test results shall be prepared for inclusion in the GCLER/GLER. Copies of laboratory test results shall also be included in the GCLER/GLER.

9.3. Surveying Results

The QAE shall ensure that the surveying results are presented on a project drawing prepared to indicate the as-built condition of the constructed components. The QAE shall work with the surveyor to develop and implement a tracking process to discretely identify each surveyed location and the date on which the survey was conducted, including failures and subsequent re-surveys. The QAE shall track each failing survey result and shall require re-work or retesting of the failed component to ensure that the completed component meets project requirements. Calculations supporting the thickness verifications shall be submitted by the surveyor to the QAE for inclusion in the GLER.

9.4. Sample Location Plan

The QAE shall be responsible for preparing and maintaining a site map which depicts the components being constructed on which can be documented the progress of the work, including inspections, sampling, testing and surveying. This map may be supplemented with additional maps and drawings sufficient to maintain proper records.

9.5. Final Reporting Requirements

The QAE shall be responsible for preparing, signing, and sealing the final GCLER/GLER document. The GCLER/GLER shall also be signed by the site operator and will be submitted to the TCEQ by the QAE. Submittal shall be to the MSW Permits Section of the Waste Permits Division for review and acceptance. If no response is received, either oral or written, within 14 days of receipt at the Waste Permits Division of the TCEQ, the report will be considered accepted. Any notice of deficiency received from the TCEQ will be promptly addressed and incorporated into the GCLER/GLER document. No solid waste will be placed over the constructed liner areas until final acceptance is obtained from the TCEQ.

If a layer of waste has not been placed over the top of protective cover within six months, then the QAE or the design engineer will visually observe that the protective cover has not undergone significant erosion that could compromise the protection of the underlying geosynthetics. A letter report documenting the observation of the cover and the repair measures undertaken to correct any cover damage will be submitted to the TCEQ for review

and acceptance. This procedure shall be repeated at six month intervals until all protective cover has been covered with a layer of waste.

The QAE shall be responsible for preparing, signing and sealing the final BER that will document that enough ballast has been placed in a lined area to offset the potential hydrostatic uplift forces which may exist below the liner. The BER shall also be signed by the site operator and will be submitted to the TCEQ by the QAE. The BER shall also verify that the liner did not undergo uplift during construction. Additional documentation to accompany the BER includes a waste as ballast placement record completed and signed by the site operator, a survey of the top of waste elevations to document that the required waste thickness has been placed, and ballast thickness calculations. Submittal of the BER shall be to the MSW Permits Section of the Waste Permits Division for review and acceptance. The ballast placement and BER will not be considered accepted, and the temporary dewatering system must remain operational, until the TCEQ has given confirmation of its acceptance, or 14 days from the date of arrival of the BER at the Waste Permits Division, TCEQ have lapsed.

10. CONSTRUCTION BELOW THE HIGHEST GROUNDWATER LEVEL

10.1. Applicability

Future landfill sectors may be constructed below groundwater levels and could potentially experience uplift due to hydrostatic pressure acting on the liner system. Measures for both short term and long term protection of the liner system against uplift forces are described in this section of the LQCP.

A temporary dewatering system consisting of a dewatering drainage geocomposite and dewatering piping installed in gravel filled collection trenches will be installed below the footprint of future sectors prior to construction of the new liner. The geocomposite will also extend up the sidewalls of each newly developed sector to prevent the buildup of hydrostatic forces on the liner system. The sidewall geocomposite will drain to a toe trench and dewatering pipe collection system that will flow to a dewatering sump at the low point of the sector.

Long term protection of the liner system will be accomplished with the placement of sufficient ballast consisting of a combination of drainage gravel, protective cover soils, waste and final cover as applicable. Sample ballast calculations are provided in Appendix E – Example Ballast Calculations.

The highest groundwater elevation contours are shown on Figure III.10D-1of Appendix D. The contours on this drawing are based upon the highest individual reading in each of the monitor wells shown and do not represent a single event, existing conditions or groundwater flow. This contour map will be updated with the design of each new sector or partial sector to incorporate any higher well level data that has been recorded since the previous sector was constructed.

10.2. Dewatering System

To prevent the buildup of hydrostatic forces on the liner system, each new sector will have a temporary dewatering system installed prior to liner construction. The temporary dewatering system design is presented in Appendix D and consists of a drainage geocomposite extending across the floor of the sector that will transmit captured groundwater to a gravel filled collection trench that drains to a groundwater collection sump. The drainage geocomposite will also extend up the sidewalls and will drain to a gravel filled toe trench that coveys collected water to the groundwater collection sump. Water collected in the sump will be pumped to the facility perimeter stormwater drainage system. The drainage geocomposite will be covered with a 1-foot thick foundation soil layer that will serve as a subgrade for the GCL component of the liner system. The foundation soil layer will consist of on-site or off-site soil material that is free of organics, angular rocks, foreign objects or other deleterious materials.

Operation of the temporary dewatering system will continue until sufficient ballast is placed to offset the potential hydrostatic uplift forces acting on the liner. The liner can only be taken out of service upon the written approval of TCEQ once sufficient documentation of ballast placement has been submitted.

Alternate temporary dewatering systems may be submitted to TCEQ for consideration and approval if circumstances warrant the development of such alternate systems. A permit modification application must be submitted detailing the purpose and details of any such changes to this LCQP.

10.3. Dewatering System Materials

10.3.1. Piping

The dewatering collection trench piping shall meet the requirements of Section 6.2.3. Collection pipes will be 6-inch diameter HDPE SDR 17 or an approved equal. Installation procedures shall be in accordance with Section 6.3.3.

10.3.2. Drainage Gravel

Aggregate for the dewatering system collection trenches shall meet the minimum specifications listed in Section 6.2.4. Calcium carbonate content requirements for the dewatering system drainage gravel will be waived as the groundwater pH is expected to be neutral. Installation of the drainage gravel shall be in accordance with Section 6.3.4.

10.3.3. Drainage Geocomposite

The drainage geocomposite shall meet the requirements specified in Appendix D as well the construction documents for the specific sector development project. Installation of the drainage geocomposite shall be in accordance with Section 6.3.

10.4. Operation of the Dewatering System

The dewatering system shall be kept in operation until the ballast evaluation report is submitted to and approved in writing by TCEQ. Pumps used for pumping out water that collects in the dewatering sumps shall be inspected on a weekly basis to ensure proper operation. The pumps will be controlled with pressure transducers to ensure that the groundwater is below the liner elevations. Alternatives to pressure transducers for measuring groundwater levels in the sump include bubbler levels or graduated measuring rods. The QAE will identify the allowable groundwater level in the dewatering sump for each sector. Water levels in the sump shall be recorded weekly and the volume of water pumped shall be recorded on a monthly basis.

10.5. Liner System Ballast

Liner protection against long-term hydrostatic uplift pressures will be provided by the counteracting weight of the materials placed above the geomembrane liner, referred to as ballast. The ballast includes the weight of the leachate collection system, protective cover soil materials, and compacted waste. Additional soil in excess of the minimum protective thickness may also be used as ballast. Example calculations for determining the height of compacted waste or additional protective cover soils above the liner system are provided in Appendix E. Once ballast has been placed to the calculated height above the liner in a newly constructed sector, the temporary dewatering system below the liner no longer needs to remain operational and the groundwater can be allowed to rebound against the bottom of the liner system. A ballast evaluation report (BER) must be prepared and submitted to TCEQ to document that the adequate height of ballast has been achieved in the sector to offset potential hydrostatic uplift forces, and to request that the temporary dewatering system operations be discontinued. Once the BER is accepted by the TCEQ in writing, operation of the temporary dewatering system may be discontinued.

Ballast calculations will be performed to provide an adequate thickness of soil and/or waste to offset the potential hydrostatic uplift forces for each sector constructed below the groundwater table. A calculated factor of safety against uplift of 1.5 will be required for ballasting with waste and a factor of safety of 1.2 will be used for soil ballast. The unit weight for waste used as ballast will be 1200 pounds per cubic yard. The unit weight for soil used as ballast will be determined by laboratory testing for each specific sector construction project.

Landfill personnel working under the supervision of the landfill superintendent will be on site full time during placement of the first 5 feet of waste over the liner system. The site operator will verify and document on a daily basis that this lower 5 feet of waste does not contain brush or large bulky items that could damage the liner system or that cannot be compacted to the required density. Documentation will also be provided on a daily basis that the waste for ballast has been compacted with compaction equipment which weighs in excess of 40,000 pounds. The site operator will complete and sign a waste-as-ballast placement record that will be attached to the BER. A copy of the form, TCEQ-10073, is included in Appendix F. The latest revision of TCEQ-10073 or an equivalent form will be submitted for each sector associated with the BER.

10.6. Verification of Liner Performance

The QAE will verify that the ballast placed is consistent with the established criteria and that uplift of the liner system did not occur during construction. The QAE shall observe the liner subgrade for evidence of seepage during construction. Any areas of seepage will be documented by the QAE as to seepage location, methods and procedures used to control the seepage, and continued monitoring of the seepage area after control.

To document that short-term uplift has not occurred during construction of the liner, the QAE shall verify that the elevations of the GCL are consistent with the design subgrade elevations on shown on the construction drawings. The QAE shall also verify that the protective cover elevations have not increased from those submitted with the GLER. Survey measurements to check against uplift will be taken at a minimum frequency of 1 point per 10,000 square feet. The protective cover uplift survey will be performed once between submittal of the GLER and the beginning of waste placement.

10.7. Documentation

The GCLER, GLER, and BER will include information relevant to construction of the liner below the groundwater table. The calculations for the constructed liner ballast installed over the liner system will be submitted with the BER. The GCLER and GLER shall include a discussion identifying areas constructed below the highest measured groundwater elevations and a discussion of current groundwater conditions. The GCLER and GLER shall also include a discussion addressing any seepage that may have been encountered during construction. The BER will contain survey information verifying that the appropriate depth of ballast has been installed and that the liner did not experience hydrostatic uplift.

I:\16jobs\16L0438\8514-City of Kingsville\8514-03\Permit Amendment\Part III\Attachment 10 LQCP\ATT10-LQCP 08-2018.docx

APPENDIX D

Temporary Dewatering System Design

For Permitting Purposes Only

JON M. REINHARD 64541

L. M. 12.

TBPE Firm No. F-417

04/25/19

CITY OF KINGSVILLE MUNICIPAL SOLID WASTE LANDFILL GROUNDWATER GEOCOMPOSITE

B DEWATERING DRAINAGE GEOCOMPOSITE FLOW CAPACITY

<u>I. Objective:</u> Verify that the dewatering drainage geocomposite has the flow capacity for the estimated groundwater flows and results in a reduction of hydrostatic forces by a factor of 1.2.

<u>II. Approach:</u> Compute the maximum depth of groundwater in the geocomposite for the estimated design flow.

III. Assumptions:

- **A:** Design groundwater flow rate is 2.42 x 10⁻⁵ cfs/ft which equates to 11.5 gpm for the flow area of 8.47 ac.
- B: Assume 200 mil geocomposite calculations.

IV. Calculations:

for surface area 8.47 ac

Q= 11.5 gpmQ= $0.02562 \text{ ft}^3/\text{sec}$

$$T_{\text{max}} = L \frac{[4(e/k) + \tan^2 B]^{1/2} - \tan B}{2 \cos B}$$

where,

T_{max}= Thickness of groundwater in the collection layer (meters (m))

L= Length of horizontal projection of groundwater layer (m)

e= impingement rate (m/sec)

k= hydraulic conductivity of drainage layer (m/sec)

B= Slope angle of the base of groundwater collection layer (degrees)

TBPE Firm No. F-417
For calculations on Pages 3.1 and 3.2

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JON M. REINHARD 64541

</CENSED

L=350 ft L= 106.715 m (1 ac.) e= 2.12E-08 m/sec use surface area compressed thickness of 187 mils 0.00475 m Use GSE HyperNet Geonet (200 mil) $2.0 \times 10^{-3} \text{ m}^2/\text{sec}$ transmissivity Use t = t allow = $0.002 \times [(1/1.5*1*1.2*1.5*4)]$ 0.000185 m²/sec t allow = t ult [(1/RFcr x Rfin x RFcc x RFbc*RFcb)] k=t/T0.039 m/sec RFcr=Creep Reduction Factor=1.5 tan B= 0.020003 RFin= Intrusion Reduction Factor=1 B=arctan(0.02) 1.146 deg RFcc=Chemical Clogging Reduction Factor=1.2 $T_{max} = 0.002894 \text{ m}$ RFbc=Biological Clogging Reduction Factor=1.5 0.00949 ft RFcb=Soil Clogging Reduction Factor=4 0.1139 in

113.9 mils
Therefore, the selected 200 mil thick drainage geocomposite is adequate.

The GSE Drainage Design Manual, Second Edition Chapter 2 - Fundamentals Of Geonets And Geocomposites

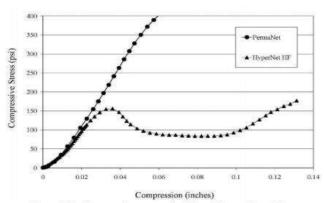


Figure 2.5. Compression strength of HyperNet vs. PermaNet.

CITY OF KINGSVILLE MUNICIPAL SOLID WASTE LANDFILL GROUNDWATER GEOCOMPOSITE

B DEWATERING DRAINAGE GEOCOMPOSITE FLOW CAPACITY (cont.)

The drainage geocomposite of the underdrain has been designed to remove groundwater inflows, so the uplift pressure in the geocomposite will be that resulting from the depth of liquid contained therein. The resulting upward hydrostatic pressure head acting on the liner (GCL, geomembrane and 2 feet of protective cover soil) is 0.1139 inches or 0.00949 feet. The factor of safety against hydrostatic uplift is calculated as follows:

Hydrostatic Uplift Pressure = 0.59 psf (.00949 feet of water head at 62.4 pcf)

Ballast Pressure = 240 psf (2 feet of protective cover at 120 pcf)

Factor of Safety = 407 > 1.2 OKAY

Since the factor of safey is well above 1.2, the temporary dewatering system will provide adequate protection from uplift during its operation.

Revision: 3 - April 2019

APPENDIX E

Ballast Thickness Calculations

For Permitting Purposes Only

JON M. REINHARD

04/25/19

TBPE Firm No. F-417

Revision 3 - April 2019

EXAMPLE BALLAST THICKNESS CALCULATIONS

Material Unit Weights:

Water = 62.4 pcf Protective Cover = 120 pcf Waste = 44.4 pcf

			Uplift Force	Top of	Protective				
	Top of	Historic High	due to	Protective	Cover			Depth of	Top of Waste
Location of	Liner	Groundwater	Groundwater	Cover	Resisting	Uplift FS from	Waste as	Waste Ballast	as Ballast
Ballast	Elevation	Elevation	Head	Elevation	Force	Protective	Ballast	Required	Elevation
Evaluation	(ft-msl)	(ft-msl)	(psf)	(ft-msl)	(psf)	Cover Only	Req'd?	(feet)	(ft-msl)
Sump 7B	22.5	40.55	1126.3	24.5	240.0	0.2	Y	32.6	57.1
Sump 7A	22.5	40	1092.0	24.5	240.0	0.2	Y	31.5	56.0
Sump 6B	22.5	39.35	1051.4	24.5	240.0	0.2	Y	30.1	54.6
Sump 6A	22.5	38.9	1023.4	24.5	240.0	0.2	Y	29.2	53.7
Sump 5B	22.5	38.7	1010.9	24.5	240.0	0.2	Y	28.7	53.2
Sump 5A	22.5	38.5	998.4	24.5	240.0	0.2	Y	28.3	52.8
Sump 4C	22.5	37.4	929.8	24.5	240.0	0.3	Y	26.0	50.5

See Figure III.10D-2 in Part III, Attachment 10, Appendix D for elevations of liner and historic high groundwater contours.

The last two columns above show the minimum depth of waste as ballast and minimum elevation of the top of waste placed as ballast that is required to provide sufficient resisting force to offset the uplift force due to groundwater with a Factor of Safety of 1.5 at each location selected. The evaluation point selected in each of the sectors is the worst case in each sector with the greatest groundwater head above liner.

FINAL FILLED CONDITION SUFFICIENT BALLAST CALCULATIONS

Material Unit Weights:

Water = $62.4 \,\mathrm{pcf}$

Protective Cover = 120 pcf

Waste = $44.4 \,\mathrm{pcf}$

Final Cover = 120 pcf

For Permitting Purposes Only

JON M. REINHARD 64541

TBPE Firm No. F-417
For calculations on Pages 6 and 7

			Uplift Force	Top of	Protective					
	Top of	Historic High	due to	Protective	Cover	Top of	Waste	Top of Final	Final Cover	Factor
Location of	Liner	Groundwater	Groundwater	Cover	Resisting	Waste	Resisting	Cover	Resisting	Of
Ballast	Elevation	Elevation	Head	Elevation	Force	Elevation	Force	Elevation	Force	Safety
Evaluation	(ft-msl)	(ft-msl)	(psf)	(ft-msl)	(psf)	(feet)	(psf)	(feet)	(ft-msl)	
Sump 7B	22.5	40.55	1126.3	24.5	240.0	87.01	2775.4	90.09	369.6	3.0
Sump 7A	22.5	40	1092.0	24.5	240.0	87.01	2775.4	90.09	369.6	3.1
Sump 6B	22.5	39.35	1051.4	24.5	240.0	87.01	2775.4	90.09	369.6	3.2
Sump 6A	22.5	38.9	1023.4	24.5	240.0	87.01	2775.4	90.09	369.6	3.3
Sump 5B	22.5	38.7	1010.9	24.5	240.0	87.01	2775.4	90.09	369.6	3.4
Sump 5A	22.5	38.5	998.4	24.5	240.0	87.01	2775.4	90.09	369.6	3.4
Sump 4C	22.5	37.4	929.8	24.5	240.0	86.91	2771.0	89.99	369.6	3.6

The calculations above demonstrate that there is sufficient waste and cover material at each of the evaluated locations to offset groundwater uplift forces by greater than a factor of safety of 1.5. Each of the locations evaluated represent the worst case scenario within the future sectors to be constructed below the groundwater table.

CITY OF KINGSVILLE LANDFILL PART III ATTACHMENT 11

GROUNDWATER SAMPLING AND ANALYSIS PLAN

THE CITY OF KINGSVILLE LANDFILL TCEQ PERMIT MSW 235-C

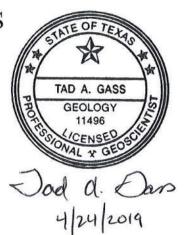
PERMIT AMENDMENT APPLICATION PART III, ATTACHMENT 11 GROUNDWATER SAMPLING AND ANALYSIS PLAN



CITY OF KINGSVILLE, TEXAS

September 2018
Revision 1 – November 2018
Revision 2 – February 2019
Revision 3 – April 2019

Prepared by





HANSON PROJECT NO. 16L0438-0003

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Appendix A

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Item 2 – Monitor Well Field Data Sheet

Item 3 – Chain-of-Custody Form

Item 4 – TCEQ 0312 Ground Water Sampling Report

Item 5 – Laboratory Review Checklist

Item 6 – Laboratory Quality Assurance/Quality Control Manual

I:\16jobs\16L0438\8514-City of Kingsville\8514-03\Permit Amendment\NODs\Technical NOD #1\Part III\Part III, Attachment 11\Part III att11 - GWSAP Cln.docx

1.0 INTRODUCTION

The State of Texas promulgated regulations governing all aspects of municipal solid waste (MSW) management in Title 30 of the Texas Administrative Code (TAC), Chapter 330. Subchapter J, Section 330.405 (b) requires that the owners or operators of Municipal Solid Waste Landfills (MSWLFs) prepare and submit a Groundwater Sampling and Analysis Plan (GWSAP) to the Texas Commission on Environmental Quality (TCEQ). The purpose of this document is to satisfy the requirements of the above-referenced regulations as they pertain to the City of Kingsville Landfill (hereafter referred to as the Kingsville Landfill) and provide groundwater sampling procedures, frequencies, analytical parameters, monitoring data evaluation, and reporting requirements.

In accordance with TCEQ regulations, this GWSAP contains the procedures and techniques to be used to conduct Background Monitoring Statistical Evaluations, Detection Monitoring, Assessment Monitoring, and Corrective Action implementation should a significant groundwater impact be determined.

1.1 Facility Description

The Kingsville Landfill is located 1.7 miles southeast of the City of Kingsville at the intersection of County Road (CR) 2130 and Farm to Market (FM) 2619 in Kleberg County, Texas. The primary land use within a one-mile radius of the site is agricultural consisting of cropland and pasture coexisting with some oil and gas production. Adjacent to the landfill on the east of the property are a series of borrow pits that have been used for the purpose of daily cover and other site soil needs. Low-density residential development is scattered throughout the one-mile radius area of the facility, with most development located to the southeast and northeast. Immediately to the east and west of the permitted facility boundary, the land use is agricultural with some oil and gas production. To the north, south, and southeast, residences are widely scattered throughout brush and agricultural areas.

1.2 Groundwater Monitoring System

Based upon an understanding of the local ground water flow regime and site stratigraphy, the groundwater monitoring system will monitor the uppermost aquifer identified in the site Geology and Groundwater Characterization Reports. Analysis of the ground water level data over the life of the facility indicate that the ground water flow tends to leave the site in all directions except the northwest. Construction at the landfill should have minimal impact on ground water flow. The most likely pollutant pathway for pollutant migration in the event that the primary barrier liner system is penetrated would follow the groundwater flow away from the site. Further discussion and detail can be seen in the provided Groundwater Characterization Report (Part III, Attachment 4, Appendix 1, Section 2.0 beginning on page 762).

The completed groundwater monitoring system will be comprised of a total of twenty-two (22) monitoring wells. Monitor Wells 6RA, 15, 22R, 23, and 30 shall be considered upgradient wells until further development of waste sectors occur. The remaining 17 monitor wells shall be considered downgradient wells. All monitoring wells will be installed and monitored throughout the active life and post-closure care period of this site. The design will provide for monitoring well spacing of not more than 600 feet at the closest practicable distance to the point of compliance

(when physical obstacles preclude installation of the groundwater monitoring wells at the point of compliance), as defined in 30 TAC §330.3, that will ensure detection of groundwater contamination of the uppermost aquifer. All parts of the groundwater monitoring system shall be operated and maintained so that they perform at least to design specifications. The design of the monitoring system is based on site specific technical information gathered during multiple site investigations and further discussed in the site Geology Report included as Part III Attachment 4 of this permit, Part III Attachment 4 Appendix 1, and the Groundwater Characterization Report included as Part III Attachment 4, Appendix 1 beginning on page 752. The City of Kingsville Landfill will promptly notify the executive director, and any local pollution agency with jurisdiction that has requested to be notified, in writing of changes in facility construction or operation or changes in adjacent property that affect or are likely to affect the direction and rate of groundwater flow and the potential for detecting groundwater contamination from a solid waste management unit and that may require the installation of additional monitoring wells or sampling points and that such additional wells or sampling points require a modification of the site development plan.

A topographic and Groundwater Contour map identifying the existing and proposed monitor well locations, installed depths, property boundary, a delineation of the waste management area, and the point of compliance line has been included in Appendix A-Item 1A and B Site Layout Maps. All monitoring wells will be constructed in accordance with 30 TAC §330.421. Monitor well installation and construction details will be provided on form TCEQ-10308, or current appropriate TCEQ reporting form, upon completion. The Groundwater Monitoring System Design Certification has been included as Appendix A-Item 2.

2.0 HEALTH AND SAFETY

Personnel performing water level measurements, well purging, or sampling will, at a minimum, wear latex or other equivalent non-powdered gloves. The gloves will be changed when they become damaged and when activities begin at a different well location. All personnel that are associated with the purging and sample collections from monitor wells will wear other appropriate Personal Protective Equipment (PPE) such as eye protection, safety vests, chemical resistant clothing and/or aprons, and air purifying respirators, as necessary.

3.0 GROUNDWATER SAMPLING FREQUENCY

3.1 Background Monitoring

At least eight (8) statistically independent background groundwater samples will be obtained on a quarterly basis prior to commencing with Detection Monitoring for each groundwater monitor well at the facility (see Appendix A, Table 1, for parameters). Background monitoring events should allow approximately 90 days between each monitoring event to allow the collection of groundwater data over the different seasons of the year.

3.2 **Detection Monitoring**

After establishment of background groundwater quality, detection monitoring will be performed on a semi-annual basis at approximately 6-month intervals during the remaining operational life and post-closure care period for this facility. Detection monitoring will begin on the first semiannual monitoring event following the completion of the background monitoring establishment period.

4.0 GROUNDWATER ANALYTICAL PARAMETERS

The constituents to be analyzed for both background monitoring and detection monitoring are listed in Appendix A-Table 1. The respective Practical Quantitation Limits (PQLs), analytical methods, and Chemical Abstracts Service number (CAS) are also located in Appendix A-Table 1 and Table 2.

At the conclusion of the background monitoring period, all the detection monitoring constituents will be thoroughly reviewed. As a result of this review, the City may request that the Executive Director eliminate subsequent monitoring for those constituents that were consistently below the method detection limits (MDL) throughout this period and are not expected to originate from the MSWLF unit.

5.0 GROUNDWATER PURGING AND SAMPLING

The following subsections will summarize tasks involved in the purging and sampling of the groundwater monitoring wells at the facility.

5.1 Well Inspection

Prior to performing any purging or sampling, each monitoring well will be inspected to assess its integrity. The visual inspection will include the lock, protective casing or collar, concrete pad, and casing for signs of damage by vandalism, animals, heavy equipment, or other causes. All necessary repairs or maintenance needed will be documented on the Monitor Well Field Data Sheet for each respective well. If it is determined that the integrity of the well has been compromised, the necessary information will be documented and the TCEQ will be notified. No additional actions will be taken without prior approval of the TCEQ.

5.2 Well Headspace Screening

Upon the opening of each monitoring well, an appropriately calibrated gas meter capable of measuring methane concentrations in percent volume and combustible gases in a percentage of the Lower Explosive Limit (LEL) will be utilized to screen the well headspace for hazardous concentrations of gasses that the sampling personnel could be exposed to during the well gauging and sampling procedures. The gas meter will contain a methane specific sensor and be able to measure the percent volume of methane in air. The concentration of methane, or percentage of the LEL, will dictate what precautions will be necessary during sampling activities. If methane is detected in excess of 5.0% by volume (100% LEL), the well will be left open and allowed to vent. No work will be performed at the well until methane concentrations fall below 5.0% by volume. Results of the well headspace screening for methane will be recorded and retained in the facility operating record.

5.3 Equipment Decontamination

All non-dedicated equipment used for water level measurement, purging, and/or the collection of groundwater samples will be decontaminated prior to use at each well location. An appropriate decontamination procedure consists of washing the non-dedicated equipment in a solution of Alconox, or equivalent laboratory-grade detergent, and distilled water followed by a distilled or deionized water rinse. Containers for the collection of rinsates will be utilized, as appropriate,

CITY OF KINGSVILLE LANDFILL PART III, ATTACHMENT 11 APPENDIX A

TABLE 3MONITOR WELL DESIGNATIONS

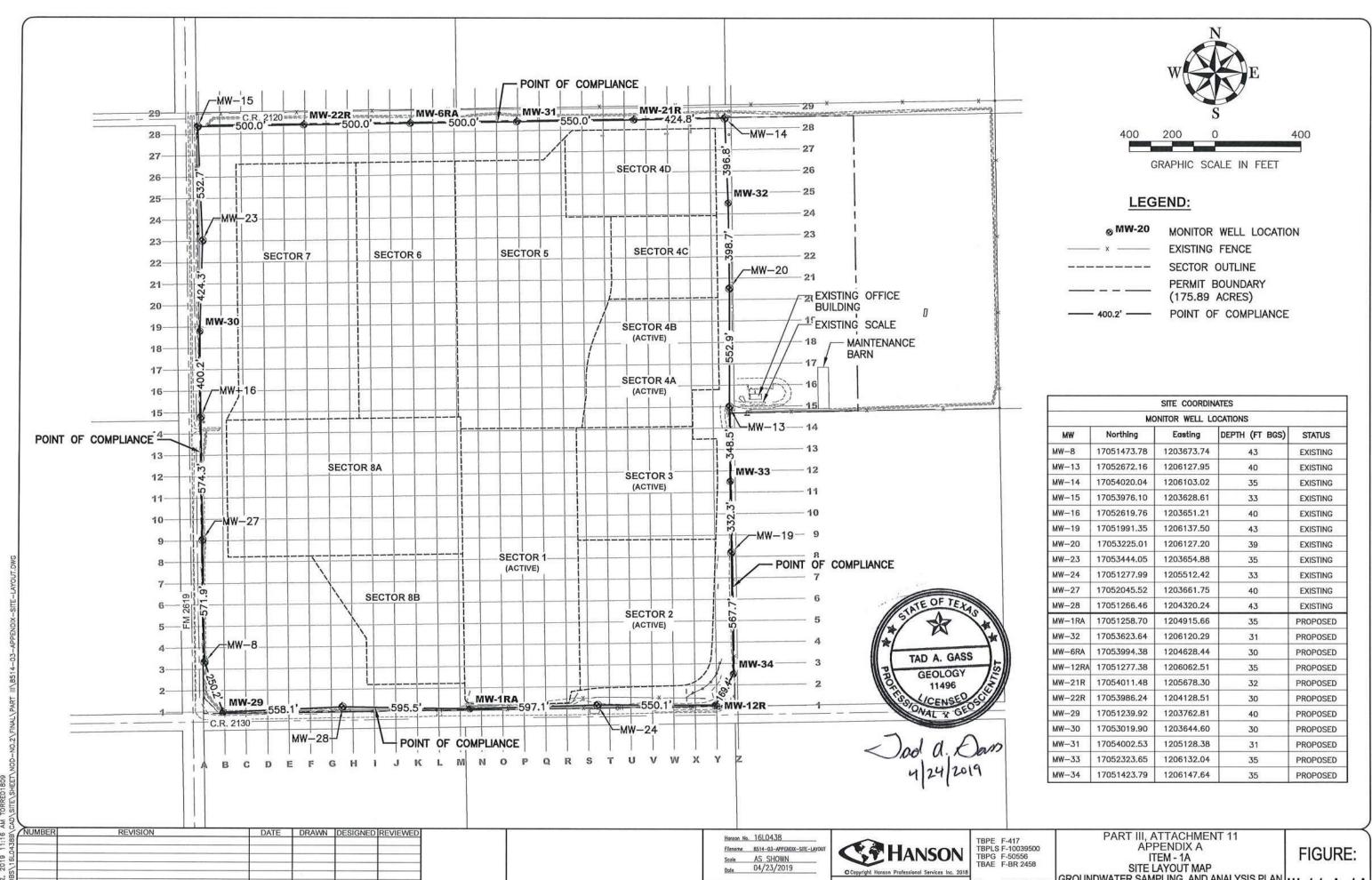
Monitor Well Designation								
Monitor Well	Sector 1	Sector 2	Sector 3	Sector 4	Sector 5	Sector 6	Sector 7	Sector 8
MW-1RA	С	С	С	С	С	С	С	С
MW-6RA	U	U	U	U	U	C	С	С
MW-8	С	С	С	С	С	С	С	С
MW-12RA	C	C	С	С	С	С	С	C
MW-13	С	С	С	С	С	С	С	С
MW-14	C	C	С	С	С	С	С	C
MW-15	U	U	U	U	U	U	U	U
MW-16	C	C	С	С	C	C	С	С
MW-19	С	С	С	С	С	С	С	С
MW-20	C	С	С	С	C	C	С	С
MW-21R	С	С	С	С	С	С	С	С
MW-22R	U	U	U	U	U	U	С	С
MW-23	U	U	U	U	U	U	U	U
MW-24	C	C	C	C	C	C	C	С
MW-27	С	С	С	С	С	С	С	С
MW-28	С	C	С	С	С	С	С	С
MW-29	С	С	С	С	С	С	С	С
MW-30	U	U	U	U	U	U	U	U
MW-31	C	C	C	С	C	C	С	C
MW-32	C	C	C	С	C	C	С	C
MW-33	C	C	C	С	С	С	С	C
MW-34	С	С	С	С	C	C	С	С

U = Upgradient Well

C = Compliance Well

CITY OF KINGSVILLE LANDFILL PART III, ATTACHMENT 11 APPENDIX A

ITEM 1A-SITE LAYOUT MAP (TOPO)
ITEM 1B-SITE LAYOUT MAP (GW CONTOUR)



LAYOUT

04/23/2019

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DRAWN

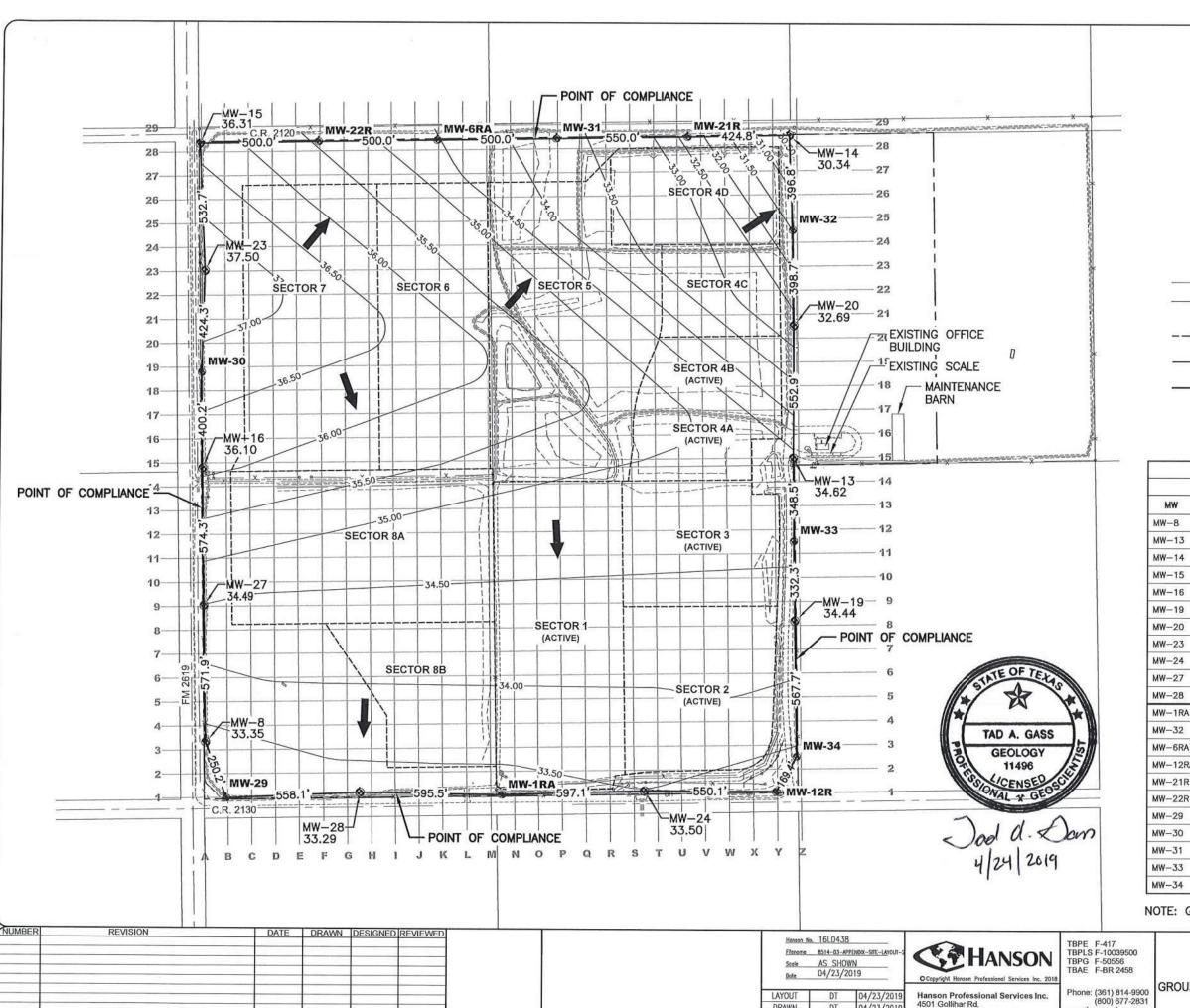
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Corpus Chrisiti, Texas 78411

Offices Nationwide

Phone: (361) 814-9900 (800) 677-2831 www.hanson-inc.com

GROUNDWATER SAMPLING AND ANALYSIS PLAN CITY OF KINGSVILLE LANDFILL PA. MSW 235-C



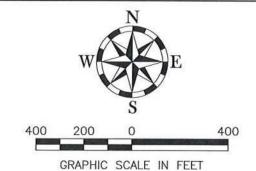
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04/23/2019

TAG 04/23/2019

Corpus Chrisiti, Texas 78411



LEGEND:

⊗ MW-20	MONITOR WELL LOCATION
—— x ——	EXISTING FENCE
35.00	GROUNDWATER CONTOURS (FEET AMSL)
	SECTOR OUTLINE
	PERMIT BOUNDARY (175.89 ACRES)
400.2'	POINT OF COMPLIANCE
\rightarrow	GROUNDWATER DIRECTIONAL FLOW ARROW

		SITE COORDIN					
MONITOR WELL LOCATIONS							
MW	Northing	Easting	DEPTH (FT BGS)	STATUS			
MW-8	17051473.78	1203673.74	43	EXISTING			
MW-13	17052672.16	1206127.95	40	EXISTING			
MW-14	17054020.04	1206103.02	35	EXISTING			
MW-15	17053976.10	1203628.61	33	EXISTING			
MW-16	17052619.76	1203651.21	40	EXISTING			
MW-19	17051991.35	1206137.50	43	EXISTING			
MW-20	17053225.01	1206127.20	39	EXISTING			
MW-23	17053444.05	1203654.88	35	EXISTING			
MW-24	17051277.99	1205512.42	33	EXISTING			
MW-27	17052045.52	1203661.75	40	EXISTING			
MW-28	17051266.46	1204320.24	43	EXISTING			
MW-1RA	17051258.70	1204915.66	35	PROPOSED			
MW-32	17053623.64	1206120.29	31	PROPOSED			
MW-6RA	17053994.38	1204628.44	30	PROPOSED			
MW-12RA	17051277.38	1206062.51	35	PROPOSED			
MW-21R	17054011.48	1205678.30	32	PROPOSED			
MW-22R	17053986.24	1204128.51	30	PROPOSED			
MW-29	17051239.92	1203762.81	40	PROPOSED			
MW-30	17053019.90	1203644.60	30	PROPOSED			
MW-31	17054002.53	1205128.38	31	PROPOSED			
MW-33	17052323.65	1206132.04	35	PROPOSED			
MW-34	17051423.79	1206147.64	35	PROPOSED			

NOTE: GROUNDWATER ELEVATIONS FROM JANUARY 2017

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APPENDIX A ITEM - 1B SITE LAYOUT MAP GROUNDWATER SAMPLING AND ANALYSIS PLAN

PART III, ATTACHMENT 11

FIGURE:

CITY OF KINGSVILLE LANDFILL KINGSVILLE, TEXAS, KLEBERG COUNTY, TEXAS

CITY OF KINGSVILLE LANDFILL PART III ATTACHMENT 12

FINAL CLOSURE PLAN

For Permitting Purposes Only

JON M. REINHARD 64541

CENSED 04/25/19

TBPE Firm No. F-417



Texas Commission on Environmental Quality

Closure Plan for Municipal Solid Waste Type I Landfill Units and Final Facility Closure

This form is for use by applicants or site operators of Municipal Solid Waste (MSW) Type I landfills to detail the plan for closure of a landfill unit, closure of associated storage or processing units, and final closure of the facility to meet the requirements in 30 TAC Chapter 330, §330.63(h) and 30 TAC Chapter 330 Subchapter K for a MSW Type I facility.

If you need assistance in completing this form, please contact the MSW Permits Section in the Waste Permits Division at (512) 239-2335.

I. General Information

Facility Name: The City Of Kingsville Landfill

MSW Permit No.: 235C

Site Operator/Permittee Name: City of Kingsville

II. Landfill and Other Waste Management Units and Operations Requiring Closure at the Facility

A. Facility Units

Table 1. Description of Landfill Units.

Name or Descriptor of Unit	Operating Status of Unit	Type of Liner System Under Unit	Above Grade Class 1 Disposal Cells in this Unit	Below Grade Class 1 Disposal Cells in this Unit	Other Class 1 Disposal Cells in this Unit (describe)	Size of Unit's Waste Footprint (acres)	Maximum Inventory of Waste Ever in Unit (cubic yards)	Other Necessary Information that Pertains to the Unit
Type I	Active	Alternate Liner				121.3	17,994,286	
Totals							17,994,286	

Closure Plan for Type I Landfill Unit and Facility

Facility Name: The City of Kingsville Landfill

Permit No: <u>235C</u> Date: <u>April 25, 2019</u>

C. Drawings Showing Details of the Waste Management Units at Closure

Table 4. Location of the Drawings showing Details of the Waste Management Units at Closure (outlines, dimensions, maximum elevations of waste and final cover of landfill units, and waste storage or processing units or operations at closure of the facility).

Drawing Location in the SDP	Drawing Figure Number	Drawing Title	Waste Management Units Details Shown
Part III, Attachment 1	III.1-3	Landfill Excavation Plan	Outlines, waste footprints, and dimensions of the landfill units
Part III, Attachment 1	III.1-4	Landfill Completion Plan	Maximum elevations of waste and final cover of the landfill units
Part III, Attachment 1	III.1-14	Support Area Layout	Locations and limits of storage and processing units in the support area

III. Description of the Final Cover System Design

A. Types and Descriptions of the Final Cover Systems

Table 5. Types and Descriptions of the Final Cover Systems Permitted or Proposed for Closure of the Landfill Units.

Landfill Unit Name or Descriptor	Type of Final Cover System	Final Cover System Components Description	Other Information (Enter other information as applicable)
Type I Landfill	Alternative Composite Final Cover	A prepared soil subgrade; A geosynthetic clay liner (GCL) layer; A forty mil (0.04 inch) thick LLDPE geomembrane layer; A geocomposite drainage layer consisting of a synthetic drainage net and geotextile fabric; A twenty five (25) inch thick protective cover soil layer, the top seven (7) inches of which must be capable of supporting vegetation.	

Revision No.: 3

Closure Plan for Type I Landfill Unit and Facility

Facility Name: The City of Kingsville Landfill

Permit No: <u>235C</u> Date: <u>April 25, 2019</u>

VII. Professional Engineer's Statement, Seal, and Signature

Name: Jon M. Reinhard, P.E. Title: Project Engineer

Date: April 25, 2019

Company Name: Hanson Professional Services Inc. Firm Registration Number: F-417

Professional Engineer's Seal

JON M. REINHARD

64541

OCCURSED

104/25/19

TBPE Firm No. F-417

Signature

Revision No.: 3

THE CITY OF KINGSVILLE LANDFILL TCEQ PERMIT MSW 235C

PERMIT AMENDMENT APPLICATION Volume 6 of 6



CITY OF KINGSVILLE, KLEBERG COUNTY, TEXAS

September 2018

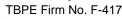
Revision 1 – November 2018

Revision 2 – February 2019

Revision 3 – April 2019

Prepared by







THE CITY OF KINGSVILLE LANDFILL TCEQ PERMIT MSW 235C

PERMIT AMENDMENT APPLICATION PART IV



CITY OF KINGSVILLE, KLEBERG COUNTY, TEXAS

September 2018 Revision 1 – November 2018 Revision 2 - February 2019 Revision 3 - April 2019

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JON M. REINHARD
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For Permitting Purposes Only

Prepared by



TBPE F-417

HANSON PROJECT NO. 16L0438-0003

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ATTACHMENT 5 - LIQUID WASTE SOLIDIFICATION OPERATING PLAN

LIST OF ACRONYMS

ADC – Alternate Daily Cover

CESQG - Conditionally Exempt Small Quantity Generator

CFC - Chlorinated Fluorocarbon

CFR – Code of Federal Regulations

DIY - Do It Yourself

EPA – Environmental Protection Agency

GLER - Geosynthetics Liner Evaluation Report

GWSAP - Groundwater Sampling and Analysis Plan

LCS – Leachate Collection System

LCWMP – Leachate and Contaminated Water Management Plan

LFG - Landfill Gas

LGMP – Landfill Gas Management Plan

LQCP – Liner Quality Control Plan

M/S – Landfill Manager/Supervisor

MSW – Municipal Solid Waste

MSWLF – Municipal Solid Waste Landfill

MSWMR – Municipal Solid Waste Management Regulations

PCB – Polychlorinated Biphenyl

RRC – Railroad Commission of Texas

SDP – Site Development Plan

SLER - Soil Liner Evaluation Report

SOP – Site Operating Plan

SOR – Site Operating Record

SPCC – Spill Prevention, Control, and Countermeasures Plan

SWAP – Special Waste Acceptance Plan

SWPPP – Stormwater Pollution Prevention Plan

TAC – Texas Administrative Code

TCEQ – Texas Commission on Environmental Quality

TPDES – Texas Pollutant Discharge Elimination System

TXDOT – Texas Department of Transportation

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should be maintained in the site operating records and should include evidence of successful completion of the training, type of training received, and the name of the instructor. The minimum level of training for the facility manager should be a Class A license as defined in §30.213. In addition, key on-site personnel should attend a course for screening for unauthorized waste.

4.2.2 Wastes Prohibited From Disposal

The City of Kingsville Landfill will not accept the following types of waste for disposal:

- Municipal Hazardous Waste other than from a Conditionally Exempt Small Quantity Generator (CESQG) as defined in 30 TAC §330.171(c)(6);
- Polychlorinated Biphenyls (PCBs) as discussed in section 4.2.1;
- Class 1industrial waste;
- Do-it-yourself (DIY) used motor vehicle oil will not be intentionally or knowingly accepted for disposal per §330.15(e)(2);
- Whole used or scrap tires shall not be accepted for disposal or disposed of in any MSW landfill, unless processed prior to disposal in a manner acceptable to the executive director per §330.15(e)(4);
- Lead acid storage batteries will not be intentionally or knowingly accepted for disposal per §330.15(e)(1);
- Used oil filters from internal combustion engines will not be intentionally or knowingly accepted for disposal per §330.171(d);
- Items containing chlorinated fluorocarbon (CFC) unless all the CFC contained within them is properly managed as defined in §330.15(e)(5);
- The following special wastes without prior approval from TCEQ and accompanied with the relevant analytical test results, MSDS documents, or process knowledge documents:
 - Septic tank pumpings which have been stabilized and have passed the paint filter test;
 - Wastes from commercial or industrial wastewater treatment plants; air pollution control facilities; and tanks, drums, or containers used for shipping or storing any material that has been listed as a hazardous constituent in 40 CFR, Part 261, Appendix VIII but has not been listed as a commercial chemical product in 40 CFR Part 261.33(e) or (f);
 - Drugs, contaminated foods, or contaminated beverages, other than those contained in normal household waste;
 - o Incinerator ash:
 - Light ballasts and/or small capacitors containing PCB compounds with a PCB content less than 50 parts per million;
 - o And waste generated outside the boundaries of Texas that contains:
 - o Any industrial waste,

- 1. The active working face(s): Municipal solid waste will be unloaded at the active working face(s). Unloading of municipal solid waste at the active working face will be confined to as small an area as practical and will not exceed 30,000 square feet, or about 300 feet by 100 feet. The size of the working face will be directly impacted by the amount of waste being received and may vary accordingly. There may be one, two or three working faces open at any given time. Typically, there will be one general purpose waste unloading area. The M/S may designate up to three waste unloading areas; one for commercial customers, one for light commercial/residential customers, and one for other wastes requiring special attention or while moving a working face (i.e., establishing a working face in a new location, while covering, or during periods of emergency clean up operations (i.e., hurricane, hailstorm, flood, etc.).
- 2. White Goods and Metal Recyclable Storage Area: The white goods and metal recyclable unloading and storage area will not be larger than 20,000 square feet (100 feet by 200 feet). Large items/white goods may include ovens, dishwashers, freezers, air conditioners, and other items. These items will not be stored in excess of 180 days.
- 3. <u>Tire storage and processing area:</u> Tires will be managed in a manner that minimizes possible ponding of water in order to eliminate potential conditions that would promote disease vectors. The quantity of tires stored on-site will not exceed 500 tires on the ground (maximum storage area of 25 feet by 25 feet), or 2,000 tires in enclosed containers (maximum storage area of one standard 40 to 52 foot trailer). The tires will be processed/reduced in size to the extent practical for disposal in the landfill or sent to an authorized tire recycler. Whole used or scrap tires will not be disposed of in the landfill. Tires will not be stored in excess of 180 days.
- 4. Liquid waste solidification area: Liquid waste will be unloaded into one (1) of four (4) approximately eight (8) feet by 20 feet liquid tight mixing containers and will be located within a lined landfill sector. The maximum size of the liquid waste solidification area will be 75 feet by 115 feet. Bulking agents such as on-site soil, sawdust, kiln dust, coal combustion residuals, auto-fluff or other inert material with absorptive capacity will be mixed with the liquids until the resulting mixture passes the paint filter test and any other requirements outlined for the specific material. Once the liquids have been solidified, the solidified waste material will be transported and disposed of in the working face. Liquid waste will be unloaded directly into the mixing containers and solidification will begin upon receipt. See Part IV, Attachment 5 for the Liquid Waste Solidification Operating Plan.
- 5. Brush storage and processing area: Vegetative material not mixed with other wastes will be diverted to a location outside of the active disposal area and drainage ways so that they do not interfere with on-site drainage or wash off-site. The maximum size of the unloading area for brush and yard waste is 200 feet by 400 feet. Brush will be processed for mulch. Brush will not be stored in excess of 180 days.

4.11.2 Site Grid System Markers §330.143(b)(5)

Site grid system markers (White) will be installed at the facility. The grid system will encompass at least the area expected to be filled within the next 3 year period. Grid markers will be maintained during the active life of the site: post-closure maintenance of the grid system is recommended but not required. The grid system will consist of lettered markers along one (1) side and numbered markers along the other perpendicular side. Markers will be spaced no greater than 100 feet apart measured along perpendicular lines. Where markers cannot be seen from opposite boundaries, intermediate markers will be installed, where feasible.

4.11.3 SLER or GLER Area Markers §330.143(b)(6)

SLER or GLER area markers (Red) will be placed so that all areas for which a SLER or GLER has been submitted and approved by TCEQ are readily determinable. Such markers are to provide site workers immediate knowledge of the extent of approved disposal areas. These markers will be located so that they are not destroyed during operations until operations extend into the next SLER or GLER. The location of these markers will be tied into the site grid system and will be reported on each SLER/GLER submitted. SLER and GLER markers will not be placed inside the constructed/evaluated areas.

4.11.4 100 Year Flood Limit Protection Markers §330.143(b)(7)

Flood protection markers (Blue) must be installed in any area within a solid waste disposal facility that is subject to flooding prior to the construction of flood protection levee. The area subject to flooding will be clearly marked by means of permanent posts spaced not more than 300 feet apart or closer if necessary to retain visual continuity. City of Kingsville Landfill is NOT located within a 100 year floodplain.

4.11.5 Site Boundary Markers §330.143(b)(2)

Site boundary markers (Black) will be placed at each corner of the site and along each boundary line at intervals no greater than 300 feet. Fencing may be placed within these markers as required.

4.11.6 Buffer Zone Markers §330.143(b)(3)

Markers (Yellow) identifying the buffer zone will be placed along each buffer zone boundary at all corners and between corners at intervals no greater than 300 feet. Placement of the landfill grid markers may be made along a buffer zone boundary.

4.11.7 Permanent Benchmark §330.143(b)(8)

A permanent monument has been established at the site. The monument is established at the site in an area that is readily accessible and will not be used for disposal. The monument elevation was surveyed from a known United States Coast and Geodetic Survey benchmark. The location (NAD 27: N 27° 26' 41.95", W 97° 48' 55.89"/NAD 83: N 27; 26'; 43.08", W 97; 48'; 56.88") and elevation (52.61 ft above mean sea level) of the reference benchmark monument are provided in Part II, Attachment 1, Figure II.1-2,

CITY OF KINGSVILLE LANDFILL ATTACHMENT 5 LIQUID WASTE SOLIDIFICATION OPERATING PLAN

For Permitting Purposes Only

JON M. REINHARD

CENSED 1/2 04/25/1

TBPE Firm No. F-417

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	Training of Operational Personnel	
	Closure	
	Fire Protection	

FIGURES

FIGURE IV.5-1 LIQUID WASTE SOLIDIFICATION AREA LAYOUT PLAN

For Permitting Purposes Only

JON M. REINHARD 64541

04/25/19

TBPE Firm No. F-417

I:\16jobs\16L0438\8514-City of Kingsville\8514-03\Permit Amendment\NODs\Technical NOD #2\Part IV\Part IV_Att 5 LWSAOP Rdln.docx

1.0 Background and Purpose

For those wastes sent to the Liquid Waste Solidification Area (LWSA), the LWSA site operating plan (SOP) is as follows. The LWSA SOP is to document the design and operation procedures of a liquid waste solidification/bulking operation, which will consist of four (4) approximately eight (8) feet by 20 feet liquid tight mixing containers/basins located within a lined landfill sector, constructed in accordance with 30 TAC §330.331(b), of the City of Kingsville Landfill permit boundary. The LWSA will be installed within an area that is operationally feasible where final cover has not been constructed; and will periodically be relocated because of general sequence of filling operations. The LWSA will include basins that may vary in size with a maximum number of four liquid tight mixing containers/basins – only one LWSA may be operational at one time. Processing or bulking of liquid material is typically needed to allow direct disposal to the landfill (i.e., liquid waste material requires bulking to pass the paint filter test). The liquid material collected at the facility will be bulked and disposed of in the landfill

2.0 Design

The facility will utilize a liquid tight mixing containers/basin(s), placed and secured in landfill material and soil. Wastes excavated during liquid tight mixing container/basin installation will be properly disposed at the active working face. The liquid tight mixing container/basin will be installed so that a minimum of 1 foot of the liquid tight mixing container/basin extends above the surrounding soil where the surrounding soils are graded away from the liquid tight mixing container/basin to prevent stormwater run-on into the liquid tight mixing container(s)/basin(s). A runoff/run-on control berm will be installed around perimeter of the liquid tight mixing container(s)/basin(s) and solidifying/stabilizing material storage area. This berm constructed of compacted earthen material will be a minimum of 2 foot in height unless the location of the LWSA is adjacent to a waste slope with potential for storm water run-on. In addition, the bottom of the liquid tight mixing container(s)/basin(s) will be at least 10 ft above the top of protective cover soil of the underlying constructed lining system. Figure IV.5-1, Liquid Waste Solidification Area Layout Plan shows typical layout and liquid tight mixing containers/basins and runoff/run-on control berm details.

3.0 Liquid Waste Processing Operations

The liquids collected at the facility will be bulked (i.e., solidified) and disposed of in the landfill. The installation of a liquid processing operation at the Facility will provide an essential service for food, beverage, and other commercial and industrial facilities in the surrounding region.

Liquid waste will be unloaded into one (1) of four (4) approximately eight (8) feet by 20 feet liquid tight mixing containers/basins and will be located within a lined landfill sector. The maximum size of the liquid waste solidification area will be 75 feet by 115 feet. Bulking agents such as on-site soil, sawdust, kiln dust, coal combustion residuals, auto-fluff or other inert material with absorptive capacity will be mixed with the liquids until the resulting mixture passes the paint filter test and any other requirements outlined for the specific material. Once the liquids have been solidified, the solidified waste material will be transported and disposed of in the working face. Liquid waste will be unloaded directly into the mixing containers/basins and solidification will begin upon receipt

Dust and odors will be controlled by covering the containers/basins or by adding sawdust or wood chips to the waste.

Any rainfall or water entering the LWSA will be managed as contaminated water and will be solidified before disposal in the landfill.

Control of liquids processed at the operation will be controlled by the procedures in Part IV – Attachment 3– Special Waste Acceptance Plan. A more complete discussion of the quality control process is presented in the following sections.

4.0 Description of Waste

Untreated liquid wastes which typically cannot pass the paint filter test include nonhazardous industrial wastes and sludges, food and beverage byproducts and other nonhazardous liquids. These liquids will generally be transported to the facility by private haulers in vacuum trucks, tank trucks, and sealed containers in accordance with §330.171(b)(3). The facility is approved to accept liquid waste by approval of this permit for processing in the LWSA. The liquids will originate from food and beverage processing plants, and other commercial and industrial facilities.

5.0 Processing Method

The bulking/solidification process involves the addition of a solid material that will absorb the liquid and form a sludge that can pass the paint filter test to be disposed of in the landfill. Liquid waste will be unloaded directly into the mixing containers/basins and solidification will

begin upon receipt. Liquid waste will be unloaded into one (1) of four (4) approximately eight (8) feet by 20 feet liquid tight mixing containers/basins located within a lined landfill sector.

Bulking agents will be mixed with the liquids until the resulting mixture passes the paint filter test and any other requirements outlined for the specific material. The bulking agent used in the liquid waste solidification process will be soil, sawdust, kiln dust, coal combustion residuals, auto-fluff or other inert material with absorptive capacity as approved by the Texas Commission on Environmental Quality (TCEQ).

Once the liquids have been solidified, the solidified waste material will be transported and disposed of in the working face.

The bulking process has the advantages of being a simple process that does not require discharge to a wastewater treatment plant.

6.0 Monitoring

Incoming liquid waste will be documented on a Part IV, Attachment 1, Form 3 – Special Waste Inspection Form, or other required manifest. Incoming waste will also be pre-characterized by the generator in accordance with the facility's approved waste acceptance procedures listed in the Part IV – Attachment 3. The pre-characterization will include analytical analysis and/or process information as necessary to make the determination that the waste is nonhazardous. No waste material will be accepted at the site that is not precharacterized or does not have the proper manifest(s).

The landfill may request and use additional information to assist in evaluating an industrial or non-industrial liquid waste for management at the Facility. Such information includes, but is not limited to, analytical data, product and/or raw component Material Safety Data Sheets (MSDS), additional waste composition data, and pertinent letters or memoranda

Upon arrival, each load shall be verified and the shipment compared to the waste approval records for conformity. Any discrepancy which cannot be rectified will result in the rejection of the load.

7.0 Storage and Processing

Accepted loads of liquids will be directed to the LWSA for discharge into the mixing containers/ basins and solidification will begin upon receipt. Bulked wastes will pass a paint filter test (EPA SW-846/9095) before disposal at the landfill working face.

Operation of the facility will include the following:

- Control of dust by wetting the roads and facility area and covering the bulking agents when not in use.
- Control of odors by covering the containers/basins, or using sawdust or wood chips for temporary odor masking.
- Protect the health and environment of employees, citizens, and surrounding communities by operating the facility in accordance with TCEQ, EPA, OSHA, and other applicable regulations.

Facility personnel will be trained in the bulking/solidification procedure, acceptable testing method, recognition of waste streams and their compatibility, daily operations, recordkeeping and reporting, implementation of emergency procedures, fire protection, and regulations pertaining to liquid waste disposal as set forth by the TCEQ.

8.0 Testing and Recordkeeping

The testing and recordkeeping requirements are listed below.

- The Paint Filter Liquid Test (EPA Method SW-846/9095) is required immediately prior to disposal of the waste in the landfill. Representative grab samples shall be obtained at a rate of one per batch of treated material.
- Records concerning the type, quantity, source, and test results of liquid wastes processed shall be maintained on a daily basis, and become part of the site operating record.

9.0 Training of Operational Personnel

Personnel involved in the bulking/ shall receive adequate training in the bulking procedure, acceptable testing method, recognition of waste streams and their compatibility, daily operations, recordkeeping and reporting, implementation of emergency procedures, and regulations pertaining to liquid waste disposal.

10.0 Closure

All liquid wastes will be treated and disposed of in the landfill or an off-site permitted disposal facility. A notice will be sent to the TCEQ and placed in the Site Operating Record noting the specific steps taken to decommission the facility.

11.0 Fire Protection

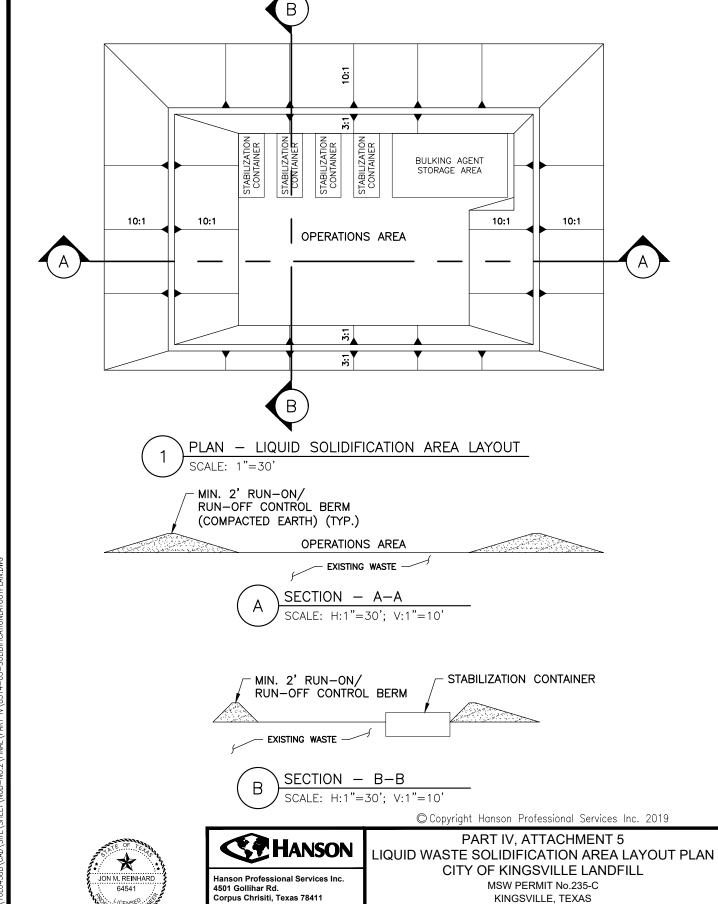
Landfill personnel, including equipment operators, will watch for signs of fire at the liquid waste solidification area. Landfill personnel will watch for fire, smoke, steam, or signs of heat. If signs of fire are detected at the liquid waste solidification area, all vehicles and equipment will be immediately moved away from the fire. The unloading of materials will either be relocated to a safe location away from the fire and a collection area established there or halted all together until the fire is extinguished.

If detected soon enough, a small fire may be fought with a hand-held fire extinguisher. The fire area may be watered down or smothered with 6 inches of soil, as appropriate, to ensure that the fire is out.

If the fire cannot be quickly extinguished with the fire extinguisher, the bulldozer, earth moving equipment, and water truck will immediately mobilize to the site of the fire. All available landfill personnel will assist with fire protection measures unless otherwise directed by the M/S.

Fire fighting methods for processed liquid wastes or bulking agents include smothering with soil, separating burning material from other waste, spraying with water from an on-site water truck, or pumping with water from an on-site pond. The burning material should be isolated or pushed away immediately before the fire can spread, or fire breaks should be cut around the fire before it can spread. If moving the material is not possible, or if it is unsafe, efforts should be made to cover the burning area with earth immediately to smother the fire.

CITY OF KINGSVILLE LANDFILL ATTACHMENT 5 FIGURE IV.5-1 LIQUID WASTE SOLIDIFICATION AREA LAYOUT PLAN



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TBPG F-50556 TBAE F-BR 2458 DT

ed By: JMR

KLEBERG COUNTY, TEXAS

Project No.: 16L0438

AS SHOWN

o4/23/2019

FIGURE

IV.5-

Dwg. File: 8514-03-SolidificationLayoutPlan

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THE CITY OF KINGSVILLE LANDFILL TCEQ PERMIT MSW 235C PERMIT AMENDMENT APPLICATION TECH NOD #2 RESPONSE - APRIL 2019 Volume 2 of 2 REDLINE STRIKEOUT



CITY OF KINGSVILLE, KLEBERG COUNTY, TEXAS

A CASON

JON M. REINHARD

CENSED 04/25/19

TBPE Firm No. F-417

Prepared by



THE CITY OF KINGSVILLE LANDFILL TCEQ PERMIT MSW 235C

PERMIT AMENDMENT APPLICATION Volume 1 of 6



CITY OF KINGSVILLE, KLEBERG COUNTY, TEXAS

September 2018
Revision 1 – November 2018
Revision 2 – February 2019
Revision 3 – April 2019

Prepared by



THE CITY OF KINGSVILLE LANDFILL TCEQ PERMIT MSW 235C

PERMIT AMENDMENT APPLICATION



CITY OF KINGSVILLE, KLEBERG COUNTY, TEXAS

September 2018
Revision 1 – November 2018
Revision 2 - February 2019
Revision 3 - April 2019

Prepared by



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THE CITY OF KINGSVILLE LANDFILL TCEQ PERMIT MSW 235C

PERMIT AMENDMENT APPLICATION Part I



CITY OF KINGSVILLE, KLEBERG COUNTY, TEXAS

September 2018
Revision 1 – November 2018
Revision 2 - February 2019
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Prepared by



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Facility Name: City of Kingsville Landfill

Permittee/Registrant Name: City of Kingsville

MSW Authorization #:235C

Initial Submittal Date: September/2018

Revision Date: April/2019



Texas Commission on Environmental Quality Part I Form for New Permit/Registration and Amendment Applications for an MSW Facility

1.	Reason for Submittal				
	☐ Initial Submittal	\boxtimes	Notice of Deficiency	(NOD) Response	
2.	Authorization Type				
	□ Permit		Registration		
3.	Application Type				
	New	\boxtimes	Major Amendment		
			Major Amendment (Limited Scope)	
4.	Application Fees				
	☐ Pay by Check		Online Payment		
	If paid online, e-Pay Confirmation Number: Trace Number: 582EA000315158, Voucher Number: 385823, Voucher Number: 385824				
5.	Application URL				
	Is the application submitted for Type I Arid Exempt (AE) and/or Type IV AE facility?				
	☐ Yes				
	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.cityofkingsville.com/departments/public-works/landfill/landfill-amendment-application/				
6.	Application Publishing				
	Party Responsible for Publishin	g No	tice:		
	Applicant Ag	gent	in Service	Consultant	
	Contact Name: Scot Collins	P G	Tit	le: Project Manager	

Facility Name: City of Kingsville Landfill MSW Authorization #: 235C Initial Submittal Date: September/2018 Revision Date: April/2019

Signature Page

I,,					
(Site Operator (Permittee/Registrant)'s Authorized Signatory) (T	itle)				
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 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 knowledge violations.	d of d				
Signature: Date:					
TO BE COMPLETED BY THE OPERATOR IF THE APPLICATION IS SIGNED BY AN AUTHORIZ REPRESENTATIVE FOR THE OPERATOR	ZED				
I,, hereby designate (Print or Type Operator Name) (Print or Type Representative Name)					
(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 forme at any hearing or before the Texas Commission on Environmental Quality in conjunct 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.	ion				
Printed or Typed Name of Operator or Principal Executive Officer					
Signature 					
SUBSCRIBED AND SWORN to before me by the said					
On this day of,					
My commission expires on the day of,					
Notary Public in and for					
County, Texas					
Note: Application Must Bear Signature & Seal of Notary Public)					

CITY OF KINGSVILLE LANDFILL PART I ATTACHMENT 1 SUPPLEMENTARY TECHNICAL REPORT

THE CITY OF KINGSVILLE LANDFILL TCEQ PERMIT MSW 235C

PERMIT AMENDMENT APPLICATION Part I

Attachment 1 Supplementary Technical Report



CITY OF KINGSVILLE, KLEBERG COUNTY, TEXAS

September 2018
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Prepared by



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1.4 Nature of Business and Solid Waste Data

The existing City of Kingsville Landfill serves residences and businesses in Kleberg County and portions of several surrounding counties, including Nueces, Jim Wells, Brooks and Kenedy. This service area is based on current economic conditions. As economic and available landfill disposal capacity change, the landfill may accept waste from areas other than those noted above.

Kingsville Landfill (current MSW Permit No. 235-B) receives approximately 100.46 tons of waste per day for disposal, six days a week (313 days), or 31,444 tons of waste per year for disposal. Types of waste accepted (currently and under the new permit amendment) for disposal include residential and commercial municipal solid waste, including household wastes, brush, construction/demolition waste and special wastes as authorized by the TCEQ. Wastes currently not accepted at the landfill include hazardous wastes, prohibited wastes, radioactive wastes, industrial wastes, some special wastes including batteries and friable asbestos.

Kingsville Landfill (under the new permit amendment) will accept wastes from residential, municipal, commercial and industrial sources. Kingsville Landfill will accept the following types of waste for processing and/or disposal at the landfill:

• Residential and commercial wastes typical of waste generated by residential and commercial businesses in the area (Municipal Solid Waste):

Municipal Solid Waste (MSW) is defined as: Any solid waste resulting from or incidental to municipal, community, commercial, institutional, and recreational activities, including garbage, rubbish, ashes, street cleanings, dead animals, abandoned automobiles, and all other solid waste other than industrial solid waste;

• Construction and demolition waste:

The waste resulting from construction or demolition projects; includes all materials that are directly or indirectly the by-products of construction work or that result from demolition of buildings and other structures, including, but not limited to, paper, cartons, gypsum board, wood, excelsior, rubber, and plastics;

• Whole and scrap tires for processing:

Whole and scrap tires are defined as any tire that can no longer be used for its original intended purpose;

• Commercial grease and grit trap waste:

Grease and grit trap waste is defined as: material collected from a grease interceptor in the sanitary sewer service line of a commercial, institutional, or industrial food service or processing establishment, including the solids resulting from dewatering processes; and grit trap wastes from interceptors placed in the drains prior to entering the sewer system at maintenance and repair shops, automobile service stations, and washes, laundries, and other similar establishments;

• Liquid wastes for solidification:

The liquid wastes accepted for solidification are characterized as/by untreated liquid wastes which typically do not pass the paint filter test including nonhazardous industrial waste and sludges, food and beverage byproducts and other nonhazardous liquids originated from food and beverage processing plants, and other commercial and industrial facilities;

• Industrial non-hazardous waste:

Solid waste resulting from or incidental to any process of industry or manufacturing, mining or agricultural operations, classified as follows:

- Class 2 Industrial Solid Waste any individual solid waste or combination of industrial solid wastes that cannot be described as Class 1 or Class 3, as defined in 30 TAC §335.506 (relating to Class 2 waste determination);
- O Class 3 Industrial Solid Waste any inert and essentially insoluble industrial solid waste, including materials such as rock, brick, glass, dirt, and certain plastics and rubber, etc., that are not readily decomposable as defined in 30 TAC §335.507 (relating to Class 3 waste determination);

• and;

• Other special wastes:

Special waste is any solid waste or combination of solid wastes that because of its quantity, concentration, physical or chemical characteristics, or biological properties requires special handling and disposal to protect human health or the environment. Special wastes as defined in 30 TAC §330.3, 30 TAC §330.171, and 30 TAC §330.173 include the following:

- O Municipal hazardous waste from conditionally exempt small-quantity generators that may be exempt from full controls under Chapter 335, Subchapter N (relating to Household Materials Which Could Be Classified as Hazardous Wastes);
- o Class 1 industrial nonhazardous waste;
- Untreated medical waste;
- Municipal wastewater treatment plant sludges, other types of domestic sewage treatment plant sludges, and water-supply treatment plant sludges;
- o Septic tank pumpings;
- o Grease and grit trap wastes;
- Wastes from commercial or industrial wastewater treatment plants; air pollution control facilities; and tanks, drums, or containers used for shipping or storing any material that has been listed as a hazardous constituent in 40 Code of Federal Regulations (CFR) Part 261, Appendix VIII but has not been listed as a commercial chemical product in 40 CFR §261.33(e) or (f);
- Slaughterhouse wastes;

- Dead animals;
- Drugs, contaminated foods, or contaminated beverages, other than those contained in normal household waste;
- o Pesticide (insecticide, herbicide, fungicide, or rodenticide) containers;
- Discarded materials containing asbestos;
- o Incinerator ash;
- Soil contaminated by petroleum products, crude oils, or chemicals in concentrations of greater than 1,500 milligrams per kilogram total petroleum hydrocarbons; or contaminated by constituents of concern that exceed the concentrations listed in Table 1 of §335.521(a)(1);
- o Used oil;
- Waste from oil, gas, and geothermal activities subject to regulation by the Railroad Commission of Texas when those wastes are to be processed, treated, or disposed of at a solid waste management facility;
- Waste generated outside the boundaries of Texas that contains:
 - any industrial waste;
 - any waste associated with oil, gas, and geothermal exploration, production, or development activities; or
 - any item listed as a special waste in this paragraph;
- Lead acid storage batteries;
- Used-oil filters from internal combustion engines;
- o Regulated asbestos-containing material (RACM) as defined in 40 CFR Part 61;
- o Nonregulated asbestos-containing material (non-RACM).

<u>Industrial (non-hazardous) and special wastes are accepted and handled in accordance with Part IV – Site Operating Plan.</u>

See Part II, Section 2 for a more detailed breakdown of the quantities, types and characteristics of wastes accepted at the facility.

The life expectancy of the existing permitted sectors is approximately 43 years. The expected rate of solid waste deposition is anticipated to increase at approximately one (1) percent per year (corresponding to the anticipated growth in population) according to information provided by the Texas State Data Center. Based on the anticipated annual growth rate, the expanded facility will last approximately 98 years. See Part II, Section 2.2 and Part III, Section 5.3 for a detailed analysis of the projected life of the expanded site.

The following table provides a summary of the current permitted conditions and proposed permit conditions.

TABLE 2: PERMIT CONDITION SUMMARY

	CURRENT CONDITIONS	PROPOSED CONDITIONS
Permitted Area	120 acres	176.33 acres
	Type I - 4,993,000 cy	
	<u>Type IV - 820,000 cy</u>	
Total Permitted Capacity	5,813,000 cy	17,994,286 cy
	1,258,576 tons	6,295,538 tons
Total Remaining Capacity	3,043,714 cy	15,225,000 cy
Remaining Projected Site Life	43	98
Maximum Elevation of Final Cover		
(msl)	125	200
Elevation of Deepest Excavation		
(msl)	42.5	22.5

2 FACILITY LOCATION §330.59(b)

2.1 Location Description

The City of Kingsville Landfill is located southeast of the City of Kingsville at the northeast corner of the intersection of Farm to Market Road 2619 and East County Road 2130. Kingsville Landfill is outside the City of Kingsville city limits which are approximately 1.45 miles from the northeast corner of the landfill boundary. It however falls within the City of Kingsville's extraterritorial jurisdiction.

2.1 Facility Name, Address and Telephone

Name: City of Kingsville Municipal Solid Waste Landfill

MSW Permit No: 235-C

Physical Address: 348 East C.R. 2130

Kingsville, TX 78363

Mailing Address: P.O Box 1458

Kingsville, TX 78364

Telephone: (361) 595-0092

2.2 Access Routes

The main local public roadways providing access to the facility are East County Road 2130 (E CR 2130), Farm to Market Road 2619 (FM 2619) and Farm to Market Road 1717 (FM 1717). The entrance to the City of Kingsville Landfill is via an existing 24-foot-wide roadway. Refer to Part II, Section 9 - Transportation for more detailed transportation information. Refer to Part I, Attachment 2, Figure I.2-2 - General Highway Map - Kleberg County for the location of the facility in relation to the surrounding roads.

2.3 Geographic Coordinates

The latitudinal and longitudinal geographic coordinates of the permanent site benchmark are:

Latitude: N 27° 26' 41.95" Longitude: W 97° 48' 55.89" Elevation (above msl): 52.60 feet

3 MAPS §330.59(c)

3.1 General Location Map §330.59(c)(1)-(2)

The following maps collectively as a group, comply with the rule requirements of §330.59(c)(1)-(2) and §305.45. These general location maps are included in Part I, Attachment 2 - General Location Maps.

Figure I.2-1 – General Location Map

Figure I.2-2 – General Highway Map - Kleberg County (Texas Department of Transportation, General Highway Map for Kleberg County, Texas)

Figure I.2-4 – Aerial Photograph

Figure I.2-5 – Facility Layout

3.2 Topographic Map

Figure I.2-3 – General Topographic Map (USGS General Topographic Map for the Ricardo, Texas Quadrant)

3.3 Land ownership and Mineral Interests Map

A Land Ownership Map and Land Owners List are included in Part I, Attachment 3. The map and list reflect current property ownership within one-quarter (1/4) mile of the permit boundary and all mineral interest ownership under the facility, as derived from the real property appraisal records as listed on the date that this application was filed. Refer to Figure I.3-1 for location of the properties and Figure I.3-2 for property ownership list. The map and list meet the requirements of 30 TAC §330.59(c)(3), and §281.5. The property ownership list in electronic form is provided in Part I, Attachment 3, Appendix 1, per the requirements of 30 TAC §330.59(c)(3)(B).

Figure I.3-1 – Adjacent Land Ownership Map

Figure I.3-2 – Land Owners List

4 CHARACTER OF THE ADJACENT LAND §305.45(a)(6)

The following sections provide an overview of the various land use conditions of the surrounding area.

- 1) <u>Wind Direction</u>. The nearest reporting station is Corpus Christi, located to the northeast of the landfill site. A wind rose is included as part of Part I, Attachment 2, Figure I.2-1. The wind is predominantly from the southeast.
- 2) Water Wells. A well search was performed using the Texas Department of Licensing and Regulation's (TDLR) State of Texas Well Report Submission and Retrieval System, developed by the Texas Water Development Board in cooperation with the TDLR and the Texas Water Information Network. Based on this search, one well (Tracking Number 178262) is identified within 500 feet of the City of Kingsville Landfill site. During a site reconnaissance visit, this well was not confirmed to be located at the identified location (near the intersection of CR 2130 and CR 2619) and is believed to be plotted incorrectly based on available data, shown on Part II, Attachment 1, Figure II.1-4.
- 3) Existing Structures. The number of structures located within 500 feet of the landfill were determined through a visual reconnaissance and review of aerial photography. Approximately four (4) non-habitable structures are located within the 500-foot boundary of the City of Kingsville Landfill. These structures are associated with agricultural activities within the surrounding areas. Within the permitted boundary of the site, there is a scale house, an office building, and a maintenance shop, (see Part I, Attachment 2, Figure I.2-5and Part III, Attachment 1, Figures III.1-2and III.1-14).
- 4) Special Use areas. A visual reconnaissance and available records search revealed that other than the City of Kingsville Landfill, there are no active disposal facilities located within one mile of the landfill. Surrounding land uses include agriculture (crop land and pasture) with a few remote residences interspaced within the agricultural areas. There are no known licensed day care facilities, hospitals, cemeteries, ponds, or lakes within one mile of the permitted boundary of the landfill.
- 5) Area Streams. The nearest stream to the City of Kingsville Landfill is the Santa Gertrudis Creek. Santa Gertrudis Creek is located about 3,000 feet to the northeast of the northeast corner of the current site and about 2,000 feet to the northeast of the northeast corner of the proposed easterly expansion. No perennial or intermittent streams are located within 500 feet of the location of the proposed expansion.

- 6) Airports. The nearest airfield is the non-public-use Kingsville Naval Air Station (NAS-Kingsville) located northeast of the landfill. The north landfill boundary line is approximately 2.73 miles to the end of the nearest runway and falls within the 6 miles jurisdictional limit of the regulatory airport restrictions. NAS-Kingsville personnel have been notified of the proposed development and how it may impact their activities. The Kingsville Naval Air Station has provided notice that the airfield operations will not be adversely affected by the development. A detailed discussion on airports within the proximity of the landfill site can be found in Part II, Section 9.5. as well as correspondence with NAS-Kingsville and the FAA can be found in Part II, Section 9.5.
- 7) <u>Easements</u>. There is one (1) known aerial electrical line easement within the permitted boundary of the City of Kingsville Landfill.
- 8) <u>Historic Sites</u>. A review of the Texas Historical Commission's database for a one-mile radius and visual observations indicated that no historic sites are present. A detailed discussion on historic sites within one-mile of the landfill site can be found in Part II, Section 15 as well as applicable correspondence with the Texas Historical Commission can be found in See Part II, Attachment 7.

5 PROPERTY OWNER INFORMATION §330.59(d)

5.1 Legal Description

The legal description for the City of Kingsville Landfill property boundary and the Kleberg County Clerk's file number are included in Part I, Attachment 4, Appendix 1. The drawing of the property boundary metes and bounds is included in Part I, Attachment 4, Appendix 1.

The legal description for the City of Kingsville Landfill permit boundary and the Kleberg County Clerk's file number are included in Part I, Attachment 4, Appendix 2. The drawing of the permit boundary metes and bounds is included in Part I, Attachment 4, Appendix 2.

5.2 Ownership

Kingsville Landfill is owned and operated by the City of Kingsville (City). The facility services residences and businesses within Kleberg County and portions of several surrounding counties, including Nueces, Jim Wells, Brooks and Kenedy.

5.3 Property Owner Affidavit

The property owner affidavit for this permit amendment application found in Part I, Attachment 6 meets the requirements of §330.59(d)(2).

6 LEGAL AUTHORITY §330.59(e)

The legal authority and status of the applicant has been verified as required by §330.59(e) and §281.5 and is included in Part I, Attachment 5 – Verification of Legal Status. The City of Kingsville owns and operates the City of Kingsville Landfill. No other person or entity owns more than 20 percent of the facility.

7 EVIDENCE OF COMPETENCY §330.59(f)

Kingsville Landfill is owned and operated by the City of Kingsville (City). The landfill serves residences and businesses within Kleberg County and portions of surrounding Texas counties. The City has been providing waste disposal since the 1970's and has successfully operated the municipal landfill operation. The City owns and operates the City of Kingsville Citizens Collection Station MSW Registration # 120081, since June 2012. The City does not own and has not operated any other solid waste sites in the last 10 years, in Texas or any other state. It has, to this date, complied with all regulations and requirements set forth by the regulatory agency and most currently, Texas Commission on Environmental Quality (TCEQ). Evidence of Competency for the City of Kingsville Landfill is provided in Part I, Attachment 7.

8 APPOINTMENTS §330.59(g)

Part I, Attachment 9 provides documentation that the person signing the application meets the requirements of §305.44 of this title (relating to Signatories to Applications). Article V, Section 31 of the City of Kingsville Charter, establishes that the City Manager is the chief administrative and executive officer of the City. As the City's executive officer, the City Manager has the authority to sign this application and to delegate signatory responsibility related to the permit amendment application.

9 OTHER PERMITS AND AUTHORIZATIONS §305.45(a)(7)

Section 11 of the TCEQ Part I Form for New Permit/Registration and Amendment Applications for an MSW Facility (TCEQ-0650) contains the required information relating to additional permits or approvals. The City of Kingsville currently has Standard Air Operating Permit (#3337), Air New Source Registration (#91376), Air New Source Registration (#54070L001) and General Permit to Discharge Under The Texas Pollutant Discharge Elimination System (TPDES) under provisions of Section 402 of the Clean Water Act and Chapter 26 of the Texas Water Code (#TXR05L074).

10 APPLICATION FEES §330.59(h)

In accordance with §330.59(h), The City of Kingsville has made payment of \$150.00. This fee was paid to TCEQ online via the TCEQ ePay online payment system, the receipt is provided in Part I, Attachment 10.

THE CITY OF KINGSVILLE LANDFILL TCEQ PERMIT MSW 235C

PERMIT AMENDMENT APPLICATION PART II



CITY OF KINGSVILLE, KLEBERG COUNTY, TEXAS

September 2018
Revision 1 – November 2018
Revision 2 - February 2019
Revision 3 - April 2019

Prepared by



HANSON PROJECT NO. 16L0438-0003

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1 EXISTING CONDITIONS SUMMARY §330.61(a)

The City of Kingsville currently operates the City of Kingsville Landfill, which is a Type I and Type IV municipal solid waste facility operating under TCEQ Permit No. 235-B. The landfill is scheduled to cease operation in 2061. The City intends to increase the site life and better utilize the available space at the landfill through the proposed expansion and design modifications.

1.1 General Facility Description

The City of Kingsville Landfill (Kingsville Landfill) is located in Kleberg County, Texas, at the northeast corner of the intersection of Farm to Market Road 2619 and County Road 2130. The northern boundary of the property is approximately 2,811 feet from FM 1717, while the eastern boundary is approximately 1,300 feet from N. County Road 1070 (See Part I, Attachment 2, Figure I.2-1 – General Location Map).

The Kingsville Landfill has been in existence since February 1977 and is intended to provide waste disposal for residences and businesses in Kleberg County and surrounding Texas counties. The nearest community is the City of Kingsville, whose city limits are approximately 1.45 miles from the northeast corner of the landfill boundary. The facility has undergone two permit amendments to date allowing it to extend its initial permit boundaries, and increase the permitted maximum elevation (Refer to Part I, Attachment 1, Section 1.2 – Permit History).

The existing Kingsville Landfill includes a scale house, an office building, and a maintenance shop, all enclosed within a perimeter fence. These facilities will continue to be operational for the life of the landfill. No new building or infrastructure improvements will be constructed as part of the proposed permit amendment.

The overall property consists of gently undulating grasslands with limited forest cover. The property generally slopes to the northeast with no major topographic features. The nearest 100-year floodplain is located to the northeast of the site along Santa Gertrudis Creek. There is one (1) known aerial electrical line easement within the permitted facility boundary. Surrounding land use is predominantly agricultural.

1.2 Purpose of the Permit Amendment Application

The City of Kingsville proposes to redesign the current City of Kingsville Landfill Permit 235-B, a Type I and Type IV Municipal Solid Waste Facility, in accordance with the Texas Administrative Code Chapter 330: Municipal Solid Waste Regulations. The redesign includes both a vertical and lateral expansion to increase the currently permitted disposal facility from 120-acres to 176.33-acres (121.3 acre waste disposal footprint), and the permitted maximum (final cover) elevation for the facility from 125-feet to 200-feet above MSL (the maximum waste elevation for the facility will be 196.92 feet-msl) as indicated in Part III, Attachment 1, Figures III.1-4 and III.7-1. The elevation of the deepest excavation will also be increased 20-feet to an elevation of 22.5 feet-msl

2 WASTE ACCEPTANCE PLAN §330.61(b)

2.1 Sources and Characteristics of Waste

The operational procedures and redesign described in the Permit Amendment Application, once approved, will allow the facility to accept, store, process and/or dispose of municipal solid waste, construction and/or demolition waste, whole and scrap tires, grease and grit trap waste, liquid waste, industrial waste non-hazardous Class 2 and Class 3 and some special wastes as defined by 30 TAC §330.3, 30 TAC §330.171, and 30 TAC §330.173.

The facility will accept for disposal the following special waste allowable under 30 TAC §330.171: special wastes from health care related facilities, dead animals and/or slaughterhouse waste, non-regulated asbestos-containing materials (non-RACM), empty containers which have been used for pesticides, herbicides, fungicides, or rodenticides, Municipal hazardous waste from a conditionally exempt small quantity generator (CESQG), sludge, grease trap waste, grit trap waste, soil contaminated by petroleum products, crude oils, or chemicals and liquid waste from oilfield activities. Procedures for accepting and processing all special waste are detailed in the Site Operating Plan (Part IV). In the event that the City of Kingsville Landfill elects to accept other special wastes in the future, TCEQ authorization will be sought and procedures for acceptance and processing will be provided. Other materials that will be received for processing and potentially beneficial reuse include scrap tires and unsorted mixed recyclables.

Consistent with 30 TAC §330.15, the City of Kingsville Landfill will not accept for disposal lead acid storage batteries, used motor vehicle oil, used oil filters, refrigerators, freezers, air conditioners or other items containing chlorinated fluorocarbons (CFC), regulated hazardous waste, polychlorinated biphenyls (PCB) waste, radioactive materials, or other wastes prohibited by TCEQ. Friable asbestos-containing materials, and empty containers, as well as industrial hazardous waste, and Non-hazardous Class 1, Class 2, and Class 3-industrial waste will not be accepted for disposal.

The Site Operating Plan in Part IV of the application contains a detailed description of the restrictions pertaining to waste acceptance procedures. The Applicant (City of Kingsville) reserves the right to reject any waste material, including those mentioned above, that contributes a constituent or characteristic that may impact or influence the design or operation of the facility.

2.2 Volume and Rate of Disposal

Kingsville Landfill received approximately 31,444 tons of incoming solid waste in 2017. The maximum annual waste acceptance rate is anticipated to increase at approximately one (1) percent per year which corresponds to the anticipated yearly population growth rate for Kleberg County (based on population projections from the Texas State Data Center).

9 TRANSPORTATION §330.61(i)

9.1 Selected Routes

Vehicles entering the City of Kingsville Landfill include semi-trailers, dump trucks and trailers, and light duty trucks. E County Road 2130 (CR E 2130), Farm to Market Road 1717 (FM 1717), and Farm to Market Road 2169 (FM 2169) will provide access to the site. These routes are asphalt paved and are the same routes currently in use for the City of Kingsville Landfill. The transportation network used to access the landfill is presented as Part II, Attachment 1. Figure II.1-1.

9.2 Adequacy of Roads

The privately owned site entrance road is currently a two-lane, 24-foot wide road maintained by the City of Kingsville to ensure access to the facility. The Texas Department of Transportation is responsible for maintaining FM 2169 and FM 1717 while E CR 2130 is maintained by Kleberg County. All roads are adequate for use by vehicles up to the legal maximum of 58,420 pounds, including solid waste collection vehicles entering and exiting the facility. Periodic maintenance of the roads is routinely undertaken by the City and TXDOT as necessary to maintain availability of these routes to the landfill and to ensure that residents and businesses along the routes have continued access. Correspondence with TXDOT regarding the adequacy of roads used to access the facility is included in Part II, Attachment 3. TXDOT responded to the NORI with a memo, dated April 16, 2019, stating that the facility is subject to the Highway Beautification Act requirements (43 TAC Chapter 21, Subchapter H). The April 16, 2019 memo is included with Part II, Attachment 3–B. Further communication with TXDOT is required to determine if the facility is subject to the Highway Beautification Act requirements or not. If it is determined that the facility is subject to the Highway Beautification Act requirements (43 TAC Chapter 21, Subchapter H), the facility will provide screening in accordance with those requirements and as approved by the TXDOT District Engineer for Kleberg County.

9.3 Existing Traffic Volumes

All landfill traffic access the facility via the single site entrance road from E County Road 2130 (E CR 2130) and Farm to Market Road 2619 (FM 2619) which is in-turn accessed via Farm to Market Road 1717 (FM 1717). TXDOT records show the Annual Average Daily Traffic (2016 AADT) is approximately 731 on FM 2619 at the nearest traffic count northwest of the landfill and 1,218 on FM 1717 at the traffic count northwest of the landfill (Refer to Part II, Attachment 1. Figure II.1-1. There are no available traffic counts for E CR 2130. Approximately 46 City, commercial, and citizen waste hauling vehicles per day use the City of Kingsville Landfill.

9.4 Projected Volume of Vehicular Traffic

The proposed vertical and lateral expansion will not have an impact on vehicular traffic in the area as the rate at which municipal solid waste is received by the facility will not be affected. The traffic volume projection is calculated at the expected annual population growth rate of approximately one (1) percent. Traffic volumes and calculations are presented in the Table 3.

CITY OF KINGSVILLE LANDFILL PART II ATTACHMENT 3-B

 $\label{eq:responses} \textbf{RESPONSE} \ \textbf{FROM}$ TEXAS DEPARTMENT OF TRANSPORTATION (TxDOT)

Part II

CITY OF KINGSVILLE LANDFILL PART II ATTACHMENT 3-C SUBMITTAL TO KLEBERG COUNTY (COUNTY)

THE CITY OF KINGSVILLE LANDFILL TCEQ PERMIT MSW 235C

PERMIT AMENDMENT APPLICATION PART III SITE DEVELOPMENT PLAN



CITY OF KINGSVILLE, KLEBERG COUNTY, TEXAS

September 2018
Revision 1 – November 2018
Revision 2 - February 2019
Revision 3 - April 2019

Prepared by



HANSON PROJECT NO. 16L0438-000

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3.2.2 Ventilation and Odor Control Measures

Potential odor sources associated with a landfill can vary considerably and may include the wastes being delivered to the landfill, waste in the open working face, landfill gas, the leachate collection system, or ponded water. Some wastes such as sludge and dead animals are a source of odor upon receipt, while other wastes have the potential for becoming a source of odor by their biodegradable nature. Leachate, liquid that has passed through or emerged from solid waste, may also be a source of odor if not properly handled in a timely manner.

Landfill operation at the site will occur in open areas within the permitted waste disposal footprint, therefore adequate ventilation will be provided. Landfill operators will ensure that odors are kept to a minimum by keeping the size of the working face area to a minimum, identifying any waste streams that require special attention to control odor, proper handling and disposal of leachate in a timely manner, and preventing ponded water. These and other odor control measures are discussed in detail in Part IV – Site Operating Plan.

The site will comply with all the applicable air quality rules and regulations. Accidental fires will be controlled, and open burning of waste will not be permitted.

3.2.3 Generalized Construction

Generalized construction details for the landfill are included in Part III, Attachments 1 through 3. Storage and Processing Area Plans, Figure III.1-16 in Part III, Attachment 1, provides details for the White Goods and Metal Recyclables Storage Area and the Tire Storage and Processing Area. Design and operation requirements for the Liquid Waste Solidification Facility Area are included in Part IV- SOP, Attachment 5. Construction details for the liquid waste solidification area are shown on Figure IV.5-1. Details of the leachate management system are included in Part III, Attachment 15. Construction details for the leachate storage tanks are shown on Part III, Attachment 15, Appendix G, Figure III.15-G-3.

3.3 Sanitation and Water Pollution Control §330.63(b)(3) – (4)

The white goods and metal recyclables storage area and the tire storage and processing area contains waste handling and storage operations but there is no process wastewater produced at these areas or other operations of the landfill. The areas will be built up with an all-weather surface that is graded and bermed to prevent surface water from running into the storage area. In addition to preventing surface water runon into the areas, the berms enclosing the areas will also serve to contain runoff. The areas will be graded to a stormwater collection sump that wil collect and hold runoff from within the area. If runoff is determined to be contaminated it will be collected and transported to the contaminated water evaporation pond or the contaminated water management area.

3.4 Endangered Species Protection §330.63(b)(5)

A literature review of threatened or endangered species in Kleberg County was conducted as discussed in Part II, Section 14. The review included both US Fish and Wildlife (USFWS) and Texas Parks and Wildlife Department documentation and their requirements for endangered species assessment and compliance. No potential habitat for federally listed threatened or endangered species or designated critical habitat occurs within the permit area, or the property. And no federally listed threatened or endangered species have been observed on the property. Neither the facility nor its operations will result in the destruction or adverse modification of the critical habitat of threatened or endangered species. If endangered species are encountered during site operations, USFWS and TPWD will be notified.

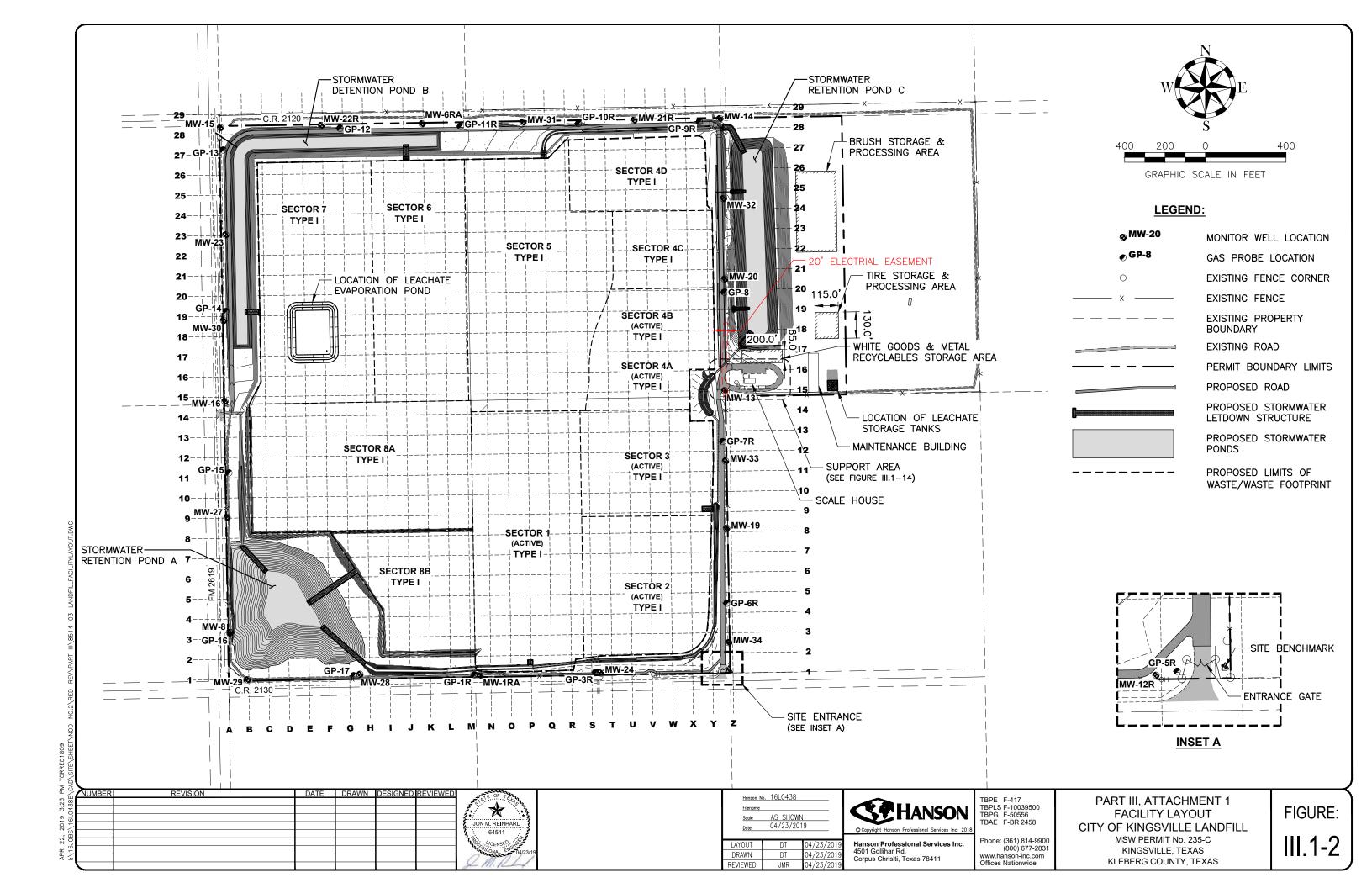
9 **CLOSURE PLAN §330.63(h)**

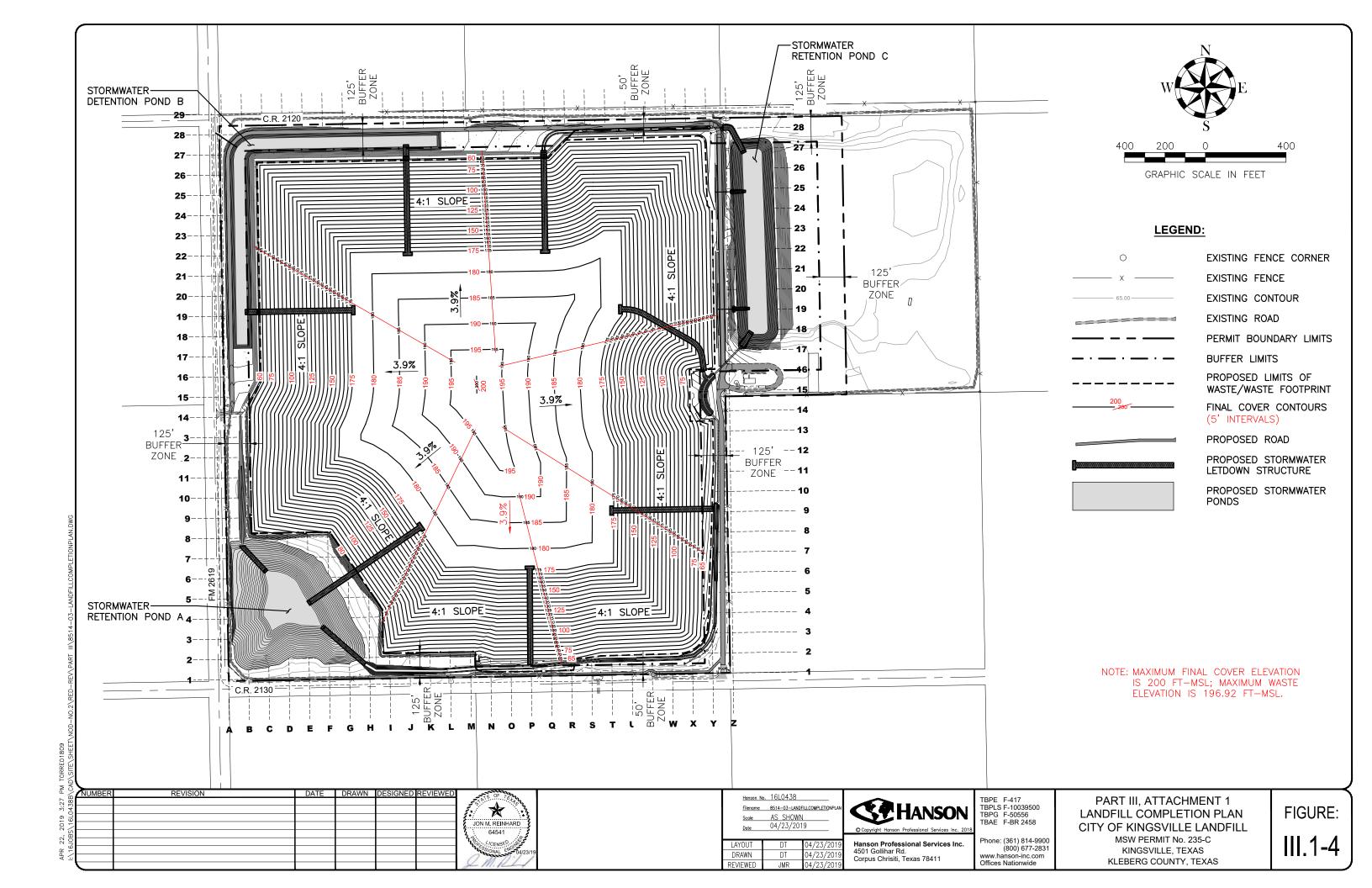
Part III, Attachment 12 - Final Closure Plan contains the details of the final cover design, which has been developed to comply with Subchapter K, §330.501 through 330.505 of the TCEQ regulations. A composite cover will be constructed over the entire landfill. The composite cover will overlay a 12-inch thick intermediate cover layer immediately above the top of waste. The composite cover will consist of, from bottom to top, a prepared soil subgrade, a geosynthetic clay liner (GCL), a 40-mil flexible membrane cover, a drainage geocomposite, and a 25-inch thick protective soil erosion layer. The Alternative Liner and Overliner Point of Compliance Demonstrations found in Part III, Attachment 5 includes a demonstration that the GCL material proposed in the final cover design is acceptable.

The initial and primary vegetative cover for the site will include appropriate native grasses. Typical types of grasses include Coastal Bermuda, Buffalo Grass, Texas Grama, Bluestem and Johnson Grass. Winter Rye and Fescue may be used in the cool seasons. The Kleberg County Extension Agent may also be consulted on the use of appropriate grasses and the appropriate planting seasons as cover projects are initiated. The maintenance of grass cover over completed areas is an essential component of erosion control in post closure care.

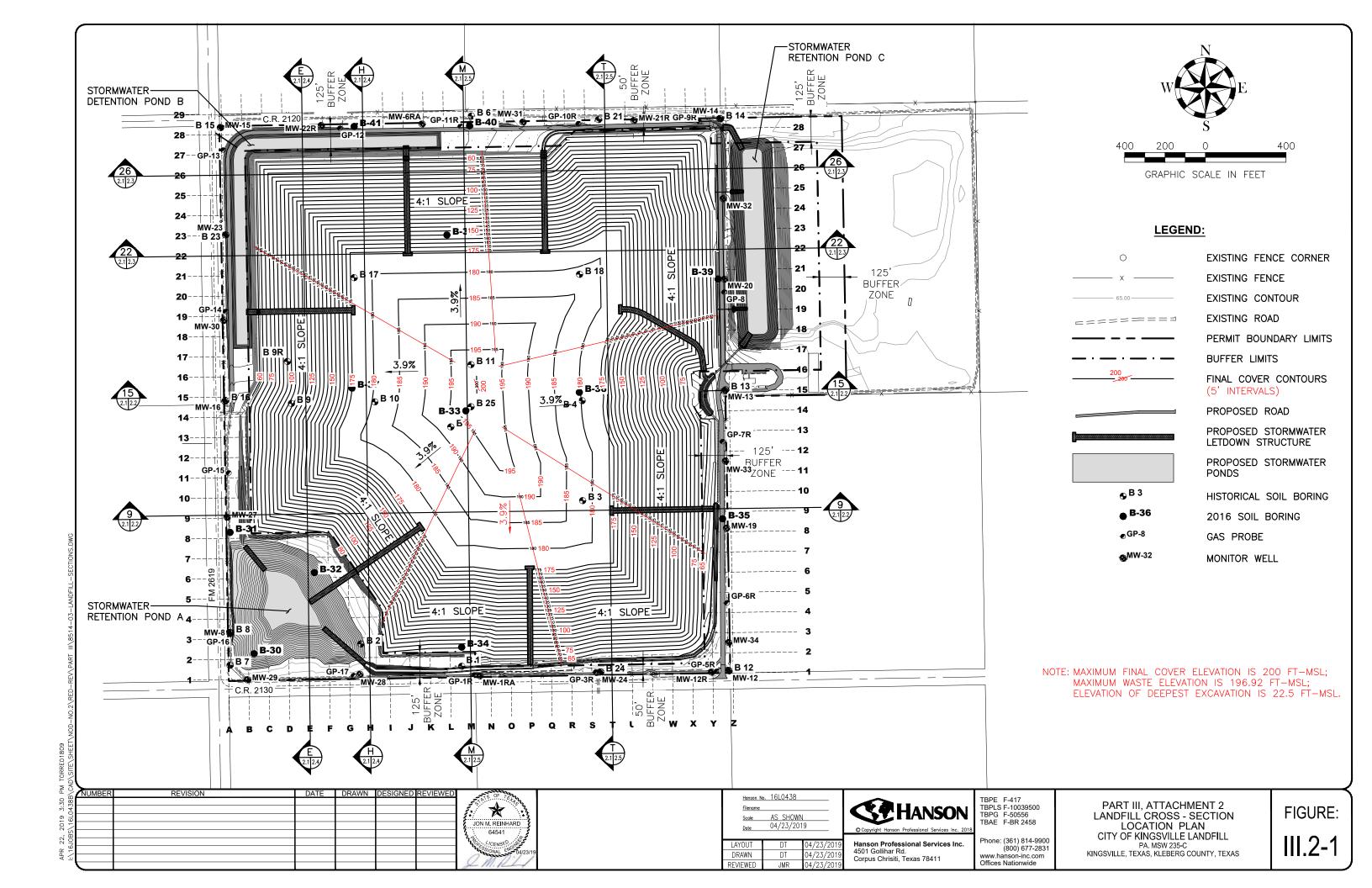
A demonstration that this specified final cover design will provide effective long term erosional stability is included in Part III, Attachment 6 - FSWDR.

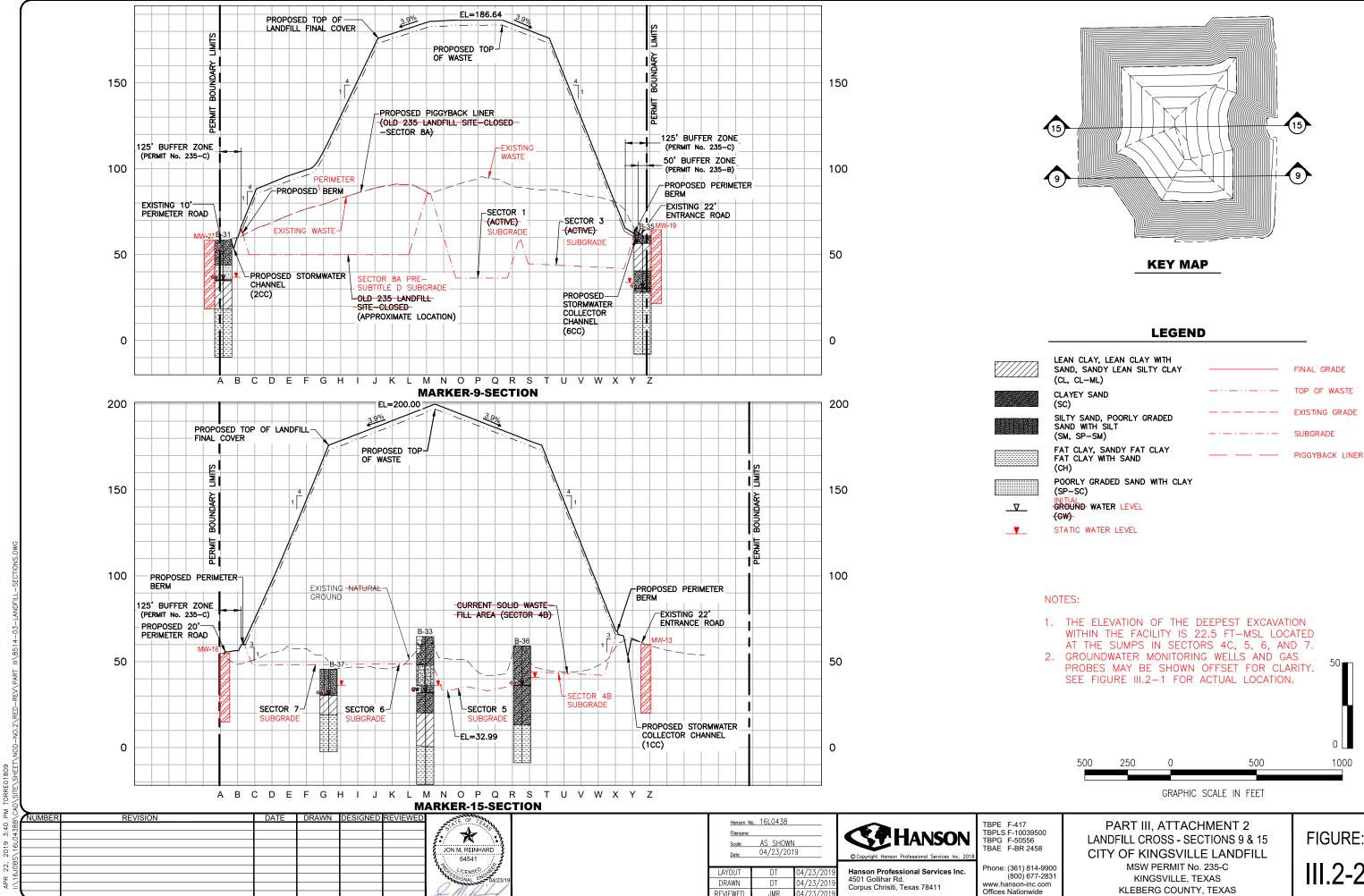
CITY OF KINGSVILLE LANDFILL PART III ATTACHMENT 1 SITE LAYOUT PLANS

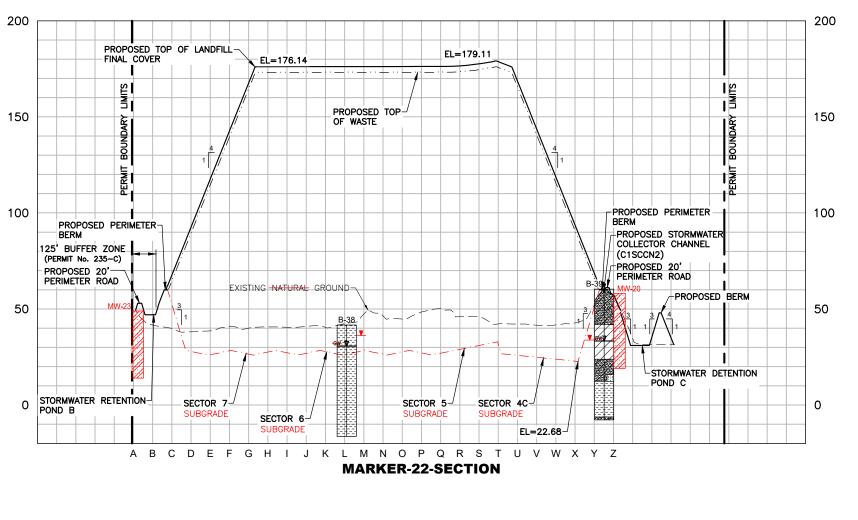


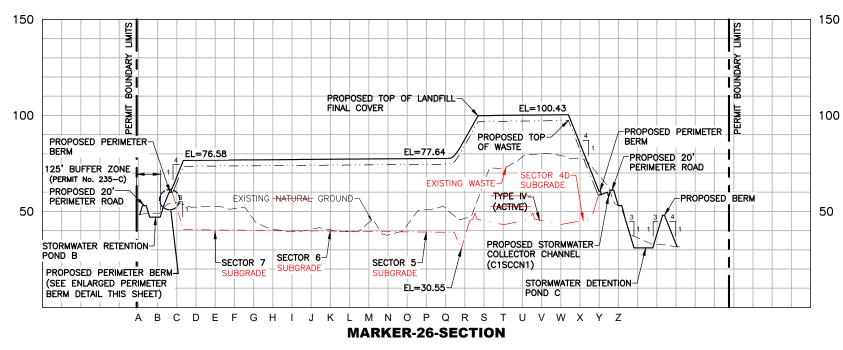


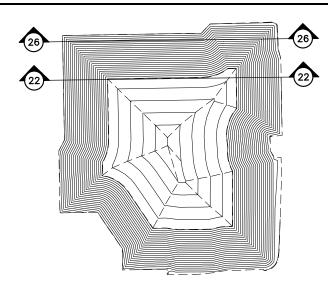
CITY OF KINGSVILLE LANDFILL PART III ATTACHMENT 2 CROSS-SECTIONS











KEY MAP

LEGEND

LEAN CLAY, LEAN CLAY WITH
SAND, SANDY LEAN SILTY CLAY
(CL, CL-ML)

CLAYEY SAND
(SC)

SILTY SAND, POORLY GRADED
SAND WITH SILTY
(SM, SP-SM)

FAT CLAY, SANDY FAT CLAY
FAT CLAY WITH SAND
(CH)

POORLY GRADED SAND WITH CLAY
(SP-SC)
INITIAL

FINAL GRADE

FINAL GRADE

TOP OF WASTE

EXISTING GRADE

SUBGRADE

PIGGYBACK LINER

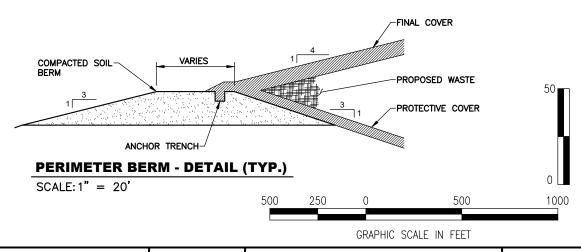
PIGGYBACK LINER

FORUMD WATER LEVEL

NOTES:

STATIC WATER LEVEL

- 1. THE ELEVATION OF THE DEEPEST EXCAVATION WITHIN THE FACILITY IS 22.5 FT-MSL LOCATED AT THE SUMPS IN SECTORS 4C, 5, 6, AND 7.
- 2. GROUNDWATER MONITORING WELLS AND GAS PROBES MAY BE SHOWN OFFSET FOR CLARITY. SEE FIGURE III.2-1 FOR ACTUAL LOCATION.



NUMBER REVISION DATE DRAWN DESIGNED REVIEWED

JON M. REINHARD
64541

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OVAL
504

Hanson No. 16L0438

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Date 04/23/2019

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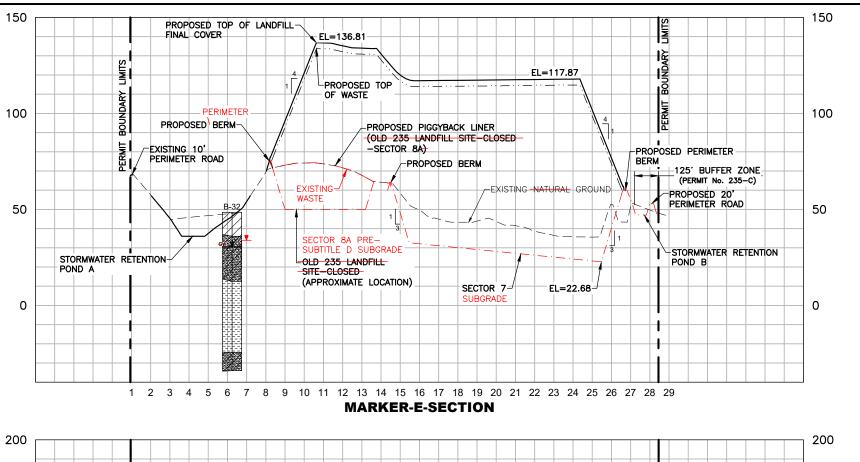
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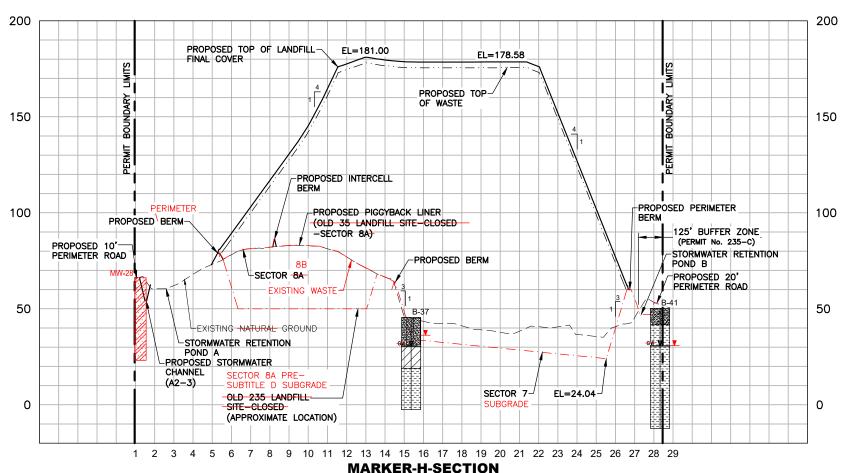
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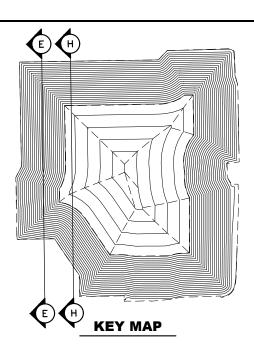
PART III, ATTACHMENT 2 LANDFILL CROSS - SECTIONS 22 & 26 CITY OF KINGSVILLE LANDFILL MSW PERMIT No. 235-C KINGSVILLE, TEXAS

KLEBERG COUNTY, TEXAS

FIGURE:







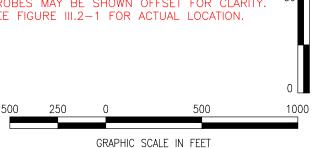
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LEAN CLAY, LEAN CLAY WITH SAND, SANDY LEAN SILTY CLAY FINAL GRADE (CL, CL-ML) TOP OF WASTE CLAYEY SAND (SC) EXISTING GRADE SILTY SAND, POORLY GRADED SAND WITH SILT SUBGRADE (SM, SP-SM) FAT CLAY, SANDY FAT CLAY PIGGYBACK LINER FAT CLAY WITH SAND POORLY GRADED SAND WITH CLAY (SP-SC) GROUND WATER LEVEL (GW) STATIC WATER LEVEL

NOTES:

1. THE ELEVATION OF THE DEEPEST EXCAVATION WITHIN THE FACILITY IS 22.5 FT-MSL LOCATED AT THE SUMPS IN SECTORS 4C, 5, 6, AND 7.

2. GROUNDWATER MONITORING WELLS AND GAS PROBES MAY BE SHOWN OFFSET FOR CLARITY. SEE FIGURE III.2-1 FOR ACTUAL LOCATION.



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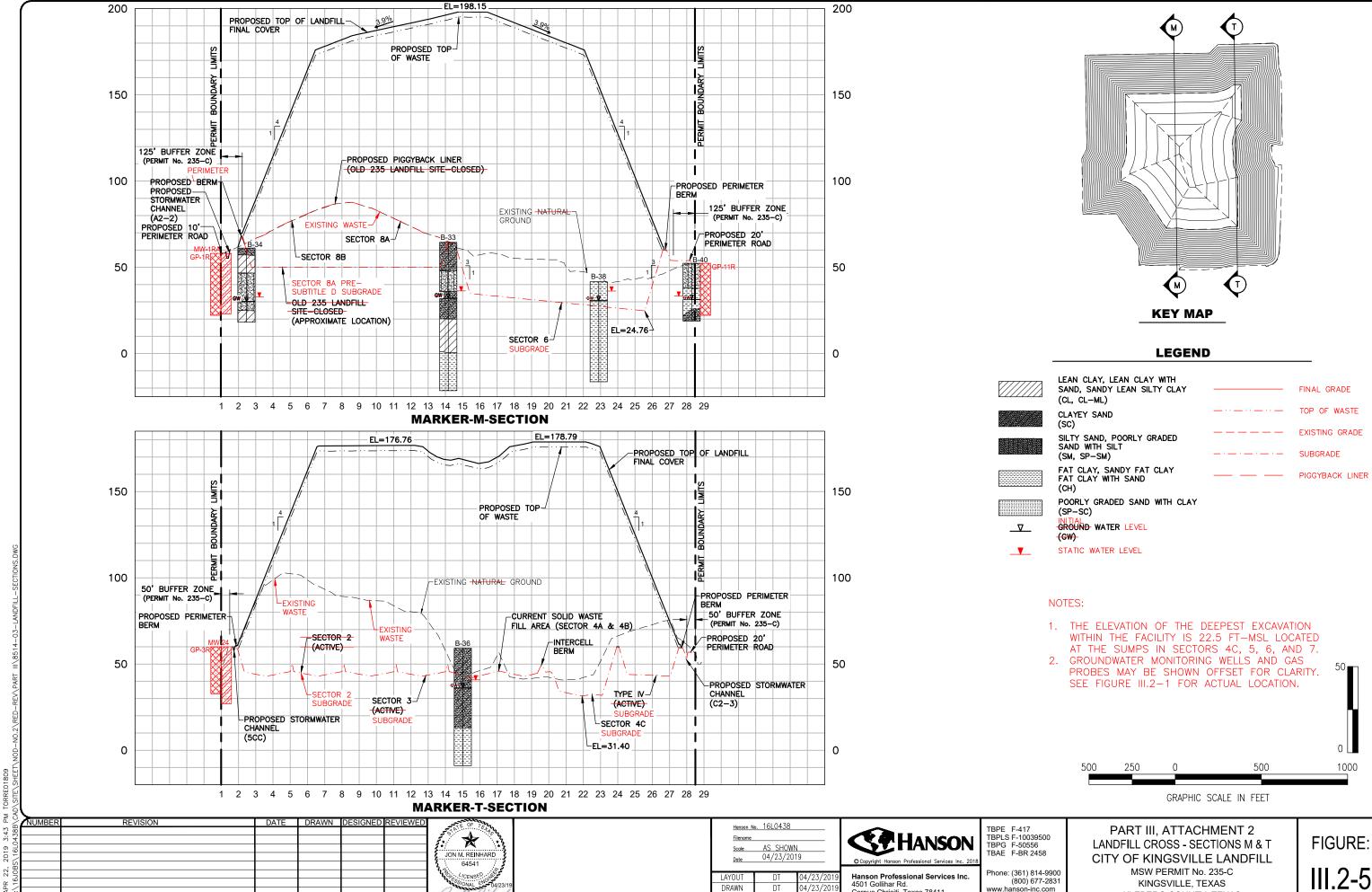
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PART III, ATTACHMENT 2 LANDFILL CROSS - SECTIONS E & H CITY OF KINGSVILLE LANDFILL MSW PERMIT No. 235-C KINGSVILLE, TEXAS

KLEBERG COUNTY, TEXAS

FIGURE:



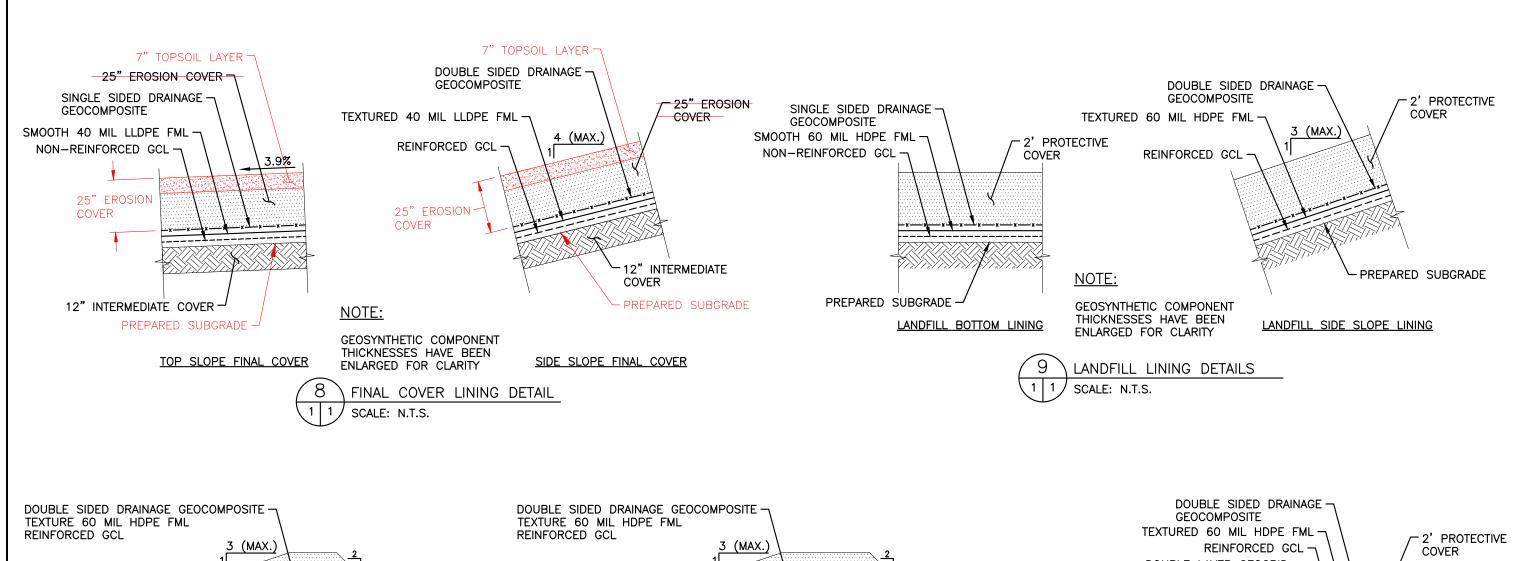
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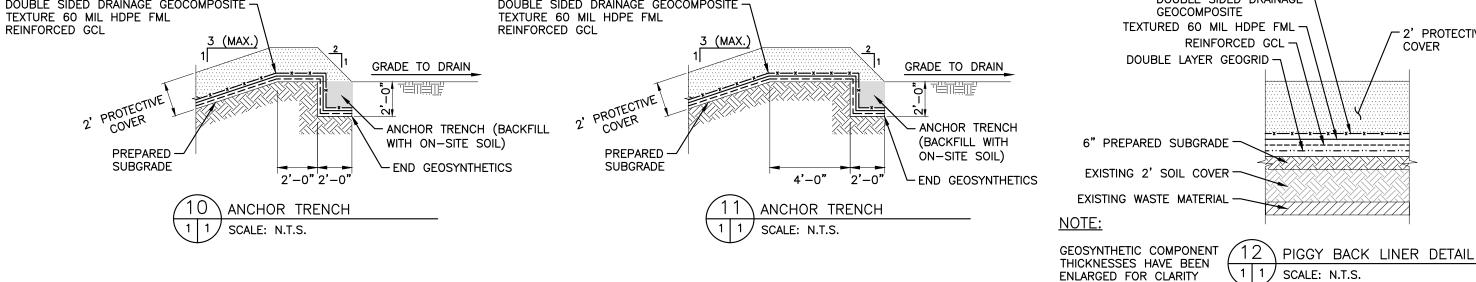
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KLEBERG COUNTY, TEXAS

CITY OF KINGSVILLE LANDFILL PART III ATTACHMENT 3

WASTE MANAGEMENT UNIT DESIGN DRAWINGS





NOTE:

1. ALL LINER SYSTEMS DEPICTED ARE ALTERNATIVE LINER SYSTEMS. ALTERNATIVE LINER DEMONSTRATIONS CAN BE FOUND IN PART III, ATTACHMENT 5.

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PART III, ATTACHMENT 3 LINER DETAILS CITY OF KINGSVILLE LANDFILL MSW PERMIT No. 235-C KINGSVILLE, TEXAS

FIGURE:

THE CITY OF KINGSVILLE LANDFILL TCEQ PERMIT MSW 235C

PERMIT AMENDMENT APPLICATION Volume 2 of 6



CITY OF KINGSVILLE, KLEBERG COUNTY, TEXAS

September 2018
Revision 1 – November 2018
Revision 2 – February 2019
Revision 3 – April 2019

Prepared by



HANSON PROJECT NO. 16L0438-0003

CITY OF KINGSVILLE LANDFILL PART III ATTACHMENT 4 GEOLOGY REPORT

THE CITY OF KINGSVILLE LANDFILL TCEQ PERMIT MSW 235C

PERMIT AMENDMENT APPLICATION PART III, ATTACHMENT 4 GEOLOGY REPORT



CITY OF KINGSVILLE, KLEBERG COUNTY, TEXAS

September 2018 Revision 1 – November 2018 Revision 2 <u>–</u> February 2019

Revision 3 – April 2019



HANSON PROJECT NO. 16L0438-0003

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1.0 INTRODUCTION

1.1 Project Information

The City of Kingsville Landfill is located approximately 1.45 miles southeast of the City of Kingsville city limits, at the northeast corner of the intersection of Farm to Market Road 2619 and East County Road 2130 as shown on Attachment 1- Location Map (Figure III.4-1-1). The initial facility was permitted by the State of Texas in 1977 (Permit No. 235), and initial filling operations began in February 1977. The original 40 acre landfill is currently closed and is not Subtitle D compliant. The City of Kingsville was authorized a permit amendment for a 40-acre lateral landfill expansion of the site in 1986 (Permit No. 235-A). The approved Permit No. 235-A was developed and Sector 1 received its first load of waste material in March 1992. The City of Kingsville was again authorized a permit amendment in 1999 (Permit No. 235-B). This amendment increased the permitted acreage from 80 acres to approximately 120 acres and a maximum height of final cover of 125 feet-msl. The Kingsville Landfill is currently operating under Permit No. 235-B and subsequent permit modifications and/or authorizations.

The City of Kingsville Landfill is currently comprised of 120 acres. The City of Kingsville wishes to increase the capacity of the landfill site via a vertical and horizontal expansion through a permit amendment. The proposed permit amendment will increase the total permitted area to 176.33 acres. This will be accomplished by incorporating additional acreage to the northeast and southwest of the current permitted boundary. The existing active 108-acre waste disposal area will be expanded to a total of 121.3-acres. Other parts of this permit amendment are to; convert the current Type IV waste sector to accept Type I waste, request approval to process and dispose of liquid wastes and used tires, and to revise the floor contour and final contour plans to incorporate the vertical and horizontal expansion previously discussed.

1.2 Scope of Investigation Investigation

The purpose of this study is to provide geological and geotechnical data for the design of the city of Kingsville Landfill. The scope of services included reviewing previous subsurface studies, summarizing the engineering properties of the subsurface materials and determining certain geotechnical design criteria such as estimated settlement and future slope stability.

1.3 Previous Subsurface Investigations

Previous subsurface investigations were conducted for the City of Kingsville Landfill to characterize subsurface conditions and assist with the development of landfill disposal cell designs. The previous testing and soils exploration work was performed by:

- Finch Energy and Environmental Services, Inc. (FEE)
- and Professional Service Industries, Inc. (PSI).

These reports are included in Appendix 1. A total of 23 soil borings were installed at this site at varying depths and testing intervals during these previous investigations. Finch Energy and Environmental Services, Inc. conducted an investigation of subsurface materials at the Landfill location. Twelve (12) soil borings were installed and sampled. Laboratory tests were performed to determine the engineering properties of the subsurface materials. The report discussed the soils, sediments, and geologic and groundwater conditions encountered by FEE, Inc. during the hydrogeological/geotechnical investigations at the City of Kingsville Landfill. The report also discussed the characteristics of the soil samples collected and tested during the investigation.

As requested by the Texas Natural Resource Conservation Commission (TNRCC) in an NOD letter, Professional Service Industries, Inc. also conducted a subsurface investigation for FEE, Inc. and the City of Kingsville to evaluate the soil and groundwater conditions present at the site and to better define the aquiclude below the landfill site. A total of eleven (11) soil test borings were drilled and laboratory tests were performed to determine the engineering properties of the subsurface materials. This additional study discussed the types of subsurface materials encountered in the test borings and the results of the field and other laboratory tests performed for this site.

1.4 Current Subsurface Investigation

As previously identified, the proposed permit boundary for this facility will incorporate 176 acres of land with 128 acres being utilized for waste disposal. In accordance with 30 TAC 330.63 (e)(4)(B), a facility of this size requires 23-26 borings with 13-15 of these borings being installed at least 30 feet below the elevation of deepest excavation (EDE) and the remainder of the borings being installed at least 5 feet below the EDE. Before this subsurface investigation, there were fifteen (15) borings that were installed at least 5 feet below the EDE and four (4) of those borings were installed at least 30 feet below the EDE.

For this investigation, nine (9) soil borings were advanced to a minimum depth of 30 feet below the elevation of the deepest excavation of 22.5 ft and one (1) additional soil boring was advanced to 5 feet below the elevation of the deepest excavation to supplement the existing facility data. The borings were drilled in the locations identified on Attachment 2- Soil Boring Location Map (Figure III.4-2-1). Attachment 2 also identifies the locations of the previously installed soil borings. Attachment 3- Groundwater Contour Map (Figure III.4-3-1) identifies groundwater elevations in addition to the current groundwater monitoring system.

The soil borings for the current subsurface investigation were installed by Tolunay-Wong Engineers, Inc. Representative samples were collected with split-barrel sampling procedures in general accordance with the procedures for "Penetration Test and Split-Barrel Sampling of Soils" (ASTM Designation D-1586) and Standard Practice for Thin-Walled Tube Sampling of Soils for Geotechnical Purposes (ASTM Designation D-1587). Borings were dry-augered using hollow stem augers to advance the boreholes until groundwater was encountered or until the boreholes became unstable and/or collapsed. Wash rotary drilling techniques were used as necessary in order to continue advancing the borings to their required completion depths. No borings collapsed during this investigation. Samples were identified according to boring number and depth, protected against moisture loss, and transported to the laboratory for analysis. After obtaining all required soil samples and groundwater level readings, the soil borings were properly plugged and abandoned in accordance with 16 TAC Chapter 76, Texas Department of Licensing and Regulation (TDLR)-Water Well Drillers and Pump Installers rules. Table 1-1 below identifies specific details for both existing and newly installed soil borings. For this investigation, borings B30 through B41 were installed. These borings were advanced to depths ranging from 33.5 to 86 feet beneath the existing ground surface. Tolunay-Wong Engineers, Inc. prepared a Geotechnical Engineering Study Report that is provided in Appendix 2. Hanson Professional Services also prepared a soil boring report that has been included as Appendix 3.

Table 1-1 Soil Borings

Boring Identification Surface Elevation (ft. bgs) Boring Depth (ft. bgs) Bottom Elevation (ft. AMSL) ≥5 Feet Below Elow Elow Elow Elow Elow Elow Elow E
(ft. AMSL) (ft. AMSL) E.D.E? E.D.E?
Finch Energy and Environmental Services, Inc. Borings
B-1 59.25 42 17.25 YES NO B-2 52.64 27 25.64 NO NO B-3 56.1 37 19.1 NO NO B-4 58.01 39 19.01 NO NO B-5 60.54 48 12.54 YES NO B-6 55.46 38 17.46 YES NO B-7 61.05 36 25.05 NO NO B-8 59.79 43 16.79 YES NO B-9 62.51 44 18.51 NO NO B-9R 41.41 17 24.41 NO NO B-10 49.78 29 20.78 NO NO B-11 60.2 33 27.2 NO NO Professional Service Industries, Inc. Borings B-12 52.38 48 4.38 YES NO B-13 59.13
B-2 52.64 27 25.64 NO NO B-3 56.1 37 19.1 NO NO B-4 58.01 39 19.01 NO NO B-5 60.54 48 12.54 YES NO B-6 55.46 38 17.46 YES NO B-7 61.05 36 25.05 NO NO B-8 59.79 43 16.79 YES NO B-9 62.51 44 18.51 NO NO B-9R 41.41 17 24.41 NO NO B-10 49.78 29 20.78 NO NO B-11 60.2 33 27.2 NO NO Professional Service Industries, Inc. Borings B-12 52.38 48 4.38 YES NO B-13 59.13 50 9.13 YES NO
B-3 56.1 37 19.1 NO NO B-4 58.01 39 19.01 NO NO B-5 60.54 48 12.54 YES NO B-6 55.46 38 17.46 YES NO B-7 61.05 36 25.05 NO NO B-8 59.79 43 16.79 YES NO B-9 62.51 44 18.51 NO NO B-9R 41.41 17 24.41 NO NO B-10 49.78 29 20.78 NO NO B-11 60.2 33 27.2 NO NO Professional Service Industries, Inc. Borings B-12 52.38 48 4.38 YES NO B-13 59.13 50 9.13 YES NO
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B-5 60.54 48 12.54 YES NO B-6 55.46 38 17.46 YES NO B-7 61.05 36 25.05 NO NO B-8 59.79 43 16.79 YES NO B-9 62.51 44 18.51 NO NO B-9R 41.41 17 24.41 NO NO B-10 49.78 29 20.78 NO NO B-11 60.2 33 27.2 NO NO Professional Service Industries, Inc. Borings B-12 52.38 48 4.38 YES NO B-13 59.13 50 9.13 YES NO
B-6 55.46 38 17.46 YES NO B-7 61.05 36 25.05 NO NO B-8 59.79 43 16.79 YES NO B-9 62.51 44 18.51 NO NO B-9R 41.41 17 24.41 NO NO B-10 49.78 29 20.78 NO NO B-11 60.2 33 27.2 NO NO Professional Service Industries, Inc. Borings B-12 52.38 48 4.38 YES NO B-13 59.13 50 9.13 YES NO
B-7 61.05 36 25.05 NO NO B-8 59.79 43 16.79 YES NO B-9 62.51 44 18.51 NO NO B-9R 41.41 17 24.41 NO NO B-10 49.78 29 20.78 NO NO B-11 60.2 33 27.2 NO NO Professional Service Industries, Inc. Borings B-12 52.38 48 4.38 YES NO B-13 59.13 50 9.13 YES NO
B-8 59.79 43 16.79 YES NO B-9 62.51 44 18.51 NO NO B-9R 41.41 17 24.41 NO NO B-10 49.78 29 20.78 NO NO B-11 60.2 33 27.2 NO NO Professional Service Industries, Inc. Borings B-12 52.38 48 4.38 YES NO B-13 59.13 50 9.13 YES NO
B-9 62.51 44 18.51 NO NO B-9R 41.41 17 24.41 NO NO B-10 49.78 29 20.78 NO NO B-11 60.2 33 27.2 NO NO Professional Service Industries, Inc. Borings B-12 52.38 48 4.38 YES NO B-13 59.13 50 9.13 YES NO
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B-10 49.78 29 20.78 NO NO B-11 60.2 33 27.2 NO NO Professional Service Industries, Inc. Borings B-12 52.38 48 4.38 YES NO B-13 59.13 50 9.13 YES NO
B-11 60.2 33 27.2 NO NO Professional Service Industries, Inc. Borings B-12 52.38 48 4.38 YES NO B-13 59.13 50 9.13 YES NO
Professional Service Industries, Inc. Borings B-12 52.38 48 4.38 YES NO B-13 59.13 50 9.13 YES NO
B-12 52.38 48 4.38 YES NO B-13 59.13 50 9.13 YES NO
B-13 59.13 50 9.13 YES NO
B-14 49.94 42 7.94 YES NO
B-15 48.39 37 11.39 YES NO
B-16 55.96 47 8.96 YES NO
B-17 41.35 33 8.35 YES NO
B-18 50.04 42 8.04 YES NO
B-21 52.41 84 -31.59 YES YES
B-23 49.5 86 -36.5 YES YES
B-24 47.38 72 -24.62 YES YES
B-25 61.12 88 -26.88 YES YES
Tolunay-Wong Engineers, Inc. Borings
B-30 45.99 82.5 -36.51 YES YES
B-31 58.37 68 -9.63 YES YES
B-32 48.46 82.5 -34.04 YES YES
B-33 64.51 86 -21.49 YES YES
B-34 61.14 43 18.14 NO NO
B-35 64.5 72.5 -8 YES YES
B-36 59.13 68 -8.87 YES YES
B-37 45.52 48 -2.48 YES NO

Boring	Surface	Boring Depth	Bottom	≥5 Feet	≥30 Feet
Identification	Elevation	(ft. bgs)	Elevation	Below	Below
	(ft. AMSL)		(ft. AMSL)	E.D.E?	E.D.E?
B-38	41.64	58	-16.36	YES	YES
B-39	60.26	68	-7.74	YES	YES
B-40	52.31	33.5	18.81	NO	NO
B-41	50.2	62.5	-12.3	YES	YES

E.D.E.-Elevation of Deepest Excavation (22.5' Above Mean Sea Level (AMSL))

Locations of borings B-32, B-33, B-34, B-35, B-38 and B-40 deviated from locations specified in the soil boring plan due to boring locations being unknowingly moved from original locations during installation. These deviations were identified when the boring locations were surveyed. The distance of boring location deviation varied from approximately 90 feet in B-35 to approximately 440 feet in B-33. With the information obtained during previous subsurface investigations, these discrepancies did not affect the ability to obtain the needed information identified in 30 TAC §330.63(e)(4)(A).

Borings B-34 and B-40 were not drilled to 5 foot below EDE due to the boring locations being unknowingly moved from the original locations during installation. Boring B-34 was 0.64 feet short of 5 foot below EDE and B-40 was 1.31 feet short of 5 foot below EDE. Although these borings were not drilled to the target depth, the information obtained from these borings is useful in characterizing the subsurface conditions at the facility and was used for that purpose. Other borings installed at the site in conjunction with the current subsurface investigation are adequate in meeting the requirements identified in 30 TAC §330.63(e)(4)(B).

2.0 REGIONAL INFORMATION

2.1 Regional Physiography

As discussed in Finch Energy and Environmental Services' Report (Appendix 1, Section 2.0, Page 11-12), the site of the landfill is located in the part of the Gulf Coastal Plain that has been defined as the Coastal Bend of Texas. The coastal plain is gently, but irregularly, inclined gulfward at about 5 feet or less per mile. In many areas, coastal plain slopes range from 1 to 3 feet per mile, and on the lagoonal wind-tidal flats, slopes are usually less than 1 foot per mile. Elevations within the county range from 0 feet (Gulf of Mexico) to 125 feet above Mean Seal Level (MSL) in the extreme northwestern part. It is characterized as an arid, desert like region where wind (Eolian) erosion and wind transported sediment have determined much of the area's character and distinctiveness. The surface features of the county are broad, dune covered mainland prairies and extensive coastal wind-tidal flats.

Eolian transport of silts and sands has produced the South Texas Eolian System (Sand Sheet). Extensive, hummocky prairies within the South Texas sand sheet are underlain by relic sand dunes and wind-deflated depressions which extend inland from broad wind-tidal flats along the landward margin of Laguna Madre and parts of Baffin Bay.

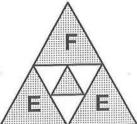
2.2 Regional Stratigraphy

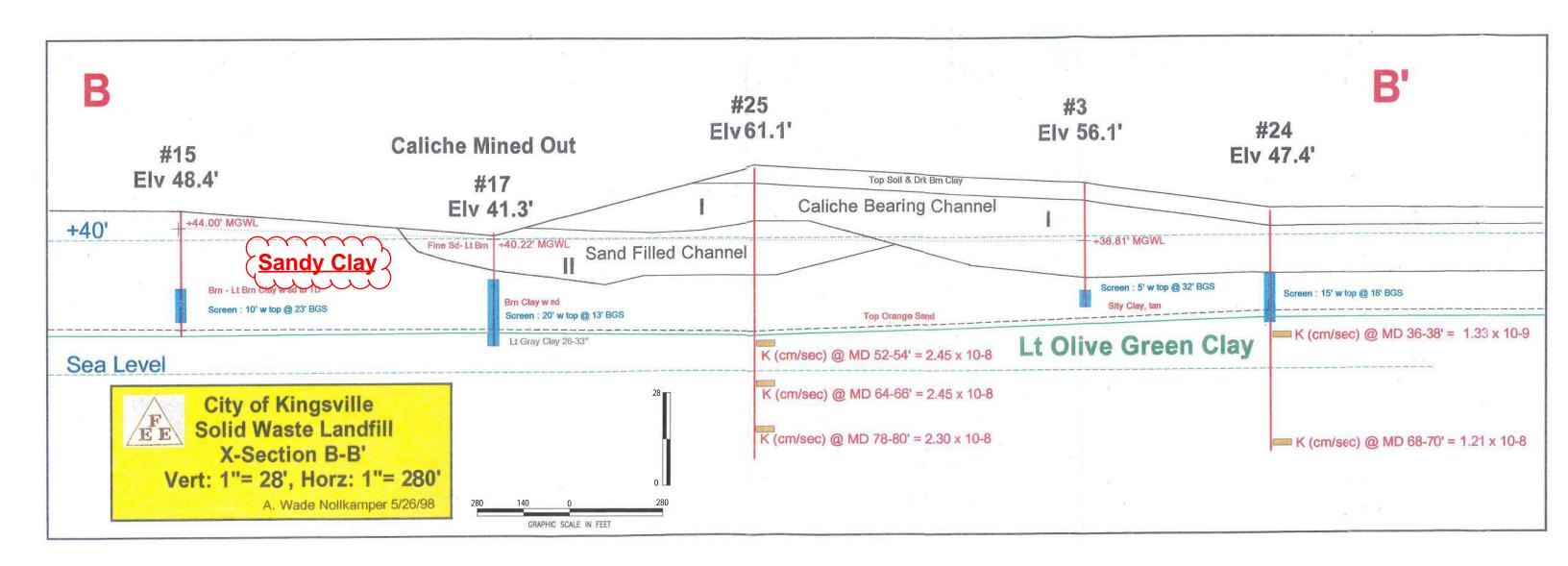
Table 2-1 presents the geologic formations that characterize the regional stratigraphy of Kleberg County.

ATTACHMENT 4 Geology Report

For Permitting Purposes Only. Applies to pages of Attachment 4 – Finch Energy & Environmental Services, Inc. Geology Report, sealed by Ray N. Finch, P.E. on 6-26-98 and 9-30-98 altered to provide a clean and legible copy and includes pages: 3, 3.0 Cover Page, 8, 9, 15 - 17,22 - 25, 29 – 30, 33 - 35, 39 - 46, 48 – 60, 60a, 62 - 98, 100 - 101, 104, 108 – 109, and D-32 - D-46 and K-1 – K-12. No information or data was altered or changed from the original 6-26-98 and 9-30-98 Geology Report other than text scale corrections on pages 48-60. Bar scales were also added to pages 48-60.

Finch Energy & Environmental Services, Inc. P.O. Box 73/1204 W. King, Kingsville, TX 78364 Phone: (512) 592-9810 Fax: (512) 592-5552





THE CITY OF KINGSVILLE LANDFILL TCEQ PERMIT MSW 235C

PERMIT AMENDMENT APPLICATION Volume 3 of 6



CITY OF KINGSVILLE, KLEBERG COUNTY, TEXAS

September 2018
Revision 1 – November 2018
Revision 2 – February 2019
Revision 3 – April 2019

Prepared by



HANSON PROJECT NO. 16L0438-0003

ATTENTION OWNER: Confidentiality Privilege Notice on on reverse side of Well Owner's copy (pink)			State WELL				Texas W	P.O. Box Austin, TX 7	177 x 13087	/ Cat
	OWNER PTY OF KILLSVILLE ADDRESS OF WELL: County (Street, RFD or other)									
3) TYPE OF WORK (Check): New Well Deepening Reconditioning Plugging	4) PROPOSED Industrial	DUSE (C	check):	Monitor njection	Pub	Environmental So	oil Boring Dor e-watering Test	omestic 5	5), MW-1 (5B-1	12
6) WELL LOG: Date Orilling: Started 7 - 7 19 9 7 Completed 7 - 7 19 9 7	- 15	om (ft.)	To (ft.)		Air F	er	Rotary Sored ble Tool Detter	d ed		
					8) Borehole Completion (Check): Open Hole Straight W. Underreamed Gravel Packed Other 6/30 - If Gravel Packed give interval from 35.0 ft. to 25.					
				CAS	1	1	WELL SCREEN DA			
				Dia.	or Used	Steel, Plastic, Perf., Slotted, Screen Mfg., if	etc.	Settin	ng (ft.) To	900
				y	N		LOC	150	72.5	
(Use reverse side of Well Ow 13) TYPE PUMP: ://r'					Method Cement Distanc	dused	tile 338.44(1)] ft. to C · O ft. to PST T. If field lines or other of the composed distance	_tt. No. of sa	acks used	
Depth to pump bowls, cylinder, jet, etc.,	sible Cylinder		-	10)	SURFA P	ACE COMPLETION ecified Surface Slab	N b Installed [Rule 33			
Depth to pump bowls, cylinder, jet, etc.,ft. 14) WELL TESTS: \(\textstyle \textstyle A \) Type test: \(\textstyle \textstyle P \textstyle m \textstyle Bailer \textstyle Jetted \textstyle Estimated \\ Yield: \textstyle gpm with \textstyle ft. drawdown after \textstyle hrs.		Specified Steel Steeve Installed [Rule 338.44(3)(A)] Pitiess Adapter Used [Rule 338.44(3)(b)] Approved Alternative Procedure Used [Rule 338.71] 11) WATER LEVEL: 1.0/A								
15) WATER QUALITY: Did you knowingly penetrate any strata constituents?				_		in flow	tt. below land surface		Depti	
Type of water?	Yes ⊋'Ño If yes, submit "REPORT OF UNDESIRABLE WATER" Type of water? Depth of strata Was a chemical analysis made? Yes No			3.5			suers	/		
	thru 15 will result in th			ed for cor	mpletion		,	of my knowledg		
Time	pe or print)						577 .	TZ.	700	. ,

ATTENTION OWNER: Cordidentiality Privilege Notice on on reverse side of Well Owner's copy (pink)		State WELL			r	Texas Wes	ter Well Drill MC P.O. Bo Austin, TX 512-23	x 13087 78711-3087	Cou
		Kin							
3) TYPE OF WORK (Check): New Weil Despering Reconditioning Plugging	☐ Industrial ☐	jection [Publi	ic Supply De-waterin	g 🗆 Testw	1	15B-		
6) WELL LOG: Date Drilling: Started Completed 77 77 19 77	LOG: DIAMETER OF HOLE Dia. (in.) From (it.) To (it.) 19 7 C Surface 50.0			7) DRILLING METHOD (Check): Driven Alr Rotary Mud Rotary & Sored					
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			-	New I	Steel, Plastic, etc.	CHEEN DAT	Settin	q (ft.)	Ga
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			4	V	TRI-LO PUC RISGA	-	:0.0	72.5	.0
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Turbine		10) SURFACE COMPLETION Specified Surface Stab Installed [Rule 338.44(2)(A)] Specified Steel Sleeve Installed [Rule 338.44(3)(A)] Pitless Adapter Used [Rule 338.44(3)(b)] Approved Alternative Procedure Used [Rule 338.71]							
	which contained undesira	ble	S	tatic len	flowft. below	gpm.	Date		
Type of water?	Depth of strata		12) P.		ns: Note Pecce		Type Type	Depti	
understand that failure to complete items 1	thru 15 will result in the log	(s) being returne	d for comp	oletion	and resubmittal.		my knowledg		1
COMPANY NAME			_						
1131					CHR 1571		2	2841	6

K-2 <u>MW-13</u>

ile WHITE COPY with: NRCC \ Box 13087, MC 177 stin, TX 78711-3087 12-239-0530		within 30 days following the required by curre	G REPORT ed and filed with the TNRCC e date the well is plugged as ent statutory law.)	P.O. E Austin, T	rillers Advisory Council sox 13087 X 78711-3087 239-0530
		A. WELL IDENTIFICATION	ON AND LOCATION DATA		
OWNER OF WELL:	(Name)	SHOU (ANTICE (Street RED or other)	(City) (State)	PINES U (CE TX (City) (Zip) GRID#	18563 (State) (Zip) 53-54-4
(NOTATION ON THE STATE OF THE S	ww	4) WELLTYPE (Check):	Water □ Monitor □ Inje		5)
			the state of the s	thin a specific grid on a full	
cale-gridded County map av placing a corresponding dot i	n the grid to the right. The	igging operations must locate an installers Certification Program. To legal description section below is	nd identify the location of the well with the location of the well should be described optional.	enoted within the grid by	
LEGAL DESCRIPTION:	NE				
Section No	Block No.	Townsh	ip	200	
Abstract No	Survey Na	me			
Distance and direction f	rom two				
	s or survey lines:	B. HISTORICAL DATA ON WE	ELL TO BE PLUGGED (if available 1694-177	e)	1975TV
5) Driller / / S	97	e) Diameter of hole	C' inches: 9) Total de	epth of well	feet.
r) Drilled	19;	B) Diameter of flore	10.00		
	6	C. CURRENT	PLUGGING DATA		
Date well plugged					
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12) Sketch of well: Using sincluding all casing and cas	pace at right, show methor cemented intervals. Installer actually performing the following state of the plugging data relative to the plugging the following state of the plugging that is a state of the plugging that it is a state of the plugging that is a state of the plugging that it i	the plugging operations Ig operations: EFT IN WELL TO (feet) CEMENT USED D. VALIDATION OF INFO	DRMATION INCLUDED IN FORM ach and all of the statements hereigned for completion and resubmitting	n are true to the best of my kr	EFFCE.
11) Sketch of well: Using sincluding all casing and 12) Name of Driller/Pump Ir License number 13) Casing and cementing DIAMETER (inches) CEMENT PLUFROM (feet) I hereby certify that this well understand that failure to company or Individual's National Company or Individual Company o	pace at right, show methor cemented intervals. Installer actually performing the following state of the plugging data relative to the plugging the following state of the plugging that is a state of the plugging that it is a state of the plugging that is a state of the plugging that it i	the plugging operations Ig operations: EFT IN WELL TO (feet) CEMENT USED D. VALIDATION OF INFO	DRMATION INCLUDED IN FORM ach and all of the statements herein the properties of the statements of the statement of the	n are true to the best of my kral.	nowledge and belief. I
11) Sketch of well: Using sincluding all casing and cas	pace at right, show methor cemented intervals. Installer actually performing the state of the plugging data relative to the plugging the state of the plugging that is the plugging that it is the plugging that it is the plugging that is the plugging that it is the plugging th	the plugging operations Ig operations: EFT IN WELL TO (feet) C SACK(S) OF CEMENT USED D. VALIDATION OF INFO	DRMATION INCLUDED IN FORM ach and all of the statements herein the properties of the statements of the statement of the	n are true to the best of my kr	E.F. SCR.
Sketch of well: Using sincluding all casing and 12) Name of Driller/Pump Ir License number License number DIAMETER (inches) CEMENT PLUFROM (feet) COMPANY CONTROL OF THE CONTROL OF TH	pace at right, show methor cemented intervals. Installer actually performing the following state of the plugging data relative to the plugging the following state of the plugging that is a state of the plugging that it is a state of the plugging that is a state of the plugging that it i	the plugging operations Ig operations: EFT IN WELL TO (feet) C SACK(S) OF CEMENT USED D. VALIDATION OF INFO	DRMATION INCLUDED IN FORM ach and all of the statements herein the properties of the statements of the statement of the	n are true to the best of my kral.	nowledge and belief. I

	WELL REPORT P.O. Box 13067 Austin, TX 78711-3087 512-239-0530
	ADDRESS PO. BOX 148 KILLSVILLS 72 783 (Street or RFD) (City) (State) (ANDFILE KINLSVILLE TZ GRID: 83-34 other) (City) (State) (Zp)
3) TYPE OF WORK (Check): A New Well Deepening Industrial C	Check): DMonitor
6) WELL LOG: Date Drilling: Started 7-8 19 97 Completed 7-3 19 97	To (ft.) Air Rotary Mud Rotary Sored Air Hammer Cable Tool Jetted Other
From (ft.) To (ft.) Description and color of forms	Straight Wall Gravel Packed Straight Wall Gravel Packed Straight Wall Gravel Packed Straight Wall Gravel Packed Straight Wall Gravel Packed give interval from 35.0 ft. to 23.0
	CASING, BLANK PIPE, AND WELL SCREEN DATA: Dia
(Use reverse side of Well Owner's copy, if necessary 13) TYPE PUMP: // /* Turbine	Method used Cemented by Distance to septic system field lines or other concentrated contamination Method of verification of above distance 10) SURFACE COMPLETION Depectified Surface Slab installed [Rule 338.44(2)(A)]
14) WELL TESTS: Type test: Pump Bailer Jetted Estr	Specified Steel Sleeve Installed
15) WATER QUALITY: Did you knowingly penetrate any strata which contained undesiconstituents? Yes No If yes, submit "REPORT OF UNDESIRABLE Type of water? Depth of strata Was a chemical analysis made? Yes No	Static level ft. below land surface Date Artesian flow gpm. Date NATER* Type Depth
understand that failure to complete items 1 thru 15 will result in the lo	n) and that each and all of the statements herein are true to the best of my knowledge and belief. I s) being returned for completion and resubmittal. WELL DRILLER'S LICENSE NO. 4674-17 (City) (State) (State)

Printege Notice on an reverse side of Well Owner's copy (pink)	State WELL!		RT		MC 1 P.O. Box Austin, TX 7 512-239	13087 8711-3087
1) OWNER 114 PF (C. UCSUT) (Name) 2) ADDRESS OF WELL: 116 K	ADDRE	iss Po	Box 1452 (Street or RFD) (AUSVICA (State)	(City (Zip)	GRID#	72 7: (Sune) \$3-34
3) TYPE OF WORK (Check): 4) (PROPOSED USE (Check):	rMonitor jection [] [Environmental Soil Public Supply 📋 De-	Bonng Dom watering Testw	estic 5	153-13
6) WELL LOG: Date Drilling: Started 18 Completed 18		0	LLING METHOD (Che id Rotary [] Mud R Mr Hammer [] Cabi Other	lotary Sole d		
From (ft.) To (ft.) Description and	color of formation material	#64	avel Packed give inter	iravelPacked E val from 33	O h to	Straight Wall / 30 S/ 4 o _ m/ / C
		CASING. Ola olin in Us	Pert., Slotted, e ed Screen Mig., if	itc	Settin	To
		41	781-20 1 700 11	c SCA	130	+015
(Use reverse side of Weil Owner's co	opy, d necessary)	Meti Cerr Dist	RENTING DATA (Runanted from // Condused nerved by ance to septic system in nod of verifications of about	F 57 7.0	tt. No of sav	cks used
Other Depth to pump bowis, cylinder, jet etc.	ħ	10) SUF	REACE COMPLETION Specified Surface Stab Specified Steel Steeve I	Installed {Rule 338 Installed {Rule 338 (Rule 338.44(3)(b))	3.44(3)(A)]	
Type test: Pump Bailer Je Yield gpm with ft dra 15) WATER QUALITY: Did you knowingly penetrate any strata which c		11) WA	TER LEVEL: 4 // ic level !	A. below land surface	e Date	
constituents? Yes No If yes, submit 'REPORT O' Type of water? Depth Was a chemical analysis made? Yes	F UNDESIRABLE WATER*	12) PAC	KERS:		Туре	Depth 2/ C -
Ehereby certify that this well was drilled by me for ununderstand that failure to complete items I thru 15 w	will result in the log(s) being returne	d for comple		,	my knowledg	
ADDRESS Street or RFD)	rd 1		05 CH2	571		

ATTENTION OWNER: Confidentiality Privilege Notice on on reverse side of Well Owner's copy (pink)			Texas Water Well Drillers Advisory Co MC 177 P.O. Box 18067 Austin, TX 78711-3087 512-239-0530							
1) OWNER 144 OF KIND	•					(City)	7836 (State)			
County CECE26	KINGS VILL & (Street, RFD or	CANDEN Other)	16	K, A	(State) (Zip)	GRID#	83-3	3		
3) TYPE OF WORK (Check): (I) New Well Despening (I) Reconditioning Plugging		migation Inj	ection	☐ Publ	Environmental Soil Boring		15B7			
6) WELL LOG:	DIAMETER OF H	IOLE	n	DRILLI	NG METHOD (Check): Dri	iven				
Date Drilling: Started 7-10 19 97 Completed 7-10 19 97	Dia. (in.) From (it.) // O Surface	To (ft.)	Air Rotary Mud Rotary Sored Air Hammer Cable Tool Jetted Other							
From (ft.) To (ft.) Descript	tion and color of formation	n material	1	☐ Unde	lerreamed Gravel Packed	Open Hole Open Hole Other 16 HO O R. 1	Straight Wall / 30 S/ to 28.0	12		
					ANK PIPE, AND WELL SCREEN	DATA:				
	0	Dia.	New	Steel, Plastic, etc. Perl., Slotted, etc. Screen Mig., if commercial	Settin	ng (ft.)	Γ			
			(in.)	N	OC BUGGEN MY		300	+		
			4	N	PUC RISHR	0.0	+2.5	L		
(Use reverse side of Well On				Method i Cement Distance	used	tt. No. of sa	acks used			
☐ Turbine ☐ Jet ☐ Submers ☐ Gitter Depth to pump bowls, cylinder, jet, etc.,				Depen	CE COMPLETION cified Surface Slab Installed [Rul					
	☐ Jetted ☐ Estima			Pitte:	icified Steel Steeve Installed [Rule ass Adapter Used [Rule 338.44(3 proved Alternative Procedure Used R LEVEL: V/A	I)(b)]				
	Yield:gpm withft. drawdown afterhrs. WATER QUALITY: Did you knowingly penetrate any strata which contained undesirable				recevel: A 7 7 7 7 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1			_		
constituents? Yes Alo If yes, submit "REF Type of water? Was a chemical analysis made?			PACKE	ERS: FONTE - FILET	Type /	Depti				
I hereby certify that this well was drilled by n understand that failure to complete items 1 to COMPANY NAME	thru 15 will result in the log(s	s) being returned	ed for cor	mpletion	and resubmittal.	4694	- m			
ADDRESS 810	se or print)	(7 2	205	CH.21511	D	7841	1		

ATTENTION OWNER: Confidentiality Privilege Notice on on reverse side of Well Owner's copy (pink)	State WELL			1407	Texas Water Well Drillers Advisory C MC 177 P.O. Box 13087 Austin, TX 78711-3087 512-239-0530				
1) OWNER CITY OF HINL	SVILLE ADDRE	ss 2	0.	BOX 1458 KING	SUILLE	72 7/			
	KINGS VICER LANDS (Street, RFD or other)					£3-3			
3) TYPE OF WORK (Check): New Well Despening Reconditioning Plugging	4) PROPOSED USE (Check): Industrial Inrigation In Information In Public Supply well, were plans su	ection	☐ Pub	lic Supply De-watering	☐ Domestic ☐ Testwell	51,114)-			
6) WELL LOG: Date Orilling: Started 7-9 19 97 Completed 7-9 19 97	7) DRILLING METHOD (Check): Driven Air Rotary Mud Rotary Sored Air Hammer Cable Tool Jetted Other								
From (ft.) To (ft.) Descripti	8)	Und	erreamed Gravel Packe	Open Hole of Other_ 33.0	Straight Wall				
		CAS	ING, BL	ANK PIPE, AND WELL SCRE	EN DATA:				
	Dia. (in.)	New or Used	Steel, Plastic, etc. Perl., Slotted, etc. Screen Mfg., if commercial		etting (ft.)				
	(Use reverse side of Well Owner's copy, if necessary) i3) TYPE PUMP: U - Turbine				OC 13.0				
13) TYPE PUMP: U A Turbine Jet Submersi Other Depth to pump bowls, cylinder, jet, etc.,					ft. No. of	f sacks used			
Type test: Pump Bailer Yield: gpm with		11)	Appl WATER	ss Adapter Used [Rule 338.4/ roved Afternative Procedure Us I LEVEL: N A	ed [Rule 338.71]	nto			
Did you knowingly penetrate any strata constituents? Yes [YNO If yes, submit 'REP Type of water?	12)	Artesiar PACKE	n flow	pm. De	Dept				
I hereby certify that this well was dniled by munderstand that failure to complete items 1 the COMPANY NAME.	nru 15 will result in the log(s) being returne	d for co	NELL D	and resubmittal. RILLER'S LICENSE NO	469	4- m			
ADDRESS (Street or (Signed)	(RFD)	10.	City)	CH21571	(State)	(2)			

ATTENTION OWNER: Confidentiality Privilege Notice on on reverse side of Wall Owner's copy (pink)		WELL	REF	POR	- 11	Aus	MC* P.O. Box tin, TX 7 512-231	177 x 13067 78711-3067 9-0530		
1) OWNER CHY OF K: NBS. (Nan County KEEL: ARE		E LAN								
3) TYPE OF WORK (Checit): P New Well Despening Reconditioning Plugging		rigation In	ection	☐ Pub	Environmental Soil Boring tic Supply De-watering NRCC? Yes No.		5	15B-R	(8)	
6) WELL LOG:	DIAMETER OF H	OLE	7	DRULL	NG METHOD (Check):	☐ Driven				
Deta Drilling: 9 19 9-7 Started 7 - 9 19 77 Completed 7 - 9 19 77	Dia. (in.) From (ft.) SUrface	Jo (ft.) 4d·0		Alr R	lotary Mud Rotary lammer Cable Tool	Bored				
rom (ft.) To (ft.) Description and color of formation material			8)	☐ Und	ele Completion (Check): erreamed	Open Hole	12 16 1	Syraight Wall 130 S/C 0 19.0	10	
					ANK PIPE, AND WELL SO	IK PIPE, AND WELL SCREEN DATA:				
		Din. (in.)	New or Used	Steel, Plastic, etc. Perf., Slotted, etc. Screen Mig., If commen	cial	Settin	g (ft.)	GCS		
			2	N	PUC SCRAGA INFG. TRI- PUC KISA	LOC	20	220	. 6	
			9)	CEMEN	TTING DATA [Rule 338.44 led from 17.0 ft. to	(1)1 3.0 n	vo. of sa	cks used 3	. 6	
(Use reverse side of Well Ow	ner's copy, if necessary)			Method Cement	used PS	I IN	C. Of SE	CKS USEC		
TYPE PUMP:			10)	Method	e to septic system field lines of verification of above dista CE COMPLETION		ntrated co	ontamination		
Depth to pump bowls, cylinder, jet, etc., 14) WELLTESTS: V A Type test: Pump Bailer	☐ Jetted ☐ Estimat			☐ Speci	cified Surface Slab Installed cified Steel Sleeve Installed as Adapter Used [Rule 33] roved Alternative Procedure	[Rule 338.44(3 8.44(3)(b)]	B)(A)]			
15) WATER QUALITY: Did you knowingly penetrate any strata constituents?			11)	Static le	RLEVEL: N/A Problem Pro		Date_			
Yes S'No If yes, submit "REP Type of water?		VATER*		PACKE	RS:	Type 1973	12'	, Depth		
I hereby certify that this well was drilled by m understand that failure to complete items 1 th	e (or under my supervision yru 15 will result in the log(s) being returne	d for co	mpletion	atements herein are true to and resubmittal. RILLER'S LICENSE NO.			-m		
(typ	o no busin					-		175111	1	
ADDRESS 210 (RFD)	0.0	20	05	CH121571	14		7841	100	

K-9

end original copy by certified return receipt re	quested mail to: TNRCC, N	MC 177, P.O. Bo	ox 130	87, Austi	n, TX 78711-3087			MW	<u>-21</u>		
ATTENTION OWNER: Confidentiality Privilege Notice on on reverse side of Well Owner's copy (pink)		State of WELL I			T	Texas Wa	s Water Well Drillers Advisory Cou MC 177 P.O. Box 13087 Austin, TX 78711-3087 512-239-0530				
1) OWNER City of Kingsville	me)	ADDRE	ss F	.O. Ec	> 1458 (Street or RFD)	Kingsville (Cit		(State)	63 (Zip)		
2) ADDRESS OF WELL: County Kleberg	Kingsville Lar (Street, RFD or			sville City)	Texas (State)	(Zip)	GRID#	83-34-	Ļ		
3) TYPE OF WORK (Check): New Well Deepening Reconditioning Plugging	New Well Deepening Industrial Irrigation					atering Testv		5)			
6) WELL LOG:	DIAMETER OF H	IOLE	7)	DRILLI	NG METHOD (Check	k): Driven					
Date Drilling: Started 4-27 19 98 Completed 4-27 19 98	Drilling: Dia. (in.) From (ft.) To (ft.) d 4-27 19 98 6.0 Surface 84.0					ary ᢓ Bored. Tool ☐ Jetted	co.		Ń		
From (ft.) To (ft.) Descript	tion and color of formation	n material	8)	Boreho	le Completion (Che	ck):	Hole	Straight Wall			
sec attached log MK-21	A. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1.	(e.t.)	☐ Und		avelPacked £	Other_gr	out				
			CAS	SING, BL	ANK PIPE, AND WE	LL SCREEN DA	TA: N/A				
								ng (ft.)	Gage Casting		
			(in.)	Used	Screen Mfg., if co	ommercial	From	То	Screen		
	THE CHANGE										
3			9)	Cement Method Cement	edby P.	ft.to 0.0 ft.to d with 5% be	ft. No. of sa entonite	icks used			
(Use reverse side of Well Ov 13) TYPE PUMP: N/A	vner's copy, ii necessary)			Distance to septic system field lines or other concentrated contaminal Method of verification of above distance							
Other Depth to pump bowls, cylinder, jet, etc.,	ft.	_	10) SURFACE COMPLETION ÎI/A Specified Surface Slab Installed [Rule 338.44(2)(A)] Specified Steel Sleeve Installed [Rule 338.44(3)(A)] Pitless Adapter Used [Rule 338.44(3)(b)]								
14) WELLTESTS: N/k Typetest: □ Pump □ Bailer	☐ Jetted ☐ Estimat	ted		Charles Co.	oved Alternative Pro						
Yield:gpm with 15) WATER QUALITY:	ft. drawdown after		11)	Static le	LEVEL: N/AS velft.t		e Date	/			
Did you knowingly penetrate any strata constituents? Yes & No If yes, submit "REF		12)	PACKE	RS: N/A		Туре	Dept	'n			
Type of water?	Depth of strata Yes ☐ No										
I hereby certify that this well was drilled by munderstand that failure to complete items 1 the	ne (or under my supervision) hru 15 will result in the log(s)	and that each a being returned	and all	of the sta	atements herein are t and resubmittal.	true to the best of	my knowledo	ge and belief.	I		
OMPANY NAME PS! Inc. (Type or print)				WELL DI	RILLER'S LICENSE	но	4694	-ti			
ADDRESS 810 SPID (Street o	(RFD)			Co (City)	rpus Christi		Texa (State)	3 (Zi	78416 0)		
(Signed) / (Licensed	Well Driller)			(Signed)		(Registered	Driller Traine	e)			
Ple	ase attach electric log, che	emical analysi	s, and	other pe	rtinent information	, if available.					

Part III

K-10 MW-23

ATTENTION OWNER: Confidentiality Privilege Notice on on reverse side of Well Owner's copy (pink)		State WELL			Γ	Texas Wa	Texas Water Well Drillers Advisory C MC 177 P.O. Box 13087 Austin, TX 78711-3087 512-239-0530				
OWNER Kingsmille City	of	ADDRE	ESS	P.0.	Box 1458 Κ1	ngsvijje Te	exas 783	63			
(Na	me)			(3	Street or RFD)	(City)	(State)	(Zip)		
2) ADDRESS OF WELL: County Kleberg	Kingsville La (Street, RFD o			ville (City)	Texas (State)	(Zip)	GRID# _	83-34-4	-		
3) TYPE OF WORK (Check): New Well Deepening Reconditioning F Plugging		Irrigation In	jection	☐ Publi	Environmental Soil Bor cSupply		1127	5)			
) WELL LOG:	DIAMETER OF	HOLE	7)	DRILLIN	G METHOD (Check):	☐ Driven					
Date Drilling: Started 4-24 19 95 Completed 4-24 19 95	Dia. (in.) From (ft.)	To (ft.)			otary		6		ń		
STATE	tion and color of formation	on material	8)		e Completion (Check	k):		Straight Wall			
see attached lag Mw-23			-	_	Packed give interval			to	ft.		
			600	CINC DI	ANK PIPE, AND WEL	I COREEN DAT	ra-N/A	OANTE .			
		THE THE PART OF SAME	CAS	1 1	Steel, Plastic, etc.	L SCHEEN DAT		ing (ft.)	Cana		
		Dia. (in.)		Perf., Slotted, etc. Screen Mfg., if com	mercial	From	To	Gage Castin Scree			
(Use reverse side of Well Owner's copy, if necessary)				Method u Cemente Distance	sednixed dbyf to septic system field	with 5% b	entonit	e			
3) TYPE PUMP: N/A ☐ Turbine ☐ Jet ☐ Submers	ble		10)	. (340), ((200)	of verification of above	1/A					
Depth to pump bowls, cylinder, jet, etc.,	ft.		, and the	☐ Speci	fied Surface Slab Insta	alled [Rule 338	.44(2)(A)]				
4) WELLTESTS: Type test: Pump Bailer				Pitles	fied Steel Sleeve Insta s Adapter Used [Rul oved Alternative Proce	e 338.44(3)(b)]					
Yield:gpm with	_ ft. drawdown after		11)	Static lev	LEVEL: N/A el ft. be						
constituents? Yes No If yes, submit "REP Type of water?	ORT OF UNDESIRABLE		12)	PACKER	s: N/A	Т	уре	Depti	h		
Was a chemical analysis made?											
hereby certify that this well was drilled by m nderstand that failure to complete items 1 th	e (or under my supervision aru 15 will result in the log(n) and that each s) being returned	and all	of the stat	ements herein are tru nd resubmittal.			ge and belief,	1		
	PSI INC.		_	WELL DR	ILLER'S LICENSE N	045	94-M		-		
OMPANY NAME(Tvp	e or print)										
OMPANY NAME	e or print)			Cor	pus Christi		Texa	35	78410		

K-11

end original copy by certified return receipt re-	quested mail to: TNRCC, N	AC 177, P.O. B	ox 130	37, Aust	in, TX 78711-3087			MW	<u>-24</u>	
ATTENTION OWNER: Confidentiality Privilege Notice on on reverse side of Well Owner's copy (pink)		State WELL			Т	Texas Water Well Drillers Advisory Co MC 177 P.O. Box 13087 Austin, TX 78711-3087 512-239-0530				
1) OWNER City of Kingsville	e me)	ADDRE	ss _F	2.06	ox 1458 (Street or RFD)	Kingsv (City	ille Texa	s 78363 (State)	(Zip)	
2) ADDRESS OF WELL: County Kleberg	Kingsville (Street, RFD or o			jsvill City)		(Zip)	GRID#8	3-34-4		
3) TYPE OF WORK (Check): New Well Deepening Reconditioning Plugging	New Well □ Deepening □ Industrial □ Irrigation □ Reconditioning □ Plugging If Public Supply well, were plans						200)		
6) WELL LOG: Date Drilling: Started #-28	DIAMETER OF H Dia. (in.) From (ft.) G.C Surface	NG METHOD (Check): Rotary								
From (ft.) To (ft.) Descript see attached log Mx=24	n material	8)	☐ Und	ole Completion (Check): erreamed	Packed A	Other 16/3	Straight Wall 10 silica 16.0	sand		
			CAS	SING, BL	ANK PIPE, AND WELL	SCREEN DAT	TA:		=3-00	
			Dia.	New or Used	Steel, Plastic, etc. Perf., Slotted, etc. Screen Mfg., if comm	ercial	Settin From	g (ft.) To	Gage Casti Scree	
			4	N	Pvc screen Mfg.		33.0	16.0	.010	
			4	N	WellsBSupply Pvc risedr		18.0,	42.5		
(Use reverse side of Well Ow	ner's copy, if necessary)			Method Cement Distanc	e to septic system field lin	O.C. ith 5% be INc. es or other co	t. No. of sac ntonite	cks used		
13) TYPE PUMP: N/A Turbine Jet Submersi Other Depth to pump bowls, cylinder, jet, etc.,	W. Company			SURFA	of verification of above dis CE COMPLETION cified Surface Slab Installe cified Steel Sleeve Installe	ed [Rule 338				
14) WELLTESTS: N/A Typetest: Pump Bailer	☐ Jetted ☐ Estimate			- 10	ss Adapter Used [Rule 3 roved Alternative Procedu		338.71]			
Yield:gpm with 15) WATER QUALITY: Did you knowingly penetrate any strata	_ ft. drawdown after which contained undesirable	2005		Static le	RLEVEL: N/A velft. below		Date_			
Type of water?	ORT OF UNDESIRABLE W Depth of strata Yes		12)	PACKE	RS: tonite pellets	ا اخ	ype 'i	Depti	1	
	e (or under my supervision) tru 15 will result in the log(s) il lnc. e or print)	and that each being returned	for cor	npletion	atements herein are true and resubmittal. RILLER'S LICENSE NO.		1.551		ľ	
ADDRESS 810 SPID (Street or	nove to the constraints.	=	(Co City)	rpus Chritei	(:	Texas State)	i (Zip	7841)	
(Signed)(Licensed Well Driller)				Signed)	ertinent information, if a		Driller Traines	r)		

Part III

nd original copy by certified return receipt re	quested mail to: TNRCC, N	MC 177, P.O. Bo	ox 13087	7, Austir	ı, TX 78711-3087			MW-	-12 - <u>25</u>		
ATTENTION OWNER: Confidentiality Privilege Notice on on reverse side -f Well Owner's copy (pink)	,	State of	of Te	xas		Texas Wa	P.O. Box Austin, TX 78	Drillers Advisory Council MC 177 , Box 13087 TX 78711-3087 2-239-0530			
Other of Pinney(1)	e	ADDRE	ss P	.0. B	ox. 1458	Kingsville	Texas 7	8363			
OWNER City of Kingsvill (Na ADDRESS OF WELL: County Kleberg	Kingsville L	andfill Ki	ngsví	(Street of HPD)	(City	() GRID#8	(State) 3-34-4	(Zip)		
TYPE OF WORK (Check):	4) PROPOSED USE (0 Industrial In Ir Public Supply well	Check):	ection	☐ Publ	nestic 5)						
Date Drilling: Started 4-29 19 98	DIAMETER OF H Dia. (in.) From (ft.) €.0 Surface	To (ft.) 86.0		DRILLIN Air R Air H							
Completed 4629 1998	·	4									
From (ft.) To (ft.) Descrip	n material		☐ Unde	e Completion (Che erreamed Gra Packed give interva	velPacked {	Other grou	straight Wall	ft.			
			CAS	ING, BL	ANK PIPE, AND WE	LL SCREEN DA	TA: N/A				
		Dia. (in.)	New or Used	Steel, Plastic, etc Perf., Slotted, etc Screen Mfg., if co).	Setting From) (ft.) To	Gage Castir Scree			
(Use reverse side of Well O	wner's copy, if necessary)			Cement Method Cement Distance	TING DATA [Rule ed from 86.0] used refeable ed by a to septic system fle of verification of abo	tt. to	ft. No. of sac bentonite	cks used			
☐ Turbine ☐ Jet ☐ Submer☐ Other☐ Depth to pump bowls, cylinder, jet, etc 14) WELLTESTS: N/A	.,tt.		1	☐ Spec	CE COMPLETION cified Surface Slab Ir cified Steel Sleeve In ss Adapter Used [I	stalled [Rule 33 stalled [Rule 33 Rule 338.44(3)(b)	8.44(3)(A)]]				
Type test: Pump Bailer Yield: gpm with 15) WATER QUALITY: Did you knowingly penetrate any strat		hrs.	11)	WATER Static le	ce Date_	Date					
constituents? ☐ Yes 집 No If yes, submit *RE Type of water? Was a chemical analysis made?	WATER"	12)	PACKE	RS: N/A		Туре	Dep	th			
I hereby certify that this well was drilled by understand that failure to complete items 1	thru 15 will result in the log(n) and that each s) being returne	20 101 00	inpietion	atements herein are and resubmittal. RILLER'S LICENSI				1.1		
COMPANY NAME(T)		-						70.1			
(to and	or RFD)			(City)	orpus Christit		(State)	(2	78#1 (ip)		
/ (Licens	ed Well Driller) Jease attach electric log, c	hamical analy				(Registere	d Driller Traine	ej			

Part III



Tolunay-Wong Engineers, Inc.

GEOTECHNICAL ENGINEERING STUDY CITY OF KINGSVILLE MUNICIPAL SOLID WASTE LANDFILL EXPANSION KINGSVILLE, TEXAS

Prepared for:

Naismith/Hanson Corpus Christi, Texas

Prepared by:

Tolunay-Wong Engineers, Inc. 826 South Padre Island Drive Corpus Christi, Texas 78416

August 30, 2018

Project No. 16.53.042 / Report No. 12788R1

For Permitting Purposes Only. Applies to boring logs in Appendix B of Tolunay-Wong Engineers, Inc. Geotechnical Engineering Study, City of Kingsville Municipal Solid Waste Landfill Expansion, Kingsville, Texas – Report No. 12788R1, sealed by Don R. Rokohl, P.E. on 8-30-18 altered to provide text showing surface elevations, and the elevations of all contacts between soil and rock layers, and unit identifiers in the soil boring logs. No information or data was altered or changed from the original report other than the addition of text showing these elevations and unit identifiers in Appendix B.



GEOTECHNICAL ENGINEERING, DEEP FOUNDATIONS TESTING, ENVIRONMENTAL SERVICES, CONSTRUCTION MATERIALS TESTING 1-888-887-9932 WWW.TWEINC.COM

PROJEC [*]	City of Kingsville CLIEN Municipal Solid Waste Landfill Aerial Expansion	ORIN IT: N	IG B laismith	3-30 Eng	inee	ring, lı	nc.					
DEPTH (ft) SAMPLE TYPE SYMBOL/USCS	COORDINATES: N 27° 26' 44.0" W 97° 49' 23.1" SURFACE ELEVATION: 45.99' AMSL DRILLING METHOD: Dry Augered: 0-ft. to 82.5-ft. Wash Bored: to	(P) POCKET PEN (tsf) (T) TORVANE (psf)	STD. PENETRATION TEST (blows/ft)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	-AILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
	MATERIAL DESCRIPTION	(E)	- S						¥			
0 -	Dense to very dense tan and gray CLAYEY SAND (SC) with gypsum crystals		11/6" 23/6" 50/5"	16		42	17				37	
5 -	-color changes to tan with ferrous staining		34/6" 50/3"									
10 -	-with sand partings <u>▼</u>		13/6" 50/3"									
15 -			7/6" 12/6" 20/6"	35							33	
	-color changes to reddish tan and light gray		6/6" 15/6" 20/6"									
20 -	Very stiff to hard reddish tan and light gray FAT CLAY (CH) with gypsum crystals LIGHT OLIVE GREEN TO GRAY CLAY		10/6" 17/6" 26/6"									
25 -	-color changes to reddish tan and tan		10/6" 18/6" 30/6"	25		50	28				92	
30	-color changes to tan and reddish brown		8/6" 11/6" 16/6"									
35	-color changes to tan and gray		8/6" 12/6" 18/6"									
COMPLET DATE BOR	ING COMPLETED: 07/23/2016 was a	during out	as encou drilling op n of 10'-6 I with cer	eratic 5". At t	ns. A	fter a 1	0 to 1	15-minu	ıte wa	iting p e ope	eriod, n bore	, water e-hole
PROJECT	NO.: J. GONZAIEZ was b		l with cer			Ü			-	Pag	je1 o	f 3

PR	О.	JECT	Municipal Solid Waste Landfill	ORIN	IG B	8-30 n Eng	inee	ring, I	nc.					
DEPTH (ft)	SAMPLE TYPE	SYMBOL/USCS	Aerial Expansion COORDINATES: N 27° 26' 44.0"	(P) POCKET PEN (tsf) (T) TORVANE (psf)	STD. PENETRATION TEST (blows/ft)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
- 35 -			Very stiff to hard reddish tan and tan FAT CLAY (CH)											
	X		with gypsum crystals and ferrous stains LIGHT OLIVE GREEN TO GRAY CLAY		10/6" 17/6" 21/6"	30							90	
- 40 -	X		-color changes to tan and reddish brown		9/6" 14/6" 21/6"									
- 45 -	X				13/6" 19/6" 29/6"									
50 -	X		-becomes sandy 48' to 52'		8/6" 11/6" 13/6"	30							70	
			-color changes to tan and becomes slickensided	(P) 4.50+		23	100	71	51				87	
55 -				(P) 4.50+										
60 -				(P) 4.50+										
65 -			-becomes sandy and color changes to tan and gray	(P) 4.50+		26	97	54	30	1.75	3		69	
70 -			-color changes to tan and reddish brown with trace calcareous nodules	(P) 3.00										
DA ⁻	TE	BOR	ING COMPLETED: 07/23/2016 Was a	water wa during c at a depth backfilled	Irilling op of 10'-6	erations". At t	ns. A he co	fter a '	10 to	15-minເ	ute wa	iting p e ope	eriod	, water e-hole

PRO	JEC ⁻	City of Kingsville CLIEN Municipal Solid Waste Landfill		IG B laismith			ring, lı	nc.					
DEPTH (ft) SAMPLE TYPE	SYMBOL/USCS	Aerial Expansion COORDINATES: N 27° 26' 50.1"	(P) POCKET PEN (tsf) (T) TORVANE (psf)	STD. PENETRATION TEST (blows/ft)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
- 0 -	X	Medium dense to very dense gray CLAYEY SAND (SC) BODY I		4/6" 5/6" 7/6"									
		-with calcareous nodules and sand pockets		10/6" 22/6" 18/6"									
- 5 -				4/6" 5/6" 6/6" 5/6"	11							46	
				6/6" 8/6" 6/6" 8/6"									
10		-with cemented sand layers		12/6" 8/6" 27/6" 29/6"	27							22	
		-color changes to tan 43.87' AMSL		18/6" 32/6" 39/6"									
- 15 -		Very dense tan POORLY GRADED SAND with CLAY (SP-SC) and sand partings BODY IV		36/6" 50/5" 12/6" 50/5" 45/6" 50/5"	15							9	
- 20 -		₹		35/6" 50/4" 17/6" 26/6" 50/5"									
		₩ 34.87' AMSL Hard reddish tan and light gray SANDY LEAN SILTY		17/6" 38/6" 38/6" 13/6"									
- 25		CLAY (CL-ML) with sand partings		20/6" 31/6" 23/6" 34/6" 50/4" 12/6" 17/6" 50/5"	26		29	7				66	
30		-color changes to reddish tan and tan with ferrous stains		13/6" 32/6" 50/5" 7/6" 36/6" 39/6" 10/6" 21/6" 36/6"	25							62	
35				10/6" 18/6" 35/6"	25							- UZ	
DATE DATE LOGG	BOR BOR ER:	ING COMPLETED: 07/21/2016 was a J. Gonzalez	during of	as encour drilling op n of 21'-6 I with cen	eratio ". At t	ns. A he co	fter a 1 mpletion	0 to 1 on of t	15-minu	ıte wa	iting p	eriod,	water
PROJ	ECT	NO.: 16.53.042 Was b		INEERS			o gro	٠			Pag	e1 of	f 2

			Municipal Solid Waste Landfill Aerial Expansion COORDINATES: N 27° 26' 50.1"	(f)	z		L				(9)			
Œ T	TYPE	/USCS	W 97° 49' 24.3" SURFACE ELEVATION: 58.37' AMSL DRILLING METHOD:	P) POCKET PEN (tsf)	STD. PENETRATION TEST (blows/ft)	URE AT (%)	DRY UNIT WEIGHT (pcf)	LIMIT	ICITY (%)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	TESTS
DEPTH (ft)	SAMPLE TYPE	SYMBOL/USCS	Dry Augered: 0-ft. to 68-ft. Wash Bored: to	OCKET). PENE TEST (bl	MOISTURE CONTENT (%)	Y UNIT W (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	OMPRE	URE ST	CONFI	SIEVE	OTHER TESTS
	٠,) N	MATERIAL DESCRIPTION	(£)	LS.		NG			Ο ω ————————————————————————————————————	IA.	_ <u>_</u>		
35 -	X		Hard reddish tan and tan SANDY LEAN CLAY (CL) with ferrous stains and laminated sands	1	17/6" 25/6" 35/6"									
	X				17/6" 13/6" 19/6"									
10	X		18.87' AMSL Very stiff to hard reddish tan and tan FAT CLAY with		7/6" 16/6" 17/6"									
40 -	X		SAND (CH) and ferrous stains LIGHT OLIVE GREEN TO GRAY CLAY		3/6" 7/6" 10/6" 9/6"	37		59	36				76	
	$\frac{\lambda}{}$		LIGHT OLIVE GREEN TO GRAT CLAT		20/6" 27/6" 5/6" 14/6" 17/6"									
4.5	\bigvee				10/6"									
45 -	$\stackrel{\wedge}{\bigvee}$		-with trace gypsum crystals and ferrous stains		18/6" 21/6" 18/6" 23/6"									
	X				30/6" 6/6" 20/6"									
	X				21/6" 9/6" 17/6"	30							83	
50 -	X				19/6" 9/6" 18/6" 23/6"									
	X		-with calcareous nodules and ferrous stains	(P) 4.50+	11/6" 23/6" 26/6"	32	91	83	50	4.14	2		87	
			-with calcareous floudies and ferrous stains	(1) 4.50+		32	31	03	30	4.14	2		07	
55 -				(P) 4.50+										
				(P) 4.50+										
~~				(P) 4.50+		34	87			2.88	2		83	
60 -			-with trace gypsum crystals and ferrous stains	(P) 4.50+										
				(P) 4.50+										
65 -														
- cc				(P) 4.50+										
			-9.63' AMSL	(P) 4.50+										
70 -			Bottom @ 68'											
	, A I'		ON DEDTH.		0.000		ot	on-::-		de = 11	of 00'	hel-	,	
DA ⁻	Έ	BOR		water wa during d at a depth	Irilling op	eratio	ns. A	fter a 1	0 to 1	15-minu	ıte wa	iting p	eriod	wat

PRO	ЭJ	IECT	: City of Kingsville CLIEN Municipal Solid Waste Landfill Aerial Expansion		IG B			ring, li	nc.					
DEPTH (ft)	SAMPLE TYPE	SYMBOL/USCS	COORDINATES: N 27° 26' 49.7" W 97° 49' 17.0" SURFACE ELEVATION: 48.46' AMSL DRILLING METHOD: Dry Augered: 0-ft. to 82.5-ft. Wash Bored: to	(P) POCKET PEN (tsf) (T) TORVANE (psf)	STD. PENETRATION TEST (blows/ft)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	-AILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
		Λ	MATERIAL DESCRIPTION	(a)	S						₹			
35 -			Medium dense to dense reddish tan and gray CLAYEY SAND (SC) with gypsum crystals 12.46' AMSL/Very stiff to hard tan FAT CLAY with SAND (CH), slickensided, with calcareous nodules	(P) 4.50+		29	89						79	
40 -			LIGHT OLIVE GREEN TO GRAY CLAY											
	X		-color changes to tan and reddish brown with gypsum crystals and ferrous stains		8/6" 12/6" 15/6"									
45 -			-color changes to tan, gray, and reddish brown	(P) 4.50+										
50 -	X		-color changes to tan and reddish brown		4/6" 9/6" 10/6"	30		73	51				82	
55 -				(P) 4.50+										
			-color changes to tan and gray	(P) 4.50+										
60 -				(P) 4.50+		26	94			0.61	2		81	
65 -			-color changes to tan, red, and brown	(P) 4.00										
70 -			-color changes to tan and gray	(P) 4.50+										
DAT DAT LOG	E G	BOR BOR	NG COMPLETED: 07/28/2016 was a J. Gonzalez	water wa e during d at a depth packfilled	Irilling op n of 14'-7	eratio ". At t	ns. A he co	fter a 1	0 to	15-minı	ute wa	iting p e ope	eriod n bore	, water e-hole
FIC)JL	_011	TOLUNAY-WONG	ENGI	NEERS	5, IN(D					Pag	je2 o	f 3

PR	RO.	JEC	City of Kingsville CLIEN Municipal Solid Waste Landfill	ORIN	IG B laismith	5-32 Eng	ineei	ring, lı	nc.					
DEPTH (ft)	SAMPLE TYPE	SYMBOL/USCS	Aerial Expansion COORDINATES: N 27° 26' 49.7"	(P) POCKET PEN (tsf) (T) TORVANE (psf)	STD. PENETRATION TEST (blows/ft)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
	L	\ \	MATERIAL DESCRIPTION	(F)	ြ						₹			
- 70 -			Very stiff to hard tan and gray FAT CLAY with SAND (CH), slickensided with gypsum crystals and calcareous nodules LIGHT OLIVE GREEN TO GRAY CLAY -24.54' AMSL			21		24					0.4	
- 75 -			Medium dense to dense tan CLAYEY SAND (SC) with calcareous nodules	(P) 0.75		21		24	8				24	
	X		-with gypsum crystals and ferrous stains		5/6" 10/6" 13/6"									
- 80 -	X		-34.04' AMSL Bottom @ 82.5'		13/6" 20/6" 20/6"									
- 85 -														
- 90 -														
- 95 -														
-100-														
-105-	1													
DA DA LO	TE TE GG	BOR	ING COMPLETED: 07/28/2016 was a	e during o	s encour drilling op n of 14'-7 with cen	eratio	ns. A he co	fter a 1 mpletion	0 to 1	15-minu	ıte wa	iting p e opei	eriod,	water e-hole
			TOLUNAY-WONG	ENGI	NEERS	S, INC	D					rag	e30	١٥

PROJ	ECT	Municipal Solid Waste Landfill Aerial Expansion	IT: N	laismith	Eng	inee	ring, lı	nc.					
DEPTH (ft) SAMPLE TYPE	SYMBOL/USCS	COORDINATES: N 27° 26' 55.9" W 97° 49' 11.3" SURFACE ELEVATION:64.51' AMSL DRILLING METHOD: Dry Augered: 0-ft. to 86-ft. Wash Bored: to	(P) POCKET PEN (tsf) (T) TORVANE (psf)	STD. PENETRATION TEST (blows/ft)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	-AILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
	U)	MATERIAL DESCRIPTION	ĒE	LS.		K			<u> </u>	FAII			<u> </u>
0 -		Medium dense to very dense tan CLAYEY SAND (SC) with gypsum crystals BODY I		2/6" 7/6" 9/6"									
5 -		-color changes to dark gray and gray with trace gravel		7/6" 11/6" 9/6"	16							47	
10 -		-color changes to tan and light gray sand partings		27/6" 50/6"									
15 -		-color changes to tan and white with trace caliche		50/5"									
		48.01' AMSL											
		Dense to very dense tan and white POORLY GRADED SAND with SILT (SP-SM), and trace caliche		17/6" 48/6" 50/3"	11		35	8				12	
-		BODY II											
0 -				17/6" 21/6" 27/6"									
25 -	200611 200611 200611 200611 200611 200611 200611 200611	-color changes to light gray and tan with gypsum crystals and ferrous stains		15/6" 17/6" 32/6"									
		¥ 36.01' AMSL											
30		Medium dense to dense gray and white CLAYEY SAND (SC) with gypsum crystals		14/6" 22/6" 26/6"	42							20	
35 -		-color changes to tan		13/6" 21/6" 22/6"									
COMPI DATE E	BOR BOR	ING COMPLETED: 08/05/2016 was a	during o	as encou drilling op n of 28'-2 I with cer	eration	ns. A he co	fter a 1 mpletio	0 to 1	15-minເ	ıte wa	iting p e ope	eriod	, wate e-hole

PR	O.	JECT	Municipal Solid Waste Landfill	ORIN IT: N	IG B	3-33 Eng	inee	ring, l	nc.					
DEPTH (ft)	SAMPLE TYPE	SYMBOL/USCS	Aerial Expansion COORDINATES: N 27° 26' 55.9" W 97° 49' 11.3" SURFACE ELEVATION: 64.51' AMSL DRILLING METHOD: Dry Augered: 0-ft. to 86-ft. Wash Bored: to	(P) POCKET PEN (tsf) (T) TORVANE (psf)	STD. PENETRATION TEST (blows/ft)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
- 35 -	X		Medium dense to dense reddish tan CLAYEY SAND (SC) with gypsum crystals and ferrous stains		6/6" 9/6" 12/6"									
- 40 -	X		-color changes to tan and reddish tan		8/6" 16/6" 18/6"									
- 45 -	X		20.01' AMSL Stiff to very stiff reddish tan LEAN CLAY with SAND (CL), slickensided, with ferrous stains SANDY SILTY CLAY BED		9/6" 12/6" 18/6"	29		43	24				79	
- 50 -	X		-color changes to reddish tan and tan with gypsum crystals 12.51' AMSL		5/6" 6/6" 9/6"									
- 55 -			Stiff to very stiff LEAN CLAY (CL), slickensided, with ferrous stains SANDY SILTY CLAY BED	(P) 2.00 (P) 3.50		40	79			1.06	3		96	
- 60 -			-color changes to reddish brown and tan with gypsum crystals	(P) 3.50		34	87							
			-0.51' AMSL Very stiff to hard tan FAT CLAY (CH), slickensided, with			32	42	64	33	2.57	2		95	
- 65 -			gypsum crystals and ferrous stains LIGHT OLIVE GREEN TO GRAY CLAY		7/6"		_							
DA	TΕ	BOR		during o	12/6" 14/6" as encou	eratio	ns. A	fter a 1	10 to 1	15-minເ	ute wa	iting p	eriod,	water
100	36	ER: ECT I	I Gonzalez	it a depth packfilled ENGI	n of 28'-2 with cer	nent-b	entor	nite gro	out.		•	Pag	e2 o	

PR	OJ	JECT	Municipal Solid Waste Landfill Aerial Expansion	ORIN	IG B laismith	3-33 Eng	ineei	ring, lı	nc.					
DEPTH (ft)	SAMPLE TYPE	SYMBOL/USCS	COORDINATES: N 27° 26' 55.9" W 97° 49' 11.3" SURFACE ELEVATION: 64.51' AMSL DRILLING METHOD: Dry Augered: 0-ft. to 86-ft. Wash Bored: to	(P) POCKET PEN (tsf) (T) TORVANE (psf)	STD. PENETRATION TEST (blows/ft)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
		١	MATERIAL DESCRIPTION	(a) (b)	ST		ă				₹			
- 70 -			Very stiff to hard tan and reddish brown FAT CLAY (CH), slickensided, with gypsum crystals and ferrous stains LIGHT OLIVE GREEN TO GRAY CLAY	(P) 4.50+										
75			-color changes to tan and light gray											
75 -	X		-with layers of calcareous nodules		9/6" 10/6" 21/6"									
			-15.49' AMSL	,										
- 80 -			Very stiff to hard tan FAT CLAY with SAND (CH) with gypsum crystals and ferrous stains LIGHT OLIVE GREEN TO GRAY CLAY	(P) 4.50+		18	106			3.57	3		77	
- 85 -			-color changes to tan and white -21.49' AMSL	(P) 4.50+										
_			Bottom @ 86'											
90 -														
95 -														
100-														
-105-														
DAT DAT	TE TE	BOR	ING COMPLETED: 08/05/2016 was a	water wa e during c at a depth packfilled	drilling op n of 28'-2	eration	ns. A he co	fter a 1 mpletio	10 to 1 on of t	15-minı	ute wa	iting p	eriod	water
			TOLUNAY-WONG	ENGI	NEERS	S, INC	D						e3 o	f 3

PROJEC	T: City of Kingsville CLIEN Municipal Solid Waste Landfill Aerial Expansion	ORIN NT: N	IG B	8-34 n Eng	l inee	ring, l	nc.					
DEPTH (ft) SAMPLE TYPE SYMBOL/USCS	COORDINATES: N 27° 26' 43.4" W 97° 49' 11.4" SURFACE ELEVATION: 61.14' AMSL DRILLING METHOD: Dry Augered: 0 ft. to 30 ft. Wash Bored: 30 ft. to 43 ft.	(P) POCKET PEN (tsf) (T) TORVANE (psf)	STD. PENETRATION TEST (blows/ft)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	-AILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
0 - 822	MATERIAL DESCRIPTION	<u> </u>	S						100			
	Medium dense dark gray, gray, and light gray CLAYEY SAND (SC) with trace of organics	(P) 4.50+	2/6" 5/6" 6/6"	15	112			2.53	6		42	
	57.14' AMSL Very stiff to hard gray and light gray SANDY LEAN	(P) 4.50+		15	115	21	7				59	
5 -	SILTY CLAY (CL-ML) with calcareous nodules	(P) 4.50+		14	114			6.13	4		62	
	-color changes to light gray	(1) 4.001		'-				0.10			02	
10	-color changes to light gray and tan		4/6" 12/6" 16/6"									
	-color changes to white and light gray		11/6" 18/6" 16/6"									
	-becomes stiff		5/6" 6/6" 8/6"									
15 -	Medium dense to dense white and light gray SILTY	,	4/6" 6/6"	17		38	7				31	
	SAND (SM) with calcareous nodules BODY II -color changes to light gray and tan with ferrous stains		8/6" 4/6" 10/6" 19/6"									
			23/6" 50/5"									
20 -			23/6" 50/4"									
	-color changes to light gray		27/6" 35/6" 50/4"	22							25	
25 -			5/6" 37/6" 45/6" 20/6"									
	-becomes medium dense		39/6" 37/6" 8/6" 12/6"	26		39	2				28	
30	□		9/6" 4/6" 12/6"	33							39	
			10/6" 5/6" 6/6" 10/6"									
35	-color changes to tan and marine green		3/6"									
DATE BO	RING COMPLETED: 06/22/2016 was a	water wa e during c at a depth packfilled	Irilling op n of 28'-4	oeratio I". At t	ns. A	fter a 1 mpletion	10 to 1	15-minເ	ute wa	iting p e ope	eriod, n bore	, water e-hole
	TOLUNAY-WONG	ENIO!	NEERS	יאן כ	_					Pag	e1 o	f 2

PR	Ю.	JEC ⁻	Municipal Solid Waste Landfill	ORIN	IG B laismith	-34 Eng	inee	ring, lı	nc.					
DEPTH (ft)	SAMPLE TYPE	SYMBOL/USCS	Aerial Expansion COORDINATES: N 27° 26' 43.4" W 97° 49' 11.4" SURFACE ELEVATION: 61.14' AMSL DRILLING METHOD: Dry Augered: 0 ft. to 30 ft. Wash Bored: 30 ft. to 43 ft. MATERIAL DESCRIPTION	(P) POCKET PEN (tsf) (T) TORVANE (psf)	STD. PENETRATION TEST (blows/ft)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
- 35 -					\ 8/6" <i>[</i>									
	X		Medium dense tan and marine green SILTY SAND (SM) with sand lenses and trace organics25.14' AMS/CHART Hard tan and light gray LEAN CLAY (CL)	(P) 4.50+	13/6"									
			SANDY SILTY CLAY BED	(P) 4.50+		30	91	40	17	0.93	1		91	
- 40 -				(P) 4.50+										
			18.14' AMSL	(P) 4.50+										
		7777	Bottom @ 43'											
- 45 -														
- 50 -														
- 55 -														
- 60 -														
- 65 -														
- 70 -														
CO DA DA	TE TE	BOR BOR	ING COMPLETED: 06/22/2016 was a	e during o	drilling op n of 28'-4'	eratio '. At t	ns. A he co	fter a 1 mpletion	0 to 1	15-minu	ıte wa	iting p	eriod,	water
		ER: ECT	J. Garcia	oackfilled	with cem	ent-b	entor	nite gro	ut.		-	Pag	e2 of	f2
			TOLUNAY-WONG	ENGI	NEERS	, INC	D					9		

PROJEC	T: City of Kingsville CLIEN Municipal Solid Waste Landfill		IG B laismith			ring, lı	nc.					
DEPTH (ft) SAMPLE TYPE SYMBOLUSCS	Aerial Expansion COORDINATES: N 27° 26' 50.5" W 97° 48' 57.2" SURFACE ELEVATION: 64.50' AMSL DRILLING METHOD: Dry Augered: 0-ft. to 72.5-ft. Wash Bored: to MATERIAL DESCRIPTION	(P) POCKET PEN (tsf) (T) TORVANE (psf)	STD. PENETRATION TEST (blows/ft)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
- 0 -	Medium dense tan and brown CLAYEY SAND (SC) with trace caliche	4)	5/6" 8/6" 7/6"									
- 5 -	-color changes to reddish brown with ferrous stains		5/6" 8/6" 5/6"	12		31	17				38	
- 10 -	56.50' AMSL Very stiff to hard reddish tan SANDY LEAN CLAY (CL) with gypsum crystals	(P) 4.50+		14	117			2.22	3		52	
- 15 -	-color changes to reddish tan and tan with ferrous stains		5/6" 10/6" 12/6"									
	-color changes to reddish tan	(P) 4.50+		17	109	42	25					
- 20 -	-color changes to reddish tan and tan	(P) 4.50+										
- 25 -	40.50' AMSL Medium dense to dense reddish tan and tan CLAYEY SAND (SC) with gypsum crystals and ferrous stains BODY III	(P) 4.50+		17	104			1.29	3		40	
- 30	-color changes to reddish tan		4/6" 7/6" 9/6"									
- 35 - 24 4	<u>∇</u>		8/6" 13/6" 20/6"									
DATE BOF	RING COMPLETED: 07/29/2016 was a	water wa e during o at a depth backfilled	drilling op n of 30'-9	eratio ". At t	ns. A he co	fter a 1 mpletio	0 to 1	15-minເ	ıte wa	iting p e opei	eriod, n bore	water -hole
	 TOLUNAY-WONG	ENGI	NEERS	S. INC	D					Pag	e1 of	3

PRC)J	ECT	City of Kingsville CLIEN Municipal Solid Waste Landfill Aerial Expansion	ORIN IT: N	IG B laismith	8-35 n Eng	inee	ring, l	nc.					
DEPTH (ft)	SAIMIPLE ITPE	SYMBOL/USCS	COORDINATES: N 27° 26' 50.5" W 97° 48' 57.2" SURFACE ELEVATION: 64.50' AMSL DRILLING METHOD: Dry Augered: 0-ft. to 72.5-ft. Wash Bored: to	(P) POCKET PEN (tsf) (T) TORVANE (psf)	STD. PENETRATION TEST (blows/ft)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	-AILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
		١	MATERIAL DESCRIPTION 28.00' AMSL	(E)	ြ						₹			
35 -	8333	3)S 222	Medium dense to dense reddish tan and tan CLAYEY SAND (SC) with gypsum crystals and ferrous stains											
			Hard tan and light gray FAT CLAY with SAND (CH), gypsum crystals, and ferrous stains LIGHT OLIVE GREEN TO GRAY CLAY		17/6" 26/6" 30/6"	25		109	72				77	
40 -			-color changes to tan and reddish brown		8/6" 15/6" 24/6"									
			-with sand partings		10/6"									
45 -					16/6" 16/6"									
50			Stiff to hard reddish brown and tan FAT CLAY (CH) with gypsum crystals and ferrous stains LIGHT OLIVE GREEN TO GRAY CLAY		4/6" 7/6" 10/6"	34							96	
			-becomes slickensided with sand layers	(P) 2.00										
55 -			-color changes to tan		4/6" 7/6" 10/6"									
60 -				(P) 3.75		33	89	90	67	3.88	4		89	
				(P) 4.25										
65 -														
70			-color changes to tan and reddish brown	(P) 4.50+										
DATE	E E	BOR BOR	NG COMPLETED: 07/29/2016 was a	water wa during c t a depth ackfilled	drilling op n of 30'-9	eration ". At t	ns. A he co	fter a 1 mpletion	10 to 1 on of t	15-minu	ıte wa	iiting p e ope	eriod, n bore	water e-hole
	_		TOLUNAY-WONG	ENIC	NEERS	2 INI	,					Pag	je2 o	f3

COORDINATES: N 27° 26′ 56.8° W 97° 49′ 04.9° SURFACE ELEVATION: 59.13′ AMSL DRILLING METHOD: Dry Augered: 0-ft. to 22-ft. Wash Bored: 22-ft. to 68-ft. MATERIAL DESCRIPTION Loose to medium dense dark gray and gray CLAYEY SAND (SC) BODY I					nc.	ing, Ir	ineer	-36 Eng	IG B Naismith	ORIN	T: City of Kingsville CLIE Municipal Solid Waste Landfill Aerial Expansion	IECT	RO	PF
Loose to medium dense dark gray and gray CLAYEY SAND (SC) -with calcareous nodules -solor changes to light gray and tan -color changes to light gray and tan -color changes to tan -color changes to tan -color changes to tan -color changes to light gray with ferrous stains -the color changes to light gray with ferrous stains -color changes to light gray with ferrous stains	PASSING #200 SIEVE (%) OTHER TESTS PERFORMED	CONFINING PRESSURE (psi)	LURE STRAIN (%)	COMPRESSIVE STRENGTH (tsf)	PLASTICITY INDEX (%)	LIQUID LIMIT (%)	RY UNIT WEIGHT (pcf)	MOISTURE CONTENT (%)	D. PENETRATION TEST (blows/ft)	POCKET PEN (tsf)) TORVANE (psf)	COORDINATES: N 27° 26' 56.8" W 97° 49' 04.9" SURFACE ELEVATION:59.13' AMSL DRILLING METHOD: Dry Augered: 0-ft. to 22-ft.	SYMBOL/USCS	SAMPLE TYPE	DEPTH (ft)
Lose to medium dense dark gray and gray CLAYEY SAND (SC) -with calcareous nodules -5 - -color changes to light gray and tan -color changes to tan -color changes to tan -color changes to tan -tolor changes to tan -tolor changes to light gray with ferrous stains			₹				ă		S	(a) (b)	MATERIAL DESCRIPTION			
- 5											SAND (SC) BODY I			- 0
-tolor changes to tan -color changes to tan -color changes to tan -color changes to tan -tolor changes to light gray with ferrous stains -tolor changes to light gray with ferrous stains -color changes to light gray with ferrous stains -tolor changes to light gray with ferrous stains -color changes to light gray with ferrous stains -tolor changes to light gray with ferrous stains	36							10	20/6"		-with calcareous nodules		X	- 5
-color changes to tan -color changes to tan -color changes to tan -color changes to tan -color changes to light gray with ferrous stains									4/6" 5/6" 5/6"		-color changes to light gray and tan		X	
-color changes to light gray with ferrous stains 4/6" 6/6" -20 -20 -becomes very dense and color changes to light gray and tan 25 -25 -25 -26 -27 -28 -28 -28 -28 -28 -28 -28	44				28	47		12	5/6"		-color changes to tan		X	- 10
-color changes to light gray with rerrous stains 10/6° 14/6° -becomes very dense and color changes to light gray and tan 15/6° 24/6° 50/6°									4/6"				X	- 15
- 25 - 12/6"									10/6"		-color changes to light gray with ferrous stains			- 20
12/6"	32							25	24/6"				X	
14/6" 15/6"									14/6"					- 25
- 30									17/6"		-becomes dense			- 30
35 × 4/6"									4/6"					- 25
COMPLETION DEPTH: DATE BORING STARTED: DATE BORING COMPLETED: LOGGER: PROJECT NO.: 68 ft 06/24/2016 06/24/2	period, wate	iting p	ite wa	15-minu	0 to 1 on of t	fter a 1 mpletic	ns. At	eratio	drilling op h of 18'-3	e during of	ING STARTED: 06/24/2016 grad ING COMPLETED: 06/24/2016 was J. Garcia	BOR BOR ER:	TE TE GG	CC DA DA LO

PRO	ΟJ	JEC ¹	City of Kingsville CLIEN Municipal Solid Waste Landfill		IG B			ring, lı	nc.					
			Aerial Expansion											
DEPTH (ft)	SAMPLE TYPE	SYMBOL/USCS	COORDINATES: N 27° 26' 56.8"	(P) POCKET PEN (tsf) (T) TORVANE (psf)	STD. PENETRATION TEST (blows/ft)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	-AILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
25	+	$\overline{}$	MATERIAL DESCRIPTION	Ε.							ш.			
- 35	X		Medium dense light gray and tan CLAYEY SAND (SC) BODY I		7/6" 8/6"									
40	X		-with sand seams, calcareous nodules, and ferrous staining		6/6" 10/6" 13/6"	21		47	30				35	
	X		-color changes to reddish brown and light gray		4/6" 8/6" 10/6"									
- 45 -			13.13' AMSL											
			Stiff to very stiff reddish brown and light gray FAT CLAY	(P) 4.50+										
			(CH), slickensided, with ferrous staining LIGHT OLIVE GREEN TO GRAY CLAY											
- 50 -	X		-with sand seams and calcareous nodules		4/6" 6/6" 8/6"	42							96	
- 55 -	X		-color changes to light gray with sand layers		11/6" 12/6" 14/6"									
- 60	X		-becomes hard		11/6" 21/6" 26/6"	37		70	44				94	
65	X				7/6" 8/6" 9/6"									
65 -	X		-color changes to brown yellow, reddish brown, and light gray -8.87' AMSL		7/6" 10/6" 10/6"									
			Bottom @ 68'											
DAT	E G	BOR BOR ER:	ING COMPLETED: 06/24/2016 was a	during of the depth deackfilled	as encoun drilling open of 18'-3' with cem	eratio '. At t ent-b	ons. A he co pentor	fter a 1 mpletio	0 to 1	15-minu	ıte wa	iting p e opei	eriod,	water e-hole

PROJEC	Municipal Solid Waste Landfill		IG B laismith			ing, lı	nc.					
DEPTH (ft) SAMPLE TYPE SYMBOL/USCS	Aerial Expansion COORDINATES: N 27° 26' 57.1"	(P) POCKET PEN (tsf) (T) TORVANE (psf)	STD. PENETRATION TEST (blows/ft)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
- 0 -	Very dense light gray and tan SILTY SAND (SM)											
	BODY II											
	-with ferrous staining		6/6" 16/6" 50/5"									
- 5 -												
	_		11/6" 50/5"	20		33	9				20	
- 10 -	-with calcareous nodules		23/6" 37/6" 50/6"									
	$\frac{\square}{\overline{z}}$ 31.02' AMSL											
- 15 -	Very stiff to hard tan and light tan SANDY LEAN SILTY CLAY (CL-ML) SANDY SILTY CLAY BED		6/6" 7/6" 10/6"	31							52	
- 20	-color changes to tan and light gray with ferrous staining		9/6" 17/6" 27/6"									
- 25 -			7/6" 12/6" 13/6"									
	19.02' AMSL		4/01	00			00				00	
	Stiff to very stiff reddish brown and light gray FAT CLAY (CH) with calcareous nodules and ferrous staining		4/6" 5/6" 9/6"	33		56	39				99	
-	LIGHT OLIVE GREEN TO GRAY CLAY											
30 -	-color changes to light gray with sand layers		5/6" 7/6" 12/6"									
			5/6"	34							86	
35				1								
DATE BOR	J. Garcia was a	during o	s encoundrilling op n of 9'-3" with cer	eratio . At the	ns. A	fter a 1 pletion	0 to 1	15-minu	ıte wa	iting p	eriod,	water
NOSEOT	TOLUNAY-WONG		NEERS			-				Pag	e1 o	f 2

PRO	JECT	: City of Kingsville CLIEN Municipal Solid Waste Landfill Aerial Expansion	ORIN IT: N	IG B Naismith	-37 Eng	inee	ring, li	nc.					
DEPTH (ft) SAMPLE TYPE	SYMBOL/USCS	COORDINATES: N 27° 26' 57.1"	(P) POCKET PEN (tsf) (T) TORVANE (psf)	STD. PENETRATION TEST (blows/ft)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
- 35		Stiff to very stiff light gray and brownish tan FAT CLAY (CH) with sand seams, calcareous nodules, and ferrous staining LIGHT OLIVE GREEN TO GRAY CLAY		7/6" 12/6"									
40		-color changes to light gray and reddish brown		4/6" 5/6" 7/6"									
- 45 -		-color changes to light gray and reddish brown -color changes to light gray		6/6" 6/6" 9/6"	35		80	51				86	
$\prod_{i} X_i$		-2.48' AMSL Bottom @ 48'		5/6" 9/6"									
- 50 -													
- 70 -	DI ET:	ON DEDTH. 40.6 DEMARKO 5	wotor	00.000	ator-	ot a=	00000	imat	dont	of 45'	hele	(ov:	in a
DATE	BOR BOR	ING COMPLETED: 06/25/2016 was a	during of the during of the depth of the dep	as encoundrilling open of the second of the	eration At the nent-b	ons. A e com pentor	fter a 1 npletion nite gro	0 to 1 n of th out.	15-minu e borin	ite wa g, the	iting p open	eriod,	water hole

PR	О.	JEC ⁻	T: City of Kingsville CLIEN Municipal Solid Waste Landfill		IG B laismith			ring, lı	nc.					
			Aerial Expansion											
DEPTH (ft)	SAMPLE TYPE	SYMBOL/USCS	COORDINATES: N 27° 27′ 03.76″	(P) POCKET PEN (tsf) (T) TORVANE (psf)	STD. PENETRATION TEST (blows/ft)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	-AILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
		<u> </u>	MATERIAL DECORNI TION	=							-			
- 35 -	X		Very stiff to hard reddish brown and light gray SANDY FAT CLAY (CH) with sand seams and layers 3.64' AMSL	(P) 4.50+	8/6" 10/6"									
			Stiff to hard light gray FAT CLAY (CH), slickensided, with calcareous nodules and ferrous stains	(P) 4.50+		42	78	100	72	2.95	2		93	
- 40 -			-color changes to reddish brown and light gray	(P) 4.50+										
			LIGHT OLIVE GREEN TO GRAY CLAY	(P) 4.50+										
- 45 -			-color changes to tannish brown and light gray with trace organics	(P) 4.50+										
	X		-color changes to light gray	(P) 4.50+	5/6" 6/6" 8/6"	30	91			2.14	3		87	
- 50 -	X				6/6" 7/6" 7/6" 4/6" 5/6"									
- 55 -			-color changes to tannish brown and light gray		5/6" 5/6" 7/6" 9/6"									
	X		-color changes to light gray -16.36' AMSL		6/6" 7/6" 9/6"									
			Bottom @ 58'		0,0									
- 60 -														
- 65 -														
- 70 -														
DA DA LO	TE TE GG	BOR	ING COMPLETED: 06/23/2016 was a J. Garcia	e during o	as encoundrilling open of 5'-5". with cerr	eratio At th	ns. A e con	fter a 1 opletion	0 to 1	15-minເ	ıte wa	iting p open	eriod, bore-	water hole
			 TOLUNAY-WONG	ENGI	NEERS	. INC	D					Pag	e2o	12

PROJEC	T: City of Kingsville CLIEN Municipal Solid Waste Landfill Aerial Expansion	ORIN IT: N	laismith	Eng	inee	ring, I	nc.					
SAMPLE TYPE SYMBOL/USCS	COORDINATES: N 27° 27' 01.3" W 97° 48' 57.3" SURFACE ELEVATION: 60.26' AMSL DRILLING METHOD: Dry Augered: 0 ft. to 26 ft. Wash Bored: 26 ft. to 68 ft.	(P) POCKET PEN (tsf) (T) TORVANE (psf)	STD. PENETRATION TEST (blows/ft)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	-AILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
	MATERIAL DESCRIPTION	(£)	ST						Ā			
0 -	Medium dense to dense tan and light gray CLAYEY SAND FILL with trace gravel		8/6" 9/6" 6/6"	18							33	
	-color changes to brown		40/6" 27/6" 19/6"									
5 -	55.76' AMSL Medium dense to dense brown and reddish brown CLAYEY SAND (SC) BODY I		6/6" 7/6" 8/6"									
	-color changes to tan and gray with calcareous nodules		4/6" 5/6" 6/6"									
0			5/6" 6/6" 8/6"	11		36	20				49	
	-color changes to tan and light gray		4/6" 6/6" 7/6"									
	-color changes to light gray		7/6" 8/6" 11/6"									
5 -	-color changes to light gray and tan with ferrous stains		6/6" 12/6" 19/6"									
	-color changes to light gray		11/6" 19/6" 22/6"									
	41.76' AMSL Stiff to hard light gray SANDY LEAN CLAY (CL) with calcareous nodules and ferrous stains		3/6" 4/6" 5/6"	19							65	
20 + 1//	calcareous flouries and refrous stains		6/6" 9/6"									
			13/6" 8/6" 11/6"									
25 -	-color changes to light tan and light gray	(P) 4.50+	20/6"									
	color changes to light gray increase to light gray	(P) 4.00										
30	-color changes to light gray and tan	(P) 4.50+	7/6" 11/6" 13/6"	19	102			1.14	7		50	
			12/6" 16/6" 20/6"									
35			8/6"	-			\vdash					
DATE BOR	RING COMPLETED: 06/24/2016 was a	during data	drilling op	eratio	ns. A he co	fter a 1	0 to 1	15-minu	ıte wa	iting p	eriod,	wate

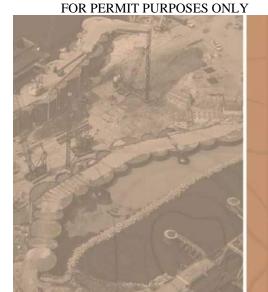
PRO	OJ	JECT	City of Kingsville CLIEN Municipal Solid Waste Landfill Aerial Expansion		IG B			ring, lı	nc.					
DЕРТН (ft)	SAMPLE TYPE	SYMBOL/USCS	COORDINATES: N 27° 27' 01.3" W 97° 48' 57.3" SURFACE ELEVATION: 60.26' AMSL DRILLING METHOD: Dry Augered: 0 ft. to 26 ft. Wash Bored: 26 ft. to 68 ft. MATERIAL DESCRIPTION	(P) POCKET PEN (tsf) (T) TORVANE (psf)	STD. PENETRATION TEST (blows/ft)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
- 35 -	X		Stiff to hard light gray and tan SANDY LEAN CLAY (CL)		12/6" 16/6"									
	X		with ferrous stains 23.76' AMSL Medium dense to dense light gray CLAYEY SAND (SC) with ferrous stains BODY III		7/6" 8/6" 11/6"									
- 40	X				11/6" 12/6" 7/6" 10/6"	25		69	51				45	
			15.76' AMSL		13/6" 13/6" 19/6" 21/6"									
- 45 -	X		Dense light gray POORLY GRADED SAND with CLAY (SP- SC)		12/6" 21/6" 20/6" 11/6"									
	Ă	"	12.26' AMSL Hard reddish brown and light gray FAT CLAY with	(P) 4.50+	16/6" 16/6"									
- 50 -			SAND (CH) LIGHT OLIVE GREEN TO GRAY CLAY	(P) 4.50+		28	93			0.85	1		72	
			-becomes slickensided with calcareous nodules	(P) 4.50+										
- 55 -			-with ferrous stains	(P) 4.50+ (P) 4.50+										
				(P) 4.50+										
- 60 -				(P) 4.50+										
	X		-becomes stiff		7/6" 7/6" 7/6"									
- 65 -			-6.24' AMSL											
	X	2222 2222 2222 2222 2222	Medium dense light gray CLAYEY SAND (SC) with calcareous nodules and ferrous stains -7.74' AMSL Bottom @ 68'		6/6" 10/6" 13/6"	20	102	61	45	1.91	5		46	
- 70 -														
DAT DAT LOG	E G	BOR BOR	ING COMPLETED: 06/24/2016 was a	during data	s encoun Irilling ope of 26'-6" with cem	eratic	ns. A he co	fter a 1 mpletio	0 to 1	15-minu	ıte wa	iting p	eriod,	water
	<i>,</i> ,,,	_011	TOLUNAY-WONG		NEERS							Pag	e2o	2

PROJEC	CT: City of Kingsville CLIEN Municipal Solid Waste Landfill Aerial Expansion		IG B Naismith			ring, lı	nc.					
DEPTH (ft) SAMPLE TYPE SYMBOLUSCS	COORDINATES: N 27° 27' 09.97" W 97° 49' 11.18" SURFACE ELEVATION: 52.31' AMSL DRILLING METHOD: Dry Augered: 0 ft. to 22 ft. Wash Bored: 22 ft. to 33.75 ft.	(P) POCKET PEN (tsf) (T) TORVANE (psf)	STD. PENETRATION TEST (blows/ft)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
	MATERIAL DESCRIPTION	9,0	ώ						12			
0 -	Loose to very dense light gray and gray SILTY SAND (SM) with trace caliche BODY II		4/6" 4/6" 6/6"									
	-color changes to light gray and tan with ferrous stains		5/6" 7/6" 11/6"	16		35	10				31	
- 5 -	-color changes to light gray with calcareous nodules		7/6" 17/6" 17/6" 12/6"									
	-color changes to light gray with calcareous hoodies		21/6" 34/6" 12/6"	18							34	
- 10 -	-color changes to white		27/6" 50/3" 15/6"									
	-color changes to light gray and white		50/3" 25/6" 50/4"									
	37.81' AMSL											
- 15 -	Hard light gray FAT CLAY with SAND (CH), calcareous nodules, and ferrous stains		7/6" 26/6" 50/5"	22		70	41				80	
			5/6" 17/6" 28/6"									
	_		10/6" 30/6"									
- 20	₹ 31.81' AMSL Hard light gray SANDY FAT CLAY (CH) with		35/6" 9/6"	31							59	
	calcareous nodules and ferrous stains		25/6" 35/6"									
			16/6" 32/6" 50/5"									
- 25 -	25.81' AMSL		16/6" 31/6" 50/5"									
	Dense to very dense light gray CLAYEY SAND (SC) with calcareous nodules		8/6" 18/6" 27/6" 6/6"	30		53	32				49	
-30			18/6" 50/6" 6/6"									
			20/6" 50/5"									
	4		3/6" 40/6" \ 50/3"	16							30	
- 35 -	Bottom @ 33.5'		23/0									
COMPLE DATE BO	RING COMPLETED: 06/22/2016 was a	during of the deptile	as encour drilling op h of 19'. <i>I</i> I with cen	eration	ns. A comp	fter a 1 letion	0 to of the	15-minu	ıte wa	iting p pen b	eriod,	water
	TOLUNAY-WONG	ENG	INEERS	S. INC	D							

PROJEC [*]	LOG OF BO		IG B			rina. Iı	nc.					
	Municipal Solid Waste Landfill Aerial Expansion			9								
DEPTH (ft) SAMPLE TYPE SYMBOL/USCS	COORDINATES: N 27° 27' 09.8" W 97° 49' 17.4" SURFACE ELEVATION: 50.20' AMSL DRILLING METHOD: Dry Augered: 0-ft. to 62.5-ft. Wash Bored: to	(P) POCKET PEN (tsf) (T) TORVANE (psf)	STD. PENETRATION TEST (blows/ft)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	-AILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
	MATERIAL DESCRIPTION	(F)	ST		ă				¥	-		
0 -	Loose to medium dense gray CLAYEY SAND (SC) with calcareous nodules BODY I		4/6" 5/6" 5/6"	8							35	
- 5 -	-color changes to light gray		4/6" 5/6" 6/6"									
	41.70' AMSL											
10	Stiff to very stiff gray SANDY FAT CLAY (CH) LIGHT OLIVE GREEN TO GRAY CLAY		5/6" 8/6" 11/6"	20		78	52				64	
- 15 -	-becomes hard and color changes to brown with interbedded sand seams		9/6" 17/6" 25/6"									
	-color changes to brown and tan		7/6" 12/6" 14/6"									
- 20 -	-color changes to tan with sand layers		3/6" 4/6" 6/6"	36							64	
- 25 -	-color changes to brown with sand partings		5/6" 4/6" 6/6"									
30	-color changes to brown and tan		6/6" 7/6" 8/6"	31		52	30				51	
- 35 -			4/6" 6/6" 6/6"									
DATE BOR DATE BOR LOGGER:	M. Anderson was a	e during o	as encour drilling op n of 19'-3	eratio	ns. A	fter a 1 mpletio	0 to 1	15-minu	ite wa	iting p	eriod,	water
PROJECT	NO.: 16.53.042 Was I TOLUNAY-WONG		NEERS			iile gil	ut.			Pag	e1 of	2

PRO))	JEC1	: City of Kingsville CLIEN Municipal Solid Waste Landfill	ORIN IT: N	IG B	- 41 Eng	inee	ring, lı	nc.					
			Aerial Expansion											
DEPTH (ft)	SAMPLE TYPE	SYMBOL/USCS	COORDINATES: N 27° 27' 09.8" W 97° 49' 17.4" SURFACE ELEVATION: 50.20' AMSL DRILLING METHOD: Dry Augered: 0-ft. to 62.5-ft. Wash Bored: to	(P) POCKET PEN (tsf) (T) TORVANE (psf)	STD. PENETRATION TEST (blows/ft)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
	4	Λ.	MATERIAL DESCRIPTION 14.20' AMSL	<u>6</u> .0	ω						Ę.			
- 35 -			Stiff to very stiff gray SANDY FAT CLAY (CH)											
		//	Very stiff brown FAT CLAY with SAND (CH)	(P) 3.25		27	92						77	
			LIGHT OLIVE GREEN TO GRAY CLAY											
- 40 -	X		-color changes to brown and tan		6/6" 13/6" 11/6"									
					11/0									
45 -	X				4/6" 9/6" 14/6"									
					6/6" 8/6"	35		97	75				84	
50	$^{\wedge}$				9/6"									
	X		-color changes to brown and gray		7/6" 9/6" 12/6"									
- 55 -			-color changes to gray	(P) 4.50+										
- 60 -														
			-12.30' AMSL	(P) 3.50										
			Bottom @ 62.5'											
- 65 -														
- 70 -														
COM	E E G	BOR BOR ER:	M. Anderson was a	water wa during d at a depth ackfilled	Irilling op n of 19'-3	eratic	ns. A he co	fter a 1 mpletio	0 to 1	15-minເ	ite wa	iting p e opei	eriod, n bore	water -hole
			TOLUNAY-WONG	ENGI	NEERS	S. INC	D					rag	e2 of	2

Part III



Tolunay-Wong Engineers, Inc.

GEOTECHNICAL ENGINEERING STUDY CITY OF KINGSVILLE MUNICIPAL SOLID WASTE LANDFILL EXPANSION KINGSVILLE, TEXAS

Prepared for:

Naismith/Hanson Corpus Christi, Texas

Prepared by:

Tolunay-Wong Engineers, Inc. 826 South Padre Island Drive Corpus Christi, Texas 78416

August 30, 2018

Project No. 16.53.042 / Report No. 12788R1

For Permitting Purposes Only. Applies to boring logs in Appendix B of Tolunay-Wong Engineers, Inc. Geotechnical Engineering Study, City of Kingsville Municipal Solid Waste Landfill Expansion, Kingsville, Texas – Report No. 12788R1, sealed by Don R. Rokohl, P.E. on 8-30-18 altered to provide text showing surface elevations, and the elevations of all contacts between soil and rock layers, and unit identifiers in the soil boring logs. No information or data was altered or changed from the original report other than the addition of text showing these elevations and unit identifiers in Appendix B.



GEOTECHNICAL ENGINEERING, DEEP FOUNDATIONS TESTING, ENVIRONMENTAL SERVICES, CONSTRUCTION MATERIALS TESTING 1-888-887-9932 WWW.TWEINC.COM

PROJ	IECT	LOG OF BO City of Kingsville CLIEN Municipal Solid Waste Landfill Aerial Expansion	ORIN IT: N	IG B laismith	B-30 n Eng	inee	ring, l	nc.					
DEPTH (ft) SAMPLE TYPE	SYMBOL/USCS	COORDINATES: N 27° 26' 44.0"	(P) POCKET PEN (tsf) (T) TORVANE (psf)	STD. PENETRATION TEST (blows/ft)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	-AILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
		MATERIAL DESCRIPTION	(a)	ST		ă				₹			
0 -		Dense to very dense tan and gray CLAYEY SAND (SC) with gypsum crystals		11/6" 23/6" 50/5"	16		42	17				37	
5 -		-color changes to tan with ferrous staining		34/6" 50/3"									
10 -		-with sand partings <u>▼</u>		13/6" 50/3"									
15 -				7/6" 12/6" 20/6"	35							33	
		-color changes to reddish tan and light gray		6/6" 15/6" 20/6"									
20 -		Very stiff to hard reddish tan and light gray FAT CLAY (CH) with gypsum crystals LIGHT OLIVE GREEN TO GRAY CLAY		10/6" 17/6" 26/6"									
25 -		-color changes to reddish tan and tan		10/6" 18/6" 30/6"	25		50	28				92	
30		-color changes to tan and reddish brown		8/6" 11/6" 16/6"									
25		-color changes to tan and gray		8/6" 12/6" 18/6"									
35 -	7												
DATE	BOR BOR	ING COMPLETED: 07/23/2016 was a	during of table a	as encou drilling op n of 10'-6 I with cer	erations". At t	ns. A	fter a 1 mpletion	10 to 1 on of t	15-minເ	ute wa	iting p e ope	eriod	, wate e-hole

DEPTH (ft) SAMPLE TYPE	L/USCS	COORDINATES: N 27° 26' 44.0"											
8	SYMBOL/USCS	W 97° 49' 23.1" SURFACE ELEVATION: 45.99' AMSL DRILLING METHOD: Dry Augered: 0-ft. to 82.5-ft. Wash Bored: to	(P) POCKET PEN (tsf) (T) TORVANE (psf)	STD. PENETRATION TEST (blows/ft)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	-AILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
	N	MATERIAL DESCRIPTION	(E)	<u> </u>						₹			
35 -		Very stiff to hard reddish tan and tan FAT CLAY (CH) with gypsum crystals and ferrous stains LIGHT OLIVE GREEN TO GRAY CLAY		10/6" 17/6" 21/6"	30							90	
40 -		-color changes to tan and reddish brown		9/6" 14/6" 21/6"									
45				13/6" 19/6" 29/6"									
50		-becomes sandy 48' to 52'		8/6" 11/6" 13/6"	30							70	
55 -		-color changes to tan and becomes slickensided	(P) 4.50+		23	100	71	51				87	
			(P) 4.50+										
60			(P) 4.50+										
65 -		-becomes sandy and color changes to tan and gray	(P) 4.50+		26	97	54	30	1.75	3		69	
70		-color changes to tan and reddish brown with trace calcareous nodules	(P) 3.00										
DATE E	BORI BORI ER:	NG COMPLETED: 07/23/2016 was a J. Gonzalez	e during o at a depth backfilled	drilling op n of 10'-6	eration ". At the nent-b	ns. A he co entor	fter a 1 mpletionite gro	0 to fon of tout.	15-minu the bori	ite wa ng, th	iting p e opei Pag	eriod,	water e-hole

PRO	JEC	City of Kingsville CLIEN Municipal Solid Waste Landfill		IG B laismith			ring, lı	nc.					
DEPTH (ft) SAMPLE TYPE	SYMBOL/USCS	Aerial Expansion COORDINATES: N 27° 26' 50.1"	(P) POCKET PEN (tsf) (T) TORVANE (psf)	STD. PENETRATION TEST (blows/ft)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
- 0 -	08.8%	Medium dense to very dense gray CLAYEY SAND (SC)	9)										
		BODY I		4/6" 5/6" 7/6"									
		-with calcareous nodules and sand pockets		10/6" 22/6" 18/6"									
5 -				4/6" 5/6" 6/6"	11							46	
				5/6" 6/6" 8/6"									
X				6/6" 8/6" 12/6"									
10		-with cemented sand layers		8/6" 27/6" 29/6"	27							22	
	***** ***** *****	-color changes to tan		18/6" 32/6" 39/6"									
15 -		Very dense tan POORLY GRADED SAND with CLAY		36/6" 50/5"									
X		(SP-SC) and sand partings BODY IV		12/6" 50/5"	15							9	
				45/6" 50/5" 35/6"									
20				50/4" 17/6"									
		¥ 34.87' AMSL		26/6" 50/5" 17/6" 38/6" 38/6"									
- 25		Hard reddish tan and light gray SANDY LEAN SILTY CLAY (CL-ML) with sand partings		13/6" 20/6" 31/6" 23/6" 34/6" 50/4" 12/6" 17/6" 50/5"	26		29	7				66	
30		-color changes to reddish tan and tan with ferrous stains		13/6" 32/6" 50/5" 7/6" 36/6" 39/6" 10/6" 21/6"									
35				36/6" 10/6" 18/6" 35/6"	25							62	
COMF DATE	BOR BOR ER:	ING COMPLETED: 07/21/2016 was a J. Gonzalez	during out	as encour drilling op n of 21'-6 I with cen	eratio ". At t	ns. A	fter a 1 mpletio	0 to 1 on of t	15-minu	ıte wa	iting p	eriod,	water
FROJ	EOI I	TOLUNAY-WONG		INEERS			3 -				Pag	e1 o	12

PRO	0.	JEC ⁻	City of Kingsville CLIEN Municipal Solid Waste Landfill Aerial Expansion		IG B laismith			ring, lı	nc.					
DEPTH (ft)	SAMPLE TYPE	SYMBOL/USCS	COORDINATES: N 27° 26' 50.1" W 97° 49' 24.3" SURFACE ELEVATION: 58.37' AMSL DRILLING METHOD: Dry Augered: 0-ft. to 68-ft. Wash Bored: to	(P) POCKET PEN (tsf) (T) TORVANE (psf)	STD. PENETRATION TEST (blows/ft)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	-AILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
		N	MATERIAL DESCRIPTION	<u>6</u>	ω						12			
- 35	X		Hard reddish tan and tan SANDY LEAN CLAY (CL) with ferrous stains and laminated sands	1	17/6" 25/6" 35/6" 17/6" 13/6" 19/6" 7/6"									
$\vdash \vdash$	Д		18.87' AMSL	,	16/6" 17/6"	<u> </u>								
- 40 -	X		Very stiff to hard reddish tan and tan FAT CLAY with SAND (CH) and ferrous stains LIGHT OLIVE GREEN TO GRAY CLAY		3/6" 7/6" 10/6" 9/6" 20/6" 27/6" 5/6" 14/6"	37		59	36				76	
- 45 -			-with trace gypsum crystals and ferrous stains		14/6" 17/6" 10/6" 18/6" 21/6" 18/6" 23/6" 30/6" 6/6" 20/6"									
- 50 -	X		-with calcareous nodules and ferrous stains	(P) 4.50+	21/6" 9/6" 17/6" 19/6" 9/6" 18/6" 23/6" 23/6" 26/6"	30	91	83	50	4.14	2		83	
- 55 -				(P) 4.50+ (P) 4.50+		34	87			2.88	2		83	
- 60 -			-with trace gypsum crystals and ferrous stains	(P) 4.50+ (P) 4.50+		34	O1			2.00			03	
- 65 - -				(P) 4.50+										
			-9.63' AMSL	(P) 4.50+										
			Bottom @ 68'											
DAT DAT LOG	E	BOR BOR	ING COMPLETED: 07/21/2016 was a	e during o at a depth backfilled	Irilling op n of 21'-6	eratio ". At t nent-b	ons. A he co pentor	fter a 1 mpletio	0 to 1	15-minu	ıte wa	iting p e opei	eriod,	water e-hole

PR	O.	IEC1	City of Kingsville CLIEN Municipal Solid Waste Landfill Aerial Expansion		IG B laismith			ring, l	nc.					
DEPTH (ft)	SAMPLE TYPE	SYMBOL/USCS	COORDINATES: N 27° 26' 49.7" W 97° 49' 17.0" SURFACE ELEVATION: 48.46' AMSL DRILLING METHOD: Dry Augered: 0-ft. to 82.5-ft. Wash Bored: to	(P) POCKET PEN (tsf) (T) TORVANE (psf)	STD. PENETRATION TEST (blows/ft)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	-AILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
0.5		1	MATERIAL DESCRIPTION	(E)	LS		Δ				₹			
35 -			Medium dense to dense reddish tan and gray CLAYEY SAND (SC) with gypsum crystals 12.46' AMSL/Very stiff to hard tan FAT CLAY with SAND (CH), slickensided, with calcareous nodules LIGHT OLIVE GREEN TO GRAY CLAY	(P) 4.50+		29	89						79	
40 -	X		-color changes to tan and reddish brown with gypsum crystals and ferrous stains		8/6" 12/6" 15/6"									
45 -			-color changes to tan, gray, and reddish brown	(P) 4.50+										
50 -	X		-color changes to tan and reddish brown		4/6" 9/6" 10/6"	30		73	51				82	
55 -			-color changes to tan and gray	(P) 4.50+ (P) 4.50+										
60 -				(P) 4.50+		26	94			0.61	2		81	
65 -			-color changes to tan, red, and brown	(P) 4.00										
70 -			-color changes to tan and gray	(P) 4.50+										
DAT DAT LOC	TE TE GG	BOR BOR	J. Gonzalez was a	e during d at a depth backfilled	Irilling op n of 14'-7	eratio ". At t nent-b	ns. A he co entor	fter a 1 mpletionite gro	0 to on of out.	15-minu the bori	ute wa ing, th	iting p e ope	eriod	, water e-hole

PR	OJ	IECT	Municipal Solid Waste Landfill Aerial Expansion	ORIN IT: N	IG B laismith	3-32 n Eng	inee	ring, l	nc.					
DEPTH (ft)	SAMPLE TYPE	SYMBOL/USCS	COORDINATES: N 27° 26' 49.7" W 97° 49' 17.0" SURFACE ELEVATION: 48.46' AMSL DRILLING METHOD: Dry Augered: 0-ft. to 82.5-ft. Wash Bored: to	(P) POCKET PEN (tsf) (T) TORVANE (psf)	STD. PENETRATION TEST (blows/ft)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
		, I	MATERIAL DESCRIPTION	€ _E	ST		□				₹			
70 -			Very stiff to hard tan and gray FAT CLAY with SAND (CH), slickensided with gypsum crystals and calcareous nodules LIGHT OLIVE GREEN TO GRAY CLAY -24.54' AMSL											
75 -			Medium dense to dense tan CLAYEY SAND (SC) with calcareous nodules	(P) 0.75		21		24	8				24	
	X		-with gypsum crystals and ferrous stains		5/6" 10/6" 13/6"									
80 -	X		-34.04' AMSL Bottom @ 82.5'		13/6" 20/6" 20/6"									
90 -														
105-														
DA ⁻	ΓE	BOR	ING COMPLETED: 07/28/2016 was a	during out a depthematical	drilling op n of 14'-7	eratio ". At t nent-b	ons. A he co pentor	fter a 1 impletionite gro	10 to 1 on of tout.	15-minu the bori	ute wa	iiting p e ope	eriod	, water e-hole

PRO	JECT	City of Kingsville CLIEN Municipal Solid Waste Landfill Aerial Expansion	ORIN IT: N	IG B laismith	3-33 n Eng	inee	ring, l	nc.					
DEPTH (ft) SAMPLE TYPE	SYMBOL/USCS	COORDINATES: N 27° 26' 55.9" W 97° 49' 11.3" SURFACE ELEVATION: 64.51' AMSL DRILLING METHOD: Dry Augered: 0-ft. to 86-ft. Wash Bored: to	(P) POCKET PEN (tsf) (T) TORVANE (psf)	STD. PENETRATION TEST (blows/ft)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
		MATERIAL DESCRIPTION	(E)	ST		ă				₹			
0 -		Medium dense to very dense tan CLAYEY SAND (SC) with gypsum crystals BODY I		2/6" 7/6" 9/6"									
5 -		-color changes to dark gray and gray with trace gravel		7/6" 11/6" 9/6"	16							47	
10 -		-color changes to tan and light gray sand partings		27/6" 50/6"									
15 -		-color changes to tan and white with trace caliche		50/5"									
\ X		48.01' AMSL Dense to very dense tan and white POORLY GRADED SAND with SILT (SP-SM), and trace caliche BODY II		17/6" 48/6" 50/3"	11		35	8				12	
20 -				17/6" 21/6" 27/6"									
25 -		-color changes to light gray and tan with gypsum crystals and ferrous stains		15/6" 17/6" 32/6"									
30		Medium dense to dense gray and white CLAYEY SAND (SC) with gypsum crystals		14/6" 22/6" 26/6"	42							20	
35 -		-color changes to tan		13/6" 21/6" 22/6"									
COMF DATE	BOR BOR	ING COMPLETED: 08/05/2016 was a	during o t a depth ackfilled	as encou drilling op n of 28'-2 I with cer	peration 2". At the ment-b	ns. A he co entor	fter a 1 mpletionite gro	10 to fon of tout.	15-minu the bori	ute wa ing, th	iting p e ope	eriod	, water e-hole

PR	OJ	IEC1	Municipal Solid Waste Landfill		IG B			ring, l	nc.					
DEPTH (ft)	SAMPLE TYPE	SYMBOL/USCS	Aerial Expansion COORDINATES: N 27° 26' 55.9" W 97° 49' 11.3" SURFACE ELEVATION: 64.51' AMSL DRILLING METHOD: Dry Augered: 0-ft. to 86-ft. Wash Bored: to MATERIAL DESCRIPTION	(P) POCKET PEN (tsf) (T) TORVANE (psf)	STD. PENETRATION TEST (blows/ft)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	-AILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
35 -		20021		_ =	0,									
	X		Medium dense to dense reddish tan CLAYEY SAND (SC) with gypsum crystals and ferrous stains		6/6" 9/6" 12/6"									
40 -	X		-color changes to tan and reddish tan		8/6" 16/6" 18/6"									
		2222 2222	20.01' AMSL											
45 -	X		Stiff to very stiff reddish tan LEAN CLAY with SAND (CL), slickensided, with ferrous stains SANDY SILTY CLAY BED		9/6" 12/6" 18/6"	29		43	24				79	
50	X		-color changes to reddish tan and tan with gypsum crystals		5/6" 6/6" 9/6"									
			12.51' AMSL Stiff to very stiff LEAN CLAY (CL), slickensided, with	(P) 2.00		40	79			1.06	3		96	
- 55 -			ferrous stains SANDY SILTY CLAY BED	(,,=,,,,										
			-color changes to reddish brown and tan with gypsum crystals	(P) 3.50										
- 60 -				(P) 4.00		34	87							
			-0.51' AMSL											
65 -			Very stiff to hard tan FAT CLAY (CH), slickensided, with gypsum crystals and ferrous stains LIGHT OLIVE GREEN TO GRAY CLAY	(P) 4.50+		32	42	64	33	2.57	2		95	
	X		-color changes to tan and reddish brown		7/6" 12/6"									
70					14/6"									
DAT DAT LOG	E G	BOR BOR	ING COMPLETED: 08/05/2016 was a	during of tadepthackfilled	drilling op n of 28'-2	eration ". At the nent-b	ons. A he co pentor	fter a 1 mpletionite gro	10 to fon of tout.	15-minu the bori	ute wa ing, th	iting p e ope Pag	eriod	, water e-hole

PR	OJ	JEC1	Municipal Solid Waste Landfill Aerial Expansion	ORIN	IG B laismith	3-33 Eng	inee	ring, l	nc.					
DEPTH (ft)	SAMPLE TYPE	SYMBOL/USCS	COORDINATES: N 27° 26' 55.9" W 97° 49' 11.3" SURFACE ELEVATION: 64.51' AMSL DRILLING METHOD: Dry Augered: 0-ft. to 86-ft. Wash Bored: to	(P) POCKET PEN (tsf) (T) TORVANE (psf)	STD. PENETRATION TEST (blows/ft)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
		١	MATERIAL DESCRIPTION	(£)	ST		۵				Ĭ.			
70 -			Very stiff to hard tan and reddish brown FAT CLAY (CH), slickensided, with gypsum crystals and ferrous stains LIGHT OLIVE GREEN TO GRAY CLAY	(P) 4.50+										
			-color changes to tan and light gray											
75 -	X		-with layers of calcareous nodules		9/6" 10/6" 21/6"									
			15 40! AMCI											
80 -			-15.49' AMSL Very stiff to hard tan FAT CLAY with SAND (CH) with gypsum crystals and ferrous stains LIGHT OLIVE GREEN TO GRAY CLAY	(P) 4.50+		18	106			3.57	3		77	
85 -			-color changes to tan and white -21.49' AMSL	(P) 4.50+										
			Bottom @ 86'											
90 -														
95 -														
100-														
105-														
DAT DAT	JE LE	BOR BOR	ING COMPLETED: 08/05/2016 was a	e during o at a depth backfilled	drilling op n of 28'-2	oeration 2". At the ment-b	ns. A he co entor	fter a 1 mpletionite gro	10 to 1 on of tout.	15-minu the bor	ute wa ing, th	iting p e ope Pag	eriod	, watei e-hole

PRO	JEC ⁻	T: City of Kingsville CLIEN Municipal Solid Waste Landfill Aerial Expansion		IG B laismith			ring, lı	nc.					
DEPTH (ft) SAMPLE TYPE	SYMBOL/USCS	COORDINATES: N 27° 26' 43.4" W 97° 49' 11.4" SURFACE ELEVATION: 61.14' AMSL DRILLING METHOD: Dry Augered: 0 ft. to 30 ft. Wash Bored: 30 ft. to 43 ft.	(P) POCKET PEN (tsf) (T) TORVANE (psf)	STD. PENETRATION TEST (blows/ft)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	-AILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
		MATERIAL DESCRIPTION	(E)	ST						₹	_		
0 -		Medium dense dark gray, gray, and light gray CLAYEY SAND (SC) with trace of organics	(P) 4.50+	2/6" 5/6" 6/6"	15	112			2.53	6		42	
		57.14' AMSL Very stiff to hard gray and light gray SANDY LEAN	(P) 4.50+		15	115	21	7				59	
- 5 -		SILTY CLAY (CL-ML) with calcareous nodules	(D) 4.50						0.40				
		-color changes to light gray	(P) 4.50+		14	114			6.13	4		62	
X		-color changes to light gray and tan		4/6" 12/6" 16/6"									
10		-color changes to white and light gray		11/6" 18/6" 16/6"									
		-becomes stiff 46.64' AMSL		5/6" 6/6" 8/6"									
- 15 -	1111	Medium dense to dense white and light gray SILTY		4/6" 6/6"	17		38	7				31	
		SAND (SM) with calcareous nodules BODY II		8/6" 4/6"									
X		-color changes to light gray and tan with ferrous stains		10/6" 19/6"									
$-\!$	1			23/6" 50/5"									
20 -	7			23/6" 50/4"									
	4	-color changes to light gray		27/6" 35/6" 50/4"	22							25	
- 25 -	7			5/6" 37/6" 45/6"									
\overline{X}	7 V	▼.		20/6" 39/6" 37/6"									
30	A	 -becomes medium dense 		8/6" 12/6" 9/6"	26		39	2				28	
\perp				4/6" 12/6" 10/6"	33							39	
	4	-color changes to tan and marine green		5/6" 6/6" 10/6"									
35	ЩЩ	5 5 5 7 7		3/6"									
DATE	BOR BOR ER:	ING COMPLETED: 06/22/2016 was a	water wa during dat a depth backfilled	Irilling op n of 28'-4	eratic l". At t	ns. A he co	fter a 1 mpletio	0 to 1	15-minu	ıte wa	iting p	eriod,	water
FROJ	LUI	TOLUNAY-WONG		NEERS			0				Pag	e1 of	f 2

PR	Ю.	JEC ⁻	Municipal Solid Waste Landfill	ORIN	IG B	-34 Eng	inee	ring, lı	nc.					
DEPTH (ft)	SAMPLE TYPE	SYMBOL/USCS	Aerial Expansion COORDINATES: N 27° 26' 43.4" W 97° 49' 11.4" SURFACE ELEVATION: 61.14' AMSL DRILLING METHOD: Dry Augered: 0 ft. to 30 ft. Wash Bored: 30 ft. to 43 ft. MATERIAL DESCRIPTION	(P) POCKET PEN (tsf) (T) TORVANE (psf)	STD. PENETRATION TEST (blows/ft)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
- 35 -					\ 8/6" <i>[</i>									
	X		Medium dense tan and marine green SILTY SAND \(\sum{(SM) with sand lenses and trace organics25,14' AMS/\(\sum{C}\) Hard tan and light gray LEAN CLAY (CL) SANDY SILTY CLAY BED	(P) 4.50+ (P) 4.50+	13/6"	30	91	40	17	0.93	1		91	
- 40 -				(P) 4.50+										
			18.14' AMSL	(P) 4.50+										
- 45 -			Bottom @ 43'											
- 50 -														
- 55 -														
- 60 -														
- 65 -														
- 70 -														
DA ¹ DA ¹ LO(TE TE GG	BOR	ING COMPLETED: 06/22/2016 was a	e during o	s encoun drilling open of 28'-4" with cem	eratio	ns. A he co	fter a 1 mpletion	0 to 1	15-minu	ıte wa	iting p e opei	eriod, n bore	water e-hole
			TOLUNAY-WONG	ENGI	NEERS	. INC	D					Pag	e2 of	f 2

PRO	JECT	Municipal Solid Waste Landfill Aerial Expansion	ORIN	l G B	Eng	inee	ring, I	nc.					
DEPTH (ft) SAMPLE TYPE	SYMBOL/USCS	COORDINATES: N 27° 26' 50.5" W 97° 48' 57.2" SURFACE ELEVATION: 64.50' AMSL DRILLING METHOD: Dry Augered: 0-ft. to 72.5-ft. Wash Bored: to	(P) POCKET PEN (tsf) (T) TORVANE (psf)	STD. PENETRATION TEST (blows/ft)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	-AILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
		MATERIAL DESCRIPTION	(a) t	ST		ä				₹			
0 -		Medium dense tan and brown CLAYEY SAND (SC) with trace caliche		5/6" 8/6" 7/6"									
5 -		-color changes to reddish brown with ferrous stains		5/6" 8/6" 5/6"	12		31	17				38	
		56.50' AMSL	(P) 4.50+		14	117			2.22	3		52	
10 -		Very stiff to hard reddish tan SANDY LEAN CLAY (CL) with gypsum crystals	(1) 4.501			117			2.22	3		32	
5 -		-color changes to reddish tan and tan with ferrous stains		5/6" 10/6" 12/6"									
		-color changes to reddish tan	(P) 4.50+		17	109	42	25					
0		-color changes to reddish tan and tan	(P) 4.50+										
		40.50! AMSI											
25 -		40.50' AMSL Medium dense to dense reddish tan and tan CLAYEY SAND (SC) with gypsum crystals and ferrous stains BODY III	(P) 4.50+		17	104			1.29	3		40	
30		-color changes to reddish tan		4/6" 7/6" 9/6"									
35 -		<u>√</u>		8/6" 13/6" 20/6"									
	BOR BOR	ING COMPLETED: 07/29/2016 was a	water wa e during d at a depth packfilled	Irilling op n of 30'-9	eratic ". At t	ns. A he co	fter a 1	10 to 1 on of t	15-minu	ıte wa	iting p e ope	eriod	, wate e-hole

	JEC1	Municipal Solid Waste Landfill Aerial Expansion		aismith	ı Eng	inee	ring, i	nc.					
DEPTH (ft)	SYMBOL/USCS	COORDINATES: N 27° 26' 50.5" W 97° 48' 57.2" SURFACE ELEVATION: 64.50' AMSL DRILLING METHOD: Dry Augered: 0-ft. to 72.5-ft. Wash Bored: to	(P) POCKET PEN (tsf) (T) TORVANE (psf)	STD. PENETRATION TEST (blows/ft)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	-AILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS
		MATERIAL DESCRIPTION	© _E	ST		ă				₹			
35 -	223 223 223 223 223 223 223 223 223 223	28.00' AMSL Medium dense to dense reddish tan and tan CLAYEY SAND (SC) with gypsum crystals and ferrous stains											
		Hard tan and light gray FAT CLAY with SAND (CH), gypsum crystals, and ferrous stains LIGHT OLIVE GREEN TO GRAY CLAY		17/6" 26/6" 30/6"	25		109	72				77	
10 -		-color changes to tan and reddish brown		8/6" 15/6" 24/6"									
45 -		-with sand partings		10/6" 16/6" 16/6"									
		16.00' AMSL Stiff to hard reddish brown and tan FAT CLAY (CH) with		4/6"	34							96	
50 X		gypsum crystals and ferrous stains LIGHT OLIVE GREEN TO GRAY CLAY		7/6" 10/6"									
55 -		-becomes slickensided with sand layers	(P) 2.00										
X		-color changes to tan		4/6" 7/6" 10/6"									
60 -			(P) 3.75		33	89	90	67	3.88	4		89	
65 -			(P) 4.25										
		-color changes to tan and reddish brown	(P) 4.50+										
70 -													
COMI DATE	BOR	ING COMPLETED: 07/29/2016 was a	water wa during d t a depth packfilled	Irilling op of 30'-9	eratio	ns. A he co	fter a 1	10 to 1 on of t	15-minu	ıte wa	iting p	eriod,	, wate

Loose to medium dense dark gray and gray CLAYEY SAND (SC) -with calcareous nodules	(P) POCKE I PEN (ts) (T) TORVANE (pst)		O CONTENT (%)	DRY UNITWEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
Loose to medium dense dark gray and gray CLAYEY SAND (SC) BODY I - 5 -	L)	18/6" 20/6"		٥				Ā			
Loose to medium dense dark gray and gray CLAYEY SAND (SC) -with calcareous nodules		20/6"	10								
- 5 -		20/6"	10								
										36	
-color changes to light gray and tan		4/6" 5/6" 5/6"									
- 10color changes to tan		4/6" 5/6" 6/6"	12		47	28				44	
- 15 - V		2/6" 4/6" 6/6"									
-color changes to light gray with ferrous stains		4/6" 10/6" 14/6"									
-becomes very dense and color changes to light gray and tan		15/6" 24/6" 50/6"	25							32	
- 25 -		12/6" 14/6" 15/6"									
- 30 - becomes dense		5/6" 17/6" 27/6"									
- 35 × 1/2		4/6"									
COMPLETION DEPTH: 68 ft DATE BORING STARTED: 06/24/2016 grade du Was at a LOGGER: PROJECT NO.: 68 ft REMARKS: Free wate DATE BORING COMPLETED: 06/24/2016 was at a Was back	uring dri depth o	illing ope of 18'-3'	eratio	ns. Af ne coi	fter a 1 mpletic	0 to 1 on of t	15-minu	ite wa	iting p e oper	eriod,	water -hole

PROJEC [*]			IG B			ring, lı	nc.					
	Municipal Solid Waste Landfill Aerial Expansion											
DEPTH (ft) SAMPLE TYPE SYMBOL/USCS	COORDINATES: N 27° 26' 56.8"	(P) POCKET PEN (tsf) (T) TORVANE (psf)	STD. PENETRATION TEST (blows/ft)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
35	Medium dense light gray and tan CLAYEY SAND (SC)		7/6" [
1000 1000 1000 1000 1000 1000 1000 100	BODY I		7/6" 8/6"									
40	-with sand seams, calcareous nodules, and ferrous staining		6/6" 10/6" 13/6"	21		47	30				35	
	-color changes to reddish brown and light gray		4/6" 8/6" 10/6"									
- 45 -	13.13' AMSL	,										
	Stiff to very stiff reddish brown and light gray FAT CLAY (CH), slickensided, with ferrous staining	(P) 4.50+										
- 50 -	-with sand seams and calcareous nodules		4/6" 6/6" 8/6"	42							96	
- 55 -	-color changes to light gray with sand layers		11/6" 12/6" 14/6"									
- 60	-becomes hard		11/6" 21/6" 26/6"	37		70	44				94	
- 65 -			7/6" 8/6" 9/6"									
	-color changes to brown yellow, reddish brown, and light gray -8.87' AMSL Bottom @ 68'	,	7/6" 10/6" 10/6"									
- 70 -	DUILUIII (00											
COMPLET DATE BOR	ING COMPLETED: 06/24/2016 was a	e during o	as encoun drilling open of 18'-3' with cem	eratio	ns. A he co	fter a 1 mpletio	0 to 1	15-minu	ıte wa	iting p e opei	eriod, n bore	water e-hole
	 TOLUNAY-WONG	ENGI	NEERS	, INC	D					Pag	e2 of	12

PRO	JECT	: City of Kingsville CLIEN Municipal Solid Waste Landfill Aerial Expansion		IG B laismith			ing, lı	nc.					
DEPTH (ft) SAMPLE TYPE	SYMBOL/USCS	COORDINATES: N 27° 26' 57.1" W 97° 49' 17.6" SURFACE ELEVATION: 45.52' AMSL DRILLING METHOD: Dry Augered: 0-ft. to 12-ft. Wash Bored: 12-ft. to 48-ft.	(P) POCKET PEN (tsf) (T) TORVANE (psf)	STD. PENETRATION TEST (blows/ft)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
		MATERIAL DESCRIPTION	(F)	S		ă				Ā			
0 -		Very dense light gray and tan SILTY SAND (SM) BODY II											
X	7	-with ferrous staining		6/6" 16/6" 50/5"									
5 -													
		▼.		11/6" 50/5"	20		33	9				20	
10 -	7	-with calcareous nodules		23/6" 37/6" 50/6"									
	ARAZA A	31.02' AMSL		6/6"	31							52	
15 -		Very stiff to hard tan and light tan SANDY LEAN SILTY CLAY (CL-ML) SANDY SILTY CLAY BED		7/6" 10/6"	31							32	
20		-color changes to tan and light gray with ferrous staining		9/6" 17/6" 27/6"									
				7/6" 12/6" 13/6"									
25 -		19.02' AMSL											
X		Stiff to very stiff reddish brown and light gray FAT CLAY (CH) with calcareous nodules and ferrous staining LIGHT OLIVE GREEN TO GRAY CLAY		4/6" 5/6" 9/6"	33		56	39				99	
30 -		-color changes to light gray with sand layers		5/6" 7/6" 12/6"									
35				5/6"	34							86	
COME	BOR	ING COMPLETED: 06/25/2016 was a	during o t a depth ackfilled	as encou drilling op n of 9'-3" I with cer	eration . At the ment-b	ns. A e com entor	fter a 1 pletion nite gro	10 to	15-minu ne borin	ute wa ig, the	iting popen open Pag	eriod	, water hole

PR	OJ	IEC7	T: City of Kingsville CLIEN Municipal Solid Waste Landfill Aerial Expansion	ORIN	IG B Naismith	-37 Eng	inee	ring, lı	nc.					
DEPTH (ft)	SAMPLE TYPE	SYMBOL/USCS	COORDINATES: N 27° 26' 57.1" W 97° 49' 17.6" SURFACE ELEVATION: 45.52' AMSL DRILLING METHOD: Dry Augered: 0-ft. to 12-ft. Wash Bored: 12-ft. to 48-ft. MATERIAL DESCRIPTION	(P) POCKET PEN (tsf) (T) TORVANE (psf)	STD. PENETRATION TEST (blows/ft)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
- 35 -	X		Stiff to very stiff light gray and brownish tan FAT CLAY (CH) with sand seams, calcareous nodules, and ferrous staining LIGHT OLIVE GREEN TO GRAY CLAY		7/6" 12/6"									
- 40	X				4/6" 5/6" 7/6"									
- 45 -	X		-color changes to light gray and reddish brown		6/6" 6/6" 9/6"									
	X		-color changes to light gray -2.48' AMSL		4/6" 5/6" 9/6"	35		80	51				86	
- 50 -			Bottom @ 48'											
DAT DAT LOC	TE I	BOR BOR	ING COMPLETED: 06/25/2016 was a J. Garcia	during of	as encoundrilling open of 9'-3".	eration At th	ns. A e con	fter a 1 opletion	0 to	15-minເ	ıte wa	iting p	eriod	water
		٠.١	TOLUNAY-WONG	ENG	INEERS	, INC	D						je2 o	f 2

PR	Ю.	JEC.	T: City of Kingsville CLIEN Municipal Solid Waste Landfill		IG B laismith			ring, lı	nc.					
			Aerial Expansion											
DEРТН (ft)	SAMPLE TYPE	SYMBOL/USCS	COORDINATES: N 27° 27' 03.76"	(P) POCKET PEN (tsf) (T) TORVANE (psf)	STD. PENETRATION TEST (blows/ft)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	-AILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
		l N	MATERIAL DESCRIPTION	6	<u></u> σ		_				12			
- 35 -	X		Very stiff to hard reddish brown and light gray SANDY FAT CLAY (CH) with sand seams and layers 3.64' AMSL	(P) 4.50+	8/6" 10/6"									
			Stiff to hard light gray FAT CLAY (CH), slickensided, with calcareous nodules and ferrous stains	(P) 4.50+		42	78	100	72	2.95	2		93	
- 40 -			-color changes to reddish brown and light gray LIGHT OLIVE GREEN TO GRAY CLAY	(P) 4.50+ (P) 4.50+										
- 45 -			-color changes to tannish brown and light gray with trace organics	(P) 4.50+										
- 50 -	X		-color changes to light gray	(P) 4.50+	5/6" 6/6" 8/6"	30	91			2.14	3		87	
	X				7/6" 7/6" 4/6" 5/6" 8/6"									
- 55 -	X		-color changes to tannish brown and light gray		5/6" 7/6" 9/6"									
	V		-color changes to light gray		6/6" 7/6"									
		//	-16.36' AMSL Bottom @ 58'	,	9/6"									
- 60 -														
- 65 -														
- 70 -	-													
DA DA	TE TE GG	BOR	ING COMPLETED: 06/23/2016	e during o at a depth backfilled	drilling open of 5'-5". with cem	eration At the nent-b	ons. A e con pentor	fter a 1 opletion	0 to	15-minເ	ıte wa	iting p open	eriod,	water hole
			TOLUNAY-WONG	ENGI	NEERS	. INC	C							

PRO	JEC ⁻	T: City of Kingsville CLIEN Municipal Solid Waste Landfill		IG B			ring, lı	nc.					
		Aerial Expansion											
DEPTH (ft)	SYMBOL/USCS	COORDINATES: N 27° 27' 01.3" W 97° 48' 57.3" SURFACE ELEVATION: 60.26' AMSL DRILLING METHOD: Dry Augered: 0 ft. to 26 ft. Wash Bored: 26 ft. to 68 ft.	(P) POCKET PEN (tsf) (T) TORVANE (psf)	STD. PENETRATION TEST (blows/ft)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	-AILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
		MATERIAL DESCRIPTION	(F)	ω						Ę			
0 -		Medium dense to dense tan and light gray CLAYEY SAND FILL with trace gravel		8/6" 9/6" 6/6"	18							33	
$ \setminus$	₩	-color changes to brown		40/6" 27/6" 19/6"									
5 -	***	55.76' AMSL Medium dense to dense brown and reddish brown		6/6"									
" X		CLAYEY SAND (SC) BODY I		7/6" 8/6"									
		-color changes to tan and gray with calcareous nodules		4/6" 5/6" 6/6"									
$\exists X$				5/6" 6/6" 8/6"	11		36	20				49	
10		-color changes to tan and light gray		4/6" 6/6" 7/6"									
		-color changes to light gray		7/6" 8/6" 11/6"									
15 -		-color changes to light gray and tan with ferrous stains		6/6" 12/6" 19/6"									
$-\nabla$		-color changes to light gray		11/6" 19/6" 22/6"									
		41.76' AMSL Stiff to hard light gray SANDY LEAN CLAY (CL) with		3/6"	19							65	
20		calcareous nodules and ferrous stains		4/6" 5/6" 6/6"									
X				9/6" 13/6" 8/6"									
25 -		-color changes to light tan and light gray	(P) 4.50+	11/6" 20/6"									
		color changes to light gray	(P) 4.00										
30		-color changes to light gray and tan	(P) 4.50+	7/6" 11/6" 13/6"	19	102			1.14	7		50	
				12/6" 16/6" 20/6"									
35				8/6"									
DATE	BOR BOR SER:	ING COMPLETED: 06/24/2016 was a	water wa e during d at a depth packfilled	Irilling op n of 26'-6	eratic 5". At t	ns. A he co	fter a 1 mpletio	0 to 1	15-minu	ıte wa	iting p e oper	eriod, n bore	water -hole
		 TOLUNAY-WONG	ENG	NEERS	SINIC						Pag	e1 of	2

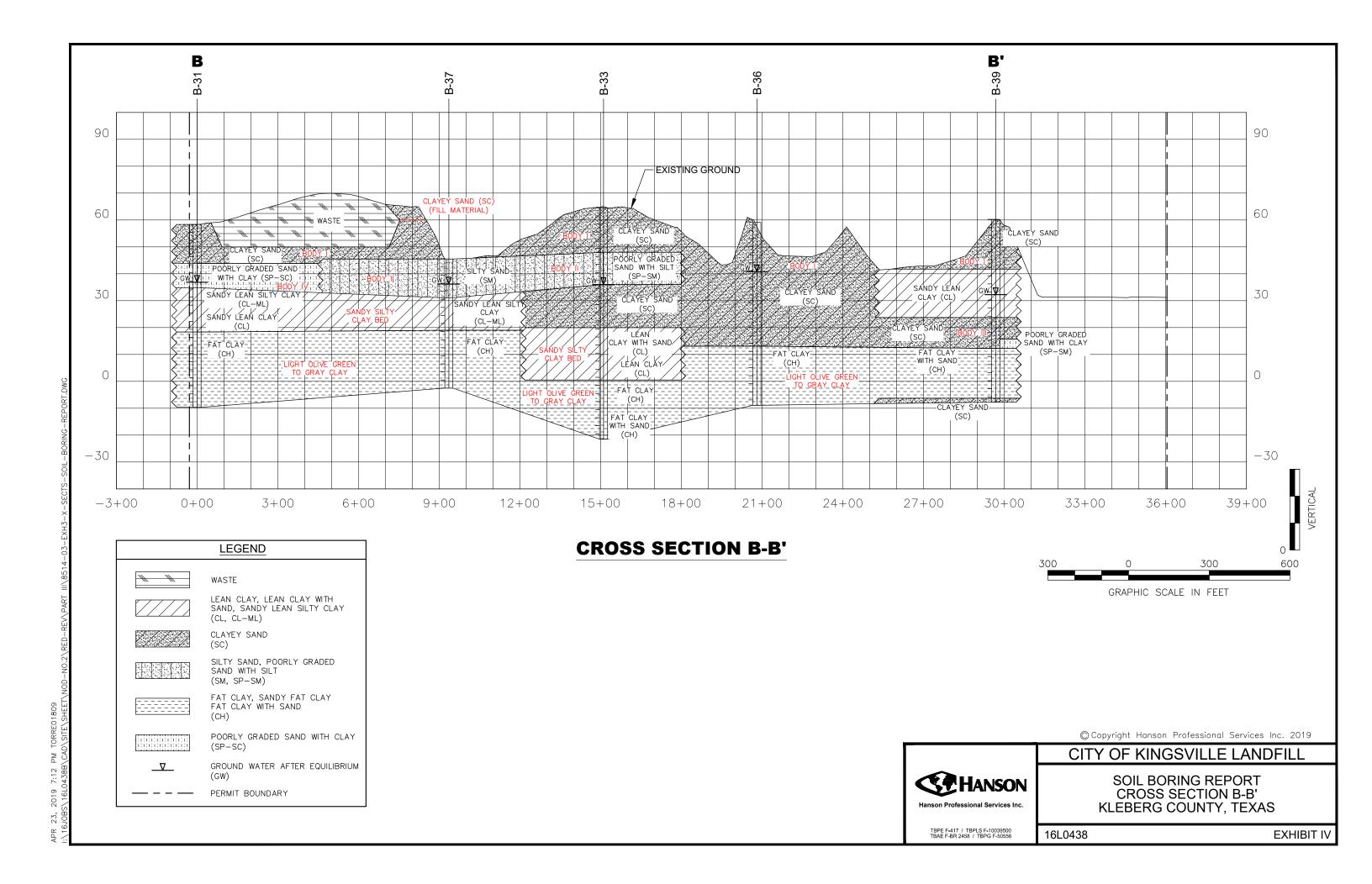
PRO	ΟJ	IEC1	: City of Kingsville CLIEN Municipal Solid Waste Landfill Aerial Expansion		IG B			ring, lı	nc.					
DEPTH (ft)	SAMPLE TYPE	SYMBOL/USCS	COORDINATES: N 27° 27' 01.3" W 97° 48' 57.3" SURFACE ELEVATION: 60.26' AMSL DRILLING METHOD: Dry Augered: 0 ft. to 26 ft. Wash Bored: 26 ft. to 68 ft. MATERIAL DESCRIPTION	(P) POCKET PEN (tsf) (T) TORVANE (psf)	STD. PENETRATION TEST (blows/ft)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
- 35	X		Stiff to hard light gray and tan SANDY LEAN CLAY (CL)		12/6" 16/6"									
	X		with ferrous stains 23.76' AMSL Medium dense to dense light gray CLAYEY SAND (SC) with ferrous stains BODY III		7/6" 8/6" 11/6"									
- 40	X				11/6" 12/6" 7/6" 10/6"	25		69	51				45	
			15.76' AMSL		13/6" 13/6" 19/6" 21/6"									
- 45 -	X		Dense light gray POORLY GRADED SAND with CLAY (SP- SC)		12/6" 21/6" 20/6" 11/6"									
	X		12.26' AMSL Hard reddish brown and light gray FAT CLAY with	(P) 4.50+	16/6" 16/6"									
- 50 -			SAND (CH) LIGHT OLIVE GREEN TO GRAY CLAY	(P) 4.50+		28	93			0.85	1		72	
			-becomes slickensided with calcareous nodules	(P) 4.50+										
- 55 - 			-with ferrous stains	(P) 4.50+ (P) 4.50+										
				(P) 4.50+										
- 60 -				(P) 4.50+										
	X	$/\!/$	-becomes stiff		7/6" 7/6" 7/6"									
- 65 -			-6.24' AMSL											
	X		Medium dense light gray CLAYEY SAND (SC) with calcareous nodules and ferrous stains -7.74' AMSL Bottom @ 68'		6/6" 10/6" 13/6"	20	102	61	45	1.91	5		46	
70 -														
DAT DAT LOG	E I	BOR BOR	ING COMPLETED: 06/24/2016 was a	during data	s encoun Irilling ope of 26'-6" with cem	eratic	ns. A he co	fter a 1 mpletio	0 to 1	15-minu	ıte wa	iting p	eriod,	water
	<i>,</i> ,,,	_011	TOLUNAY-WONG		NEERS							Pag	e2o	2

PROJEC	City of Kingsville CLIEN Municipal Solid Waste Landfill Aerial Expansion	ORIN	IG B Naismith	-40 Eng	inee	ring, li	nc.					
DEPTH (ft) SAMPLE TYPE SYMBOL/USCS	COORDINATES: N 27° 27' 09.97" W 97° 49' 11.18" SURFACE ELEVATION: 52.31' AMSL DRILLING METHOD: Dry Augered: 0 ft. to 22 ft. Wash Bored: 22 ft. to 33.75 ft.	(P) POCKET PEN (tsf) (T) TORVANE (psf)	STD. PENETRATION TEST (blows/ft)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	-AILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
	MATERIAL DESCRIPTION	<u>@</u> E	S		۵				Ĭ.			
0 -	Loose to very dense light gray and gray SILTY SAND (SM) with trace caliche		4/6" 4/6" 6/6"									
	-color changes to light gray and tan with ferrous stains		5/6" 7/6" 11/6"	16		35	10				31	
5 -	-color changes to light gray with calcareous nodules		7/6" 17/6" 17/6" 12/6"									
	-color changes to light gray and white		21/6" 34/6" 12/6"	18							34	
10 -	-color changes to white		27/6" 50/3" 15/6" 50/3"									
	-color changes to light gray and white		25/6" 50/4"									
15 - 🗸	37.81' AMSL Hard light gray FAT CLAY with SAND (CH), calcareous		7/6"	22		70	41				80	
	nodules, and ferrous stains		26/6" 50/5" 5/6"									
	▼		17/6" 28/6" 10/6" 30/6"									
20	\(\frac{\frac{1}{2}}{2} \) 31.81' AMSL		35/6"									
	Hard light gray SANDY FAT CLAY (CH) with calcareous nodules and ferrous stains		9/6" 25/6" 35/6" 16/6"	31							59	
			32/6" 50/5" 16/6"									
25 -	25.81' AMSL		31/6" 50/5"									
	Dense to very dense light gray CLAYEY SAND (SC) with calcareous nodules		8/6" 18/6" 27/6" 6/6"	30		53	32				49	
30			18/6" 50/6" 6/6" 20/6"									
- H 222			50/5" 3/6"	16							30	
X	18.81' AMSL Bottom @ 33.5'		40/6" 50/3"	+-								
35 -	3											
DATE BOR	ING COMPLETED: 06/22/2016 was a	during out	as encour drilling op h of 19'. <i>I</i> I with cen	eratio	ns. A comp	fter a 1 detion	0 to of the	15-minu	ıte wa	iting p pen b	eriod,	water
	TOLUNAY-WONG	ENG	INEERS	s, INC	D							

PROJEC ³	LOG OF BO		IG B			rina. lı	nc.					
	Municipal Solid Waste Landfill Aerial Expansion	•••	i diomini	9		9,	.0.					
DEPTH (ft) SAMPLE TYPE SYMBOL/USCS	COORDINATES: N 27° 27' 09.8" W 97° 49' 17.4" SURFACE ELEVATION: 50.20' AMSL DRILLING METHOD: Dry Augered: 0-ft. to 62.5-ft. Wash Bored: to	(P) POCKET PEN (tsf) (T) TORVANE (psf)	STD. PENETRATION TEST (blows/ft)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	-AILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
	MATERIAL DESCRIPTION	(F)	ST		ă				₹			
0 -	Loose to medium dense gray CLAYEY SAND (SC) with calcareous nodules BODY I		4/6" 5/6" 5/6"	8							35	
- 5 -	-color changes to light gray		4/6" 5/6" 6/6"									
2533	41.70' AMSL											
10	Stiff to very stiff gray SANDY FAT CLAY (CH) LIGHT OLIVE GREEN TO GRAY CLAY		5/6" 8/6" 11/6"	20		78	52				64	
- 15 -	-becomes hard and color changes to brown with interbedded sand seams		9/6" 17/6" 25/6"									
	-color changes to brown and tan		7/6" 12/6" 14/6"									
- 20 -	-color changes to tan with sand layers		3/6" 4/6" 6/6"	36							64	
- 25 -	-color changes to brown with sand partings		5/6" 4/6" 6/6"									
30	-color changes to brown and tan		6/6" 7/6" 8/6"	31		52	30				51	
- 35 -			4/6" 6/6" 6/6"									
DATE BOR DATE BOR LOGGER:	M. Anderson was a	e during o	as encour drilling op n of 19'-3	eratio	ns. A	fter a 1 mpletio	0 to 1	15-minu	ite wa	iting p	eriod,	water
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PRO	OJ	IECT		ORIN IT: N	IG B	- 41 Eng	inee	ring, lı	nc.					
			Municipal Solid Waste Landfill Aerial Expansion											
DEPTH (ft)	SAMPLE TYPE	SYMBOL/USCS	COORDINATES: N 27° 27' 09.8" W 97° 49' 17.4" SURFACE ELEVATION: 50.20' AMSL DRILLING METHOD: Dry Augered: 0-ft. to 62.5-ft. Wash Bored: to	(P) POCKET PEN (tsf) (T) TORVANE (psf)	STD. PENETRATION TEST (blows/ft)	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	PASSING #200 SIEVE (%)	OTHER TESTS PERFORMED
- 35 -	\dashv	1	MATERIAL DESCRIPTION 14.20' AMSL	E -	<u>σ</u>						正			
33			Stiff to very stiff gray SANDY FAT CLAY (CH)	(P) 3.25		27	92						77	
			Very stiff brown FAT CLAY with SAND (CH) LIGHT OLIVE GREEN TO GRAY CLAY	(F) 3.23		21	92						,,	
- 40 -	X		-color changes to brown and tan		6/6" 13/6" 11/6"									
					4 (6)									
- 45 -	X				4/6" 9/6" 14/6"									
- 50	X				6/6" 8/6" 9/6"	35		97	75				84	
- 55 -	X		-color changes to brown and gray		7/6" 9/6" 12/6"									
			-color changes to gray	(P) 4.50+										
- 60 -			-12.30' AMSL	(P) 3.50										
		,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	Bottom @ 62.5'											
- 65 -														
- 70 -														
DAT DAT LOG	E G	BOR BOR	M. Anderson was a	water wa during d at a depth packfilled	Irilling op n of 19'-3	eratic	ns. A he co	fter a 1 mpletio	0 to 1	15-minເ	ite wa	iting p e opei	eriod, n bore	water -hole
			TOLUNAY-WONG	ENGI	NEERS	S, INC	D					rag	e2 of	2

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CITY OF KINGSVILLE LANDFILL PART III, ATTACHMENT 4 ATTACHMENT 6

WATER WELL SURVEY DATA TABLE

Well ID	Figure 4.15 ID	Well Use	Aquifer	Well Depth (Ft.)	Approximate Distance from Site
			Wells Identified by FEE		•
83-34-501	501	Domestic	Evangeline Aquifer (Goliad Sand)	631	~0.6 Miles South
83 34 502	N/A	Domestic	Evangeline Aquifer (Goliad Sand)	656	~1.8 Miles South
83-34-503	503	N/A	Aguifer Code Is Not Applicable to this Well	6131	~ 0.8 Miles Northeast
83-34-2C	2C	Domestic	*Evangeline Aquifer (Goliad Sand)	618	~0.9 Miles Northeast
83-34-2D	2D	Other	*Evangeline Aquifer (Goliad Sand)		~0.9 Miles Northeast
83-34-2H	2H	Domestic	*Evangeline Aquifer (Goliad Sand)		~0.9 Mile Northwest
83-34-2K	2K	Domestic	*Evangeline Aquifer (Goliad Sand)		~0.9 Miles Northwest
83-34-2K	2K	Domestic	*Evangeline Aquifer (Goliad Sand)		~0.9 Miles Northwest
83-34-4K	4K	Domestic	*Evangeline Aquifer (Goliad Sand)	692	~0.9 Miles Southwest
83-34-45	45	Domestic	*Evangeline Aquifer (Goliad Sand)		~0.8 Miles Southwest
83-34-5B	5B	Domestic	*Evangeline Aquifer (Goliad Sand)		~0.4 Miles Southeast
83-34-5D	5D	Domestic	*Evangeline Aquifer (Goliad Sand)		~0.7 Miles Northeast
83-34-5E	5E	Domestic	*Evangeline Aquifer (Goliad Sand)	612	~0.5 Miles Northwest
83-34-5F	5F	Domestic	*Evangeline Aquifer (Goliad Sand)		~0.5 Miles North
83-34-5G	5G	Domestic	*Evangeline Aquifer (Goliad Sand)		~0.9 Miles Southwest
83-34-5H	5H	Domestic	*Evangeline Aquifer (Goliad Sand)	687	~0.5 Miles South
83-34-5U	5J	Domestic	*Evangeline Aquifer (Goliad Sand)	640	~ 0.7 Miles Northeast
83-34-1	1(1)	Irrigation	*Evangeline Aquifer (Goliad Sand)		~0.5 Miles Northwest
83-34-2	2(1)	Domestic	*Evangeline Aquifer (Goliad Sand)	540	~1.0 Miles Northeast
83-34-4	4(1)	Domestic	*Evangeline Aquifer (Goliad Sand)		~0.7 Miles Northwest
83-34-5	5(1)	Domestic	*Evangeline Aquifer (Goliad Sand)	573	~0.3 Miles Southwest
83-34-5	5(2)	Domestic	*Evangeline Aquifer (Goliad Sand)		~0.4 Miles Northwest
83-34-5	5(3)	Domestic	*Evangeline Aquifer (Goliad Sand)	662	~0.3 Miles Southeast
83-34-5	5(4)	Domestic	*Evangeline Aquifer (Goliad Sand)		~0.5 Miles Southeast
83-34-5	5(5)	Domestic	*Evangeline Aquifer (Goliad Sand)	661	~0.7 Miles Southwest
83-34-5	5(6)	Domestic	*Evangeline Aquifer (Goliad Sand)		~0.3 Miles East
83-34-5	5(7)	Supply	*Evangeline Aquifer (Goliad Sand)		~0.9 Miles Southeast
83-34-5	5(8)	Industrial	*Evangeline Aquifer (Goliad Sand)		~0.5 Miles West
83-34-5	5(9)	Domestic	*Evangeline Aquifer (Goliad Sand)	645	~0.8 Miles Southwest
83-34-5	5(10)	Domestic	*Evangeline Aquifer (Goliad Sand)	656	~0.5 Miles Southeast
83-34-5	5(11)	Domestic	*Evangeline Aquifer (Goliad Sand)	663	~0.7 Miles Southwest
83-34-5	5(12)	Domestic	*Evangeline Aquifer (Goliad Sand)	612	~0.3 Miles Southeast
			Additional Wells Identified by Hanson Profe		
Tracking #	Owner Well #	Well Use	Aguifer	Well Depth (Ft.)	Approximate Distance from Site
155775	No Data	Domestic	*Evangeline Aquifer (Goliad Sand)	· ` ` ´	~0.7 Miles Northeast
100867	NOLLKINPER #2	Rig Supply	*Evangeline Aquifer (Goliad Sand)		~0.6 Miles Northeast
425307	2	Stock	*Evangeline Aquifer (Goliad Sand)		~0.9 Miles Northeast
425295	1	Domestic	*Evangeline Aquifer (Goliad Sand)		~0.9 Miles Northeast
494827	FLAMINGO #1		*Evangeline Aquifer (Goliad Sand)		~1.0 Miles Southeast
372796	1		*Evangeline Aquifer (Goliad Sand)		~1.0 Miles Southeast
155888	No Data	Industrial	*Evangeline Aquifer (Goliad Sand)		~0.5 Miles Southwest
305970	No Data	Industrial	*Evangeline Aquifer (Goliad Sand)		~0.8 Miles Southwest
342528	No Data	Domestic	*Evangeline Aquifer (Goliad Sand)		~0.5 Miles Southwest
178262	No Data	Domestic	*Evangeline Aquifer (Goliad Sand)		~0.2 Miles Southwest
208460	No Data	Domestic	*Evangeline Aquifer (Goliad Sand)		~0.8 Milles Northwest
246291	No Data	Domestic	*Evangeline Aquifer (Goliad Sand)		~0.8 Milles Northwest
413217	No Data	Domestic	*Evangeline Aquifer (Goliad Sand)		~0.8 Milles Northwest
295148	No Data	Domestic	*Evangeline Aquifer (Goliad Sand)	600	~0.5 Milles Northeast
8334503	No Data	Oil or Gas	Aquifer Code Is Not Applicable to this Well	6131	~0.3 Milles East
166733	No Data	Industrial	*Evangeline Aquifer (Goliad Sand)	612	~1.0 Miles Southeast
494833	No Data	Stock	*Evangeline Aquifer (Goliad Sand)	560	~0.9 Miles Northwest
8334501	No Data	Domestic	Evangeline Aquifer (Goliad Sand)	631	~0.4 Milles South
190906	No Data	Domestic	*Evangeline Aquifer (Goliad Sand)	648	~1.0 Miles Southwest
			d Screening Interval	3.0	

THE CITY OF KINGSVILLE LANDFILL TCEQ PERMIT MSW 235C

PERMIT AMENDMENT APPLICATION Volume 4 of 6



CITY OF KINGSVILLE, KLEBERG COUNTY, TEXAS

September 2018
Revision 1 – November 2018
Revision 2 – February 2019
Revision 3 – April 2019

Prepared by



HANSON PROJECT NO. 16L0438-0003

CITY OF KINGSVILLE LANDFILL PART III ATTACHMENT 5

ALTERNATIVE LINER AND OVERLINER
POINT OF COMPLIANCE DEMONSTRATIONS

ATTACHMENT 5 ALTERNATIVE LINER AND OVERLINER DESIGN AND POINT OF COMPLIANCE DEMONSTRATIONS

CONTENTS

1. INTRODUCTION

- 1.1 Purpose and Scope
- 1.2 Proposed Alternate Liner
- 1.3 Proposed Overliner System
- 1.4 Site Geology and Hydrogeology
- 1.5 Liner Quality Control Plan (LQCP)

2. ALTERNATE LINER DEMONSTRATION METHODS

- 2.1 HELP Model
- 2.2 MULTIMED Model
- 2.3 Landfill Configurations Analyzed
- 2.4 Slope Stability Analysis
- 2.5 Alternate Composite Final Cover Design Demonstration

3. MODEL INPUT PARAMETERS

4. POINT OF COMPLIANCE DEMONSTRATION RESULTS

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- A.2 Permit Amendment Application MSW-235C Landfill Completion Excavation Plan
- A.3 Permit Amendment Application MSW-235C Landfill Point of Compliance Locations
- A.4 Permit Amendment Application MSW-235C Landfill Groundwater Contour Map/Hydraulic Gradient
- A.5. Permit Amendment Application MSW-235C Landfill Typical Profile-Interim Landfill with Alternative Liner
- A.6 Permit Amendment Application MSW-235C Landfill Typical Profile-Closed Landfill with Alternative Liner
- A.7 Permit Amendment Application MSW-235C Landfill Typical Profile-Interim Landfill with Alternative Liner and Overliner
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- B.4 HELP Output for Alternative Liner Interim Case 2-Location 2
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HELP MODEL ANALYSIS ALTERNATIVE LINER AND OVERLINER

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 - C.7.1 Appendix E Alternate Liner Design Report-City of Kingsville Municipal Solid Waste Disposal Facility Permit Amendment Application MSW 235-B', Pages 467-473 from Permit 235-B Amendment Volume V of V
 - C.7.2 City of Kingsville MSWLF-Permit 235-B Attachment 4-Geology Report, 4.0 Regional Aquifers', Pages 36-39 from 235-B Amendment Volume II of V
 - C.7.3 City of Kingsville MSWLF-Permit 235-B 'Figure 5.16 Boring Plot Plan', Page 197 from Permit 235-B Amendment Volume II of V
 - C.7.4 City of Kingsville MSWLF-Permit 235-B 'Subsurface Exploration Record B/W No. 21', Page 371 from Permit 235-B Amendment Volume II of V
 - C.7.5 City of Kingsville MSWLF-Permit 235-B 'Subsurface Exploration Record B/W No. 18', Page 369 from Permit 235-B Amendment

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- C.7.6 City of Kingsville MSWLF-Permit 235-B 'Subsurface Exploration Record B/W No. 25', Page 374 from Permit 235-B Amendment Volume II of V
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- D.3 Typical Profile-Alternative Liner and Overliner Interim Landfill DAF
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- F.1 MULTIMED Output for Alternative Liner Interim Case 1-Location 1
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- F.4 MULTIMED Output for Alternative Liner Interim Case 4-Location 4
- F.5 MULTIMED Output for Alternative Liner Closed Case 5-Location 1
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- F.11 MULTIMED Output for Alternative Liner/Overliner Interim Case 3OL-Location 3
- F.12 MULTIMED Output for Alternative Liner/Overliner Interim Case 4OL-Location 4
- F.13 MULTIMED Output for Alternative Liner/Overliner Closed Case 5OL-Location 1
- F.14 MULTIMED Output for Alternative Liner/Overliner Closed Case 6OL-Location 2
- F.15 MULTIMED Output for Alternative Liner/Overliner Closed Case 7OL-Location 3
- F.16 MUTLIMED Output for Alternative Liner/Overliner Closed Case 8OL-Location 4

APPENDIX G

ALTERNATE COMPOSITE FINAL COVER DESIGN DEMONSTRATION

G.1 Infiltration Rate Comparison-GCL Alternate Final Cover

APPENDIX H

MULTIMED MODEL SENSITIVITY ANALYSIS

- H.1 MULTIMED Model Sensitivity Analysis Tables
- H.2 HELP Model Input and Output Files for Case 1OL Base Case & Case 1OL Base Case With Liner Defects (4 Defects/Acre)
- H.3 MULTIMED Model Output Files

APPENDIX I

PRE-SUBTITLE D AREA (SECTOR 8A AND SECTOR 8B) FINAL COVER TEST DATA & PROPERTIES FIGURE

I.1 Pre-Subtitle D Area (Sector 8A and Sector 8B) Final Cover Test Data & Properties

Appendices C.7.1 through C.7.11. The upper clay (light olive green clay) is ubiquitous under the site with a minimum proven thickness of 38 feet thick, the Chicot Aquifer is approximately 220 feet below ground surface, and the Evangeline Aquifer is approximately 500 feet below ground surface. The light olive green clay layer serves as aquiclude between the uppermost acquifer below the landfill site and the Chicot acquifer. To provide a conservative assumption given the bottom of the landfill and the groundwater, the percolation through the alternate liner and overliner system was assumed to be conveyed directly to the upper strata and therefore travel time, dilution, and attenuation are not accounted for in this analysis for upper soils.

2.4 SLOPE STABILITY ANALYSIS

The alternative liner and overliner system were analyzed for slope stability by performing two dimensional, effective stress slope stability analyses for the final, closed geometry, using the computer program SLIDE. The slope stability calculations are presented in Part III Attachment 4, Appendix 2-Section 7 WASTE MASS STABILITY and Appendix F: Graphical Representation of Mass Stability Analyses Results.

2.5 ALTERNATE COMPOSITE FINAL COVER DESIGN DEMONSTRATION

The alternate composite final cover design demonstration will demonstrate that the use of a geosynthetic clay liner (GCL) will provide equivalent infiltration and protection from wind and water erosion as the conventional composite final cover defined in 30 TAC §330.457 (d)(1) & (d)(2). The design demonstration is shown in Appendix G.

4 POINT OF COMPLIANCE DEMONSTRATION RESULTS

The HELP and MULTIMED models were used to evaluate the proposed design of the alternative liner and overliner system by estimating constituent concentrations at the POC for the landfill cases discussed in Section 2.3. The percolation rates obtained from the HELP Model cases included in Appendix C.3 and Appendix C.4 were used as input for the MULTIMED model to determine the DAF. Conservatively, the constituent concentrations at the base of the landfill liner and at the POC were used to calculate the DAF.

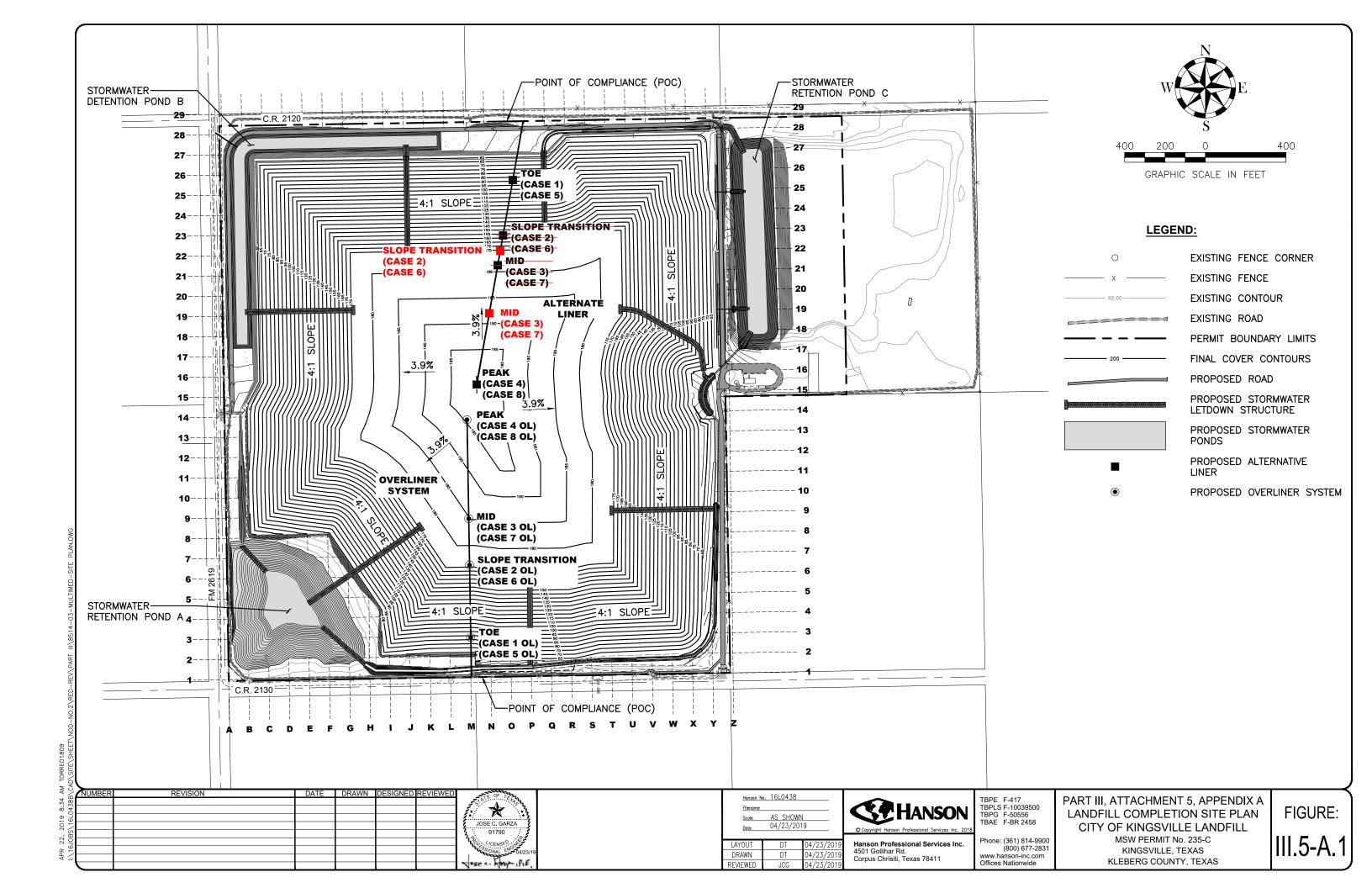
A summary of the calculated DAF is presented below and in Appendix D.

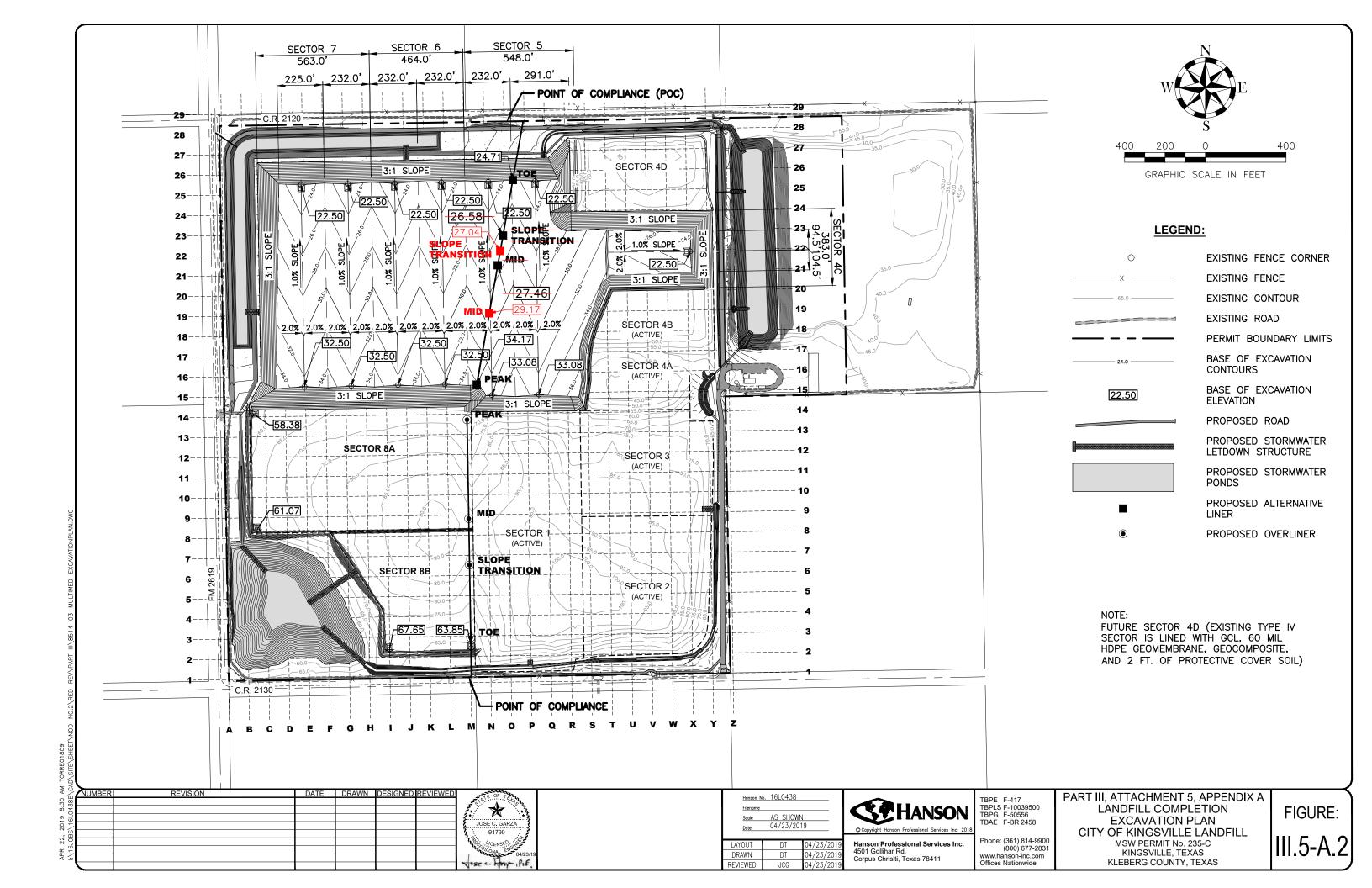
	Interim Case	
Location	DAF	Closed Case DAF
Alternative Liner Location 1	33,979 40,833	85,106 102,301
Alternative Liner Location 2	57,471 <u>68,446</u>	201,288 239,750
Alternative Liner Location 3	80,645 137,381	282,566 481,231
Alternative Liner Location 4	286,533	1,003,814

	Interim Case	
Location	DAF	Closed Case DAF
Overliner Location 1	18,797	65,833
Overliner Location 2	77,640	232,450
Overliner Location 3	158,253	473,934
Overliner Location 4	615,385	1,842,639

The results demonstrate that the proposed alternative liner design and overliner design meets or exceeds the requirements of Title 30 TAC §330.331(a)(1). The DAF calculated by the use of HELP and MULTIMED are well in excess of the 260 minimum criterion. The actual DAFs are expected to be substantially higher than the DAFs predicted by this modeling demonstration because the model input was conservatively estimated as discussed in previous sections of this report.

APPENDIX A POINT OF COMPLIANCE FIGURES





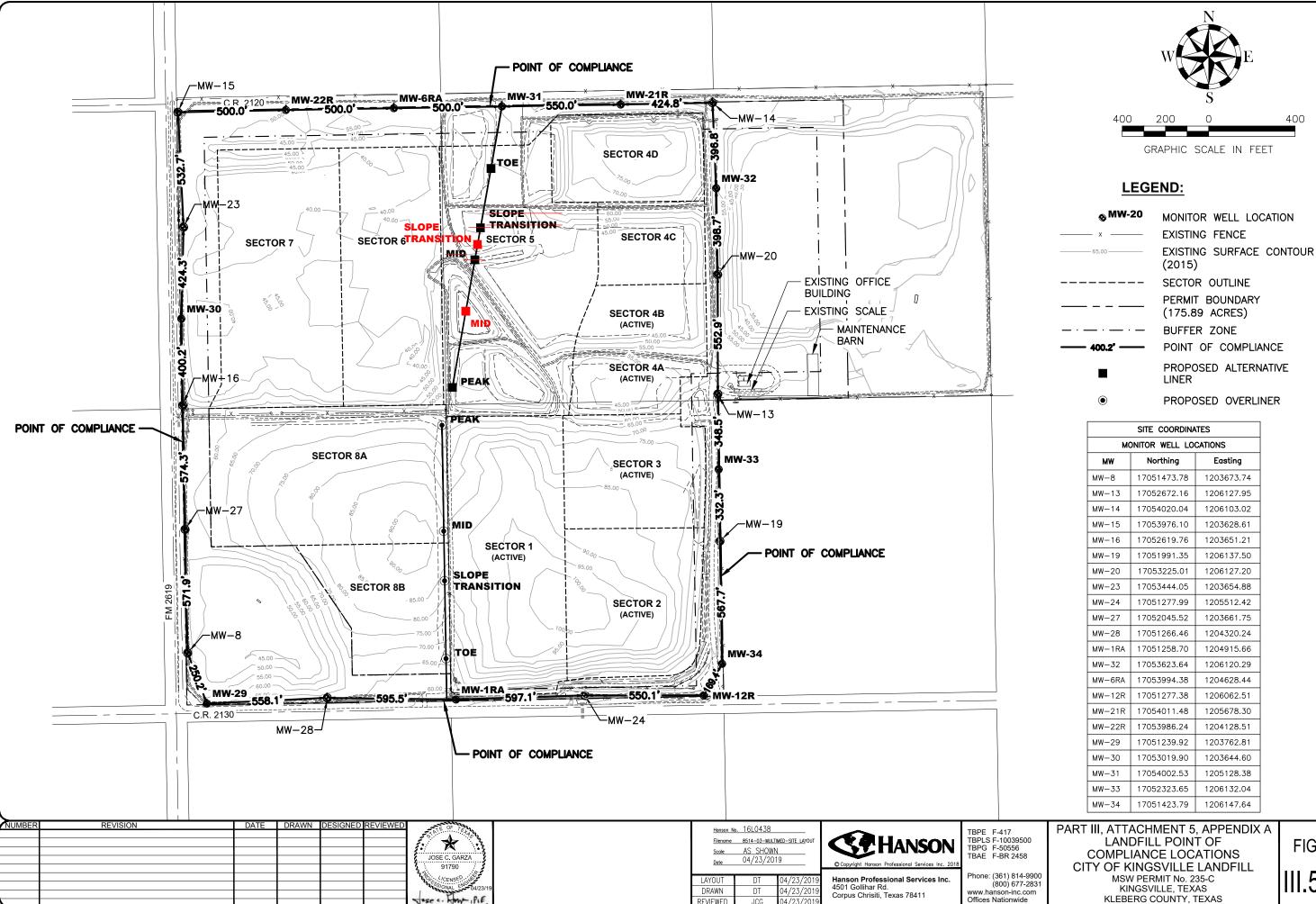
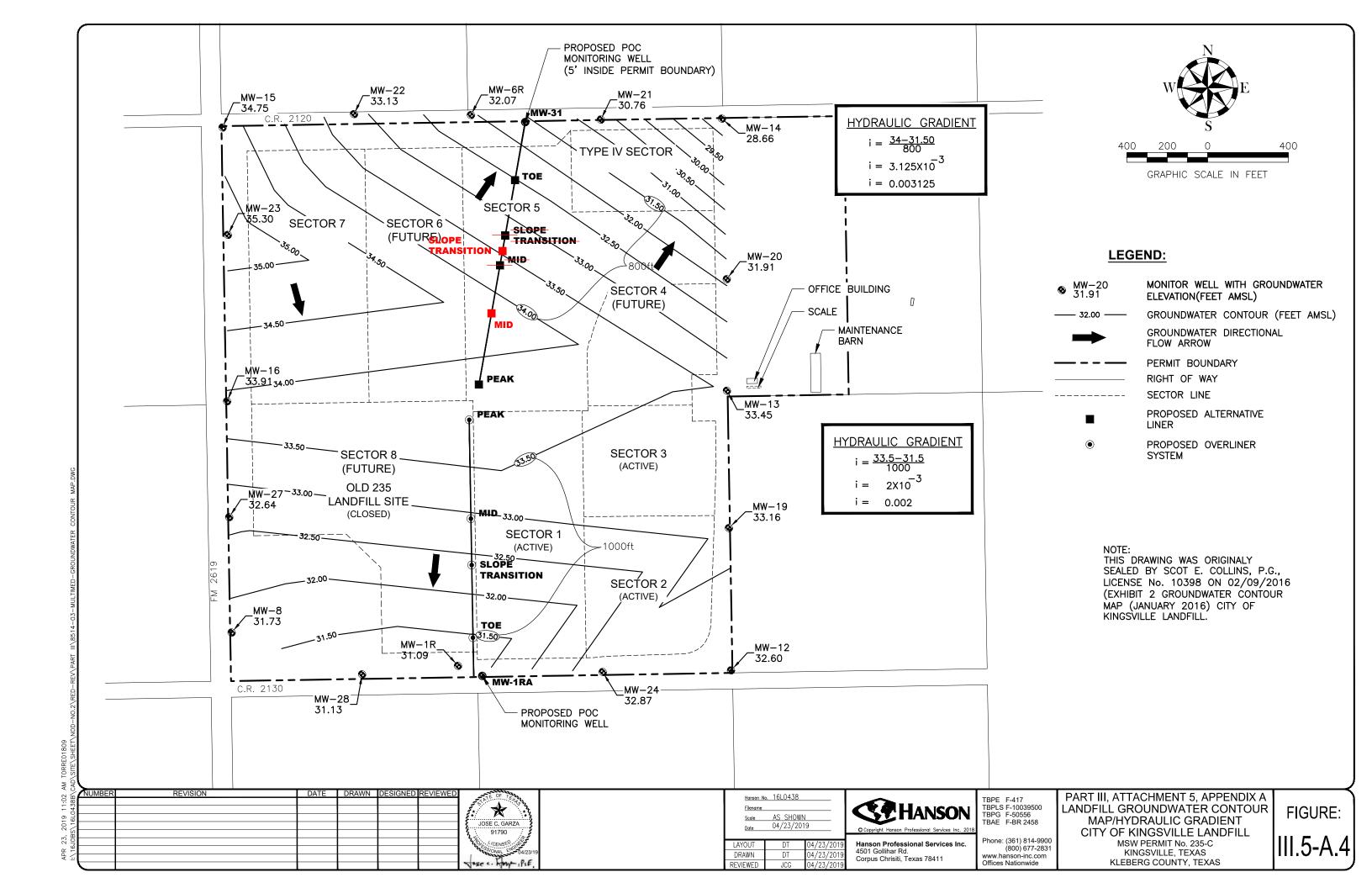
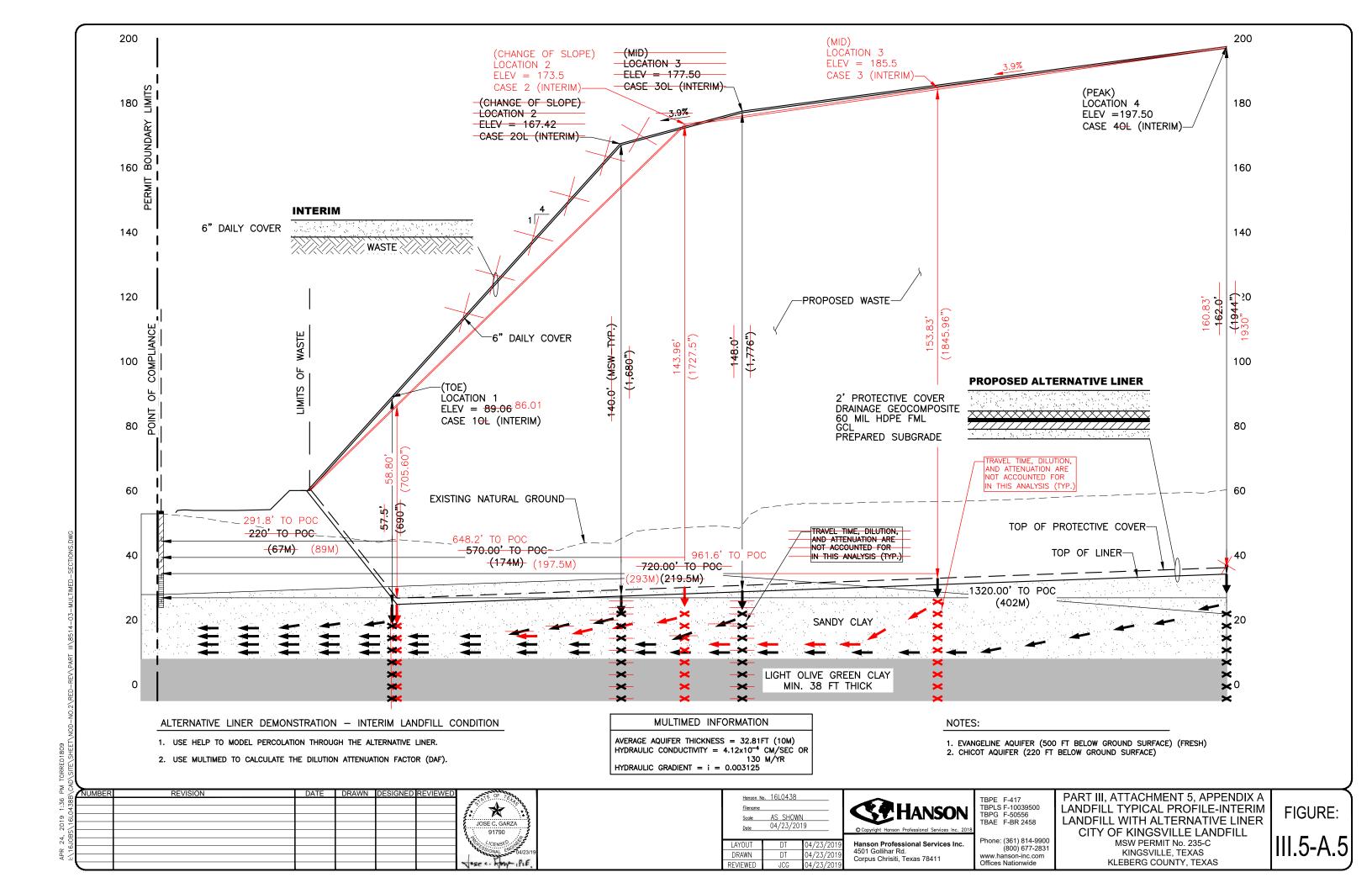


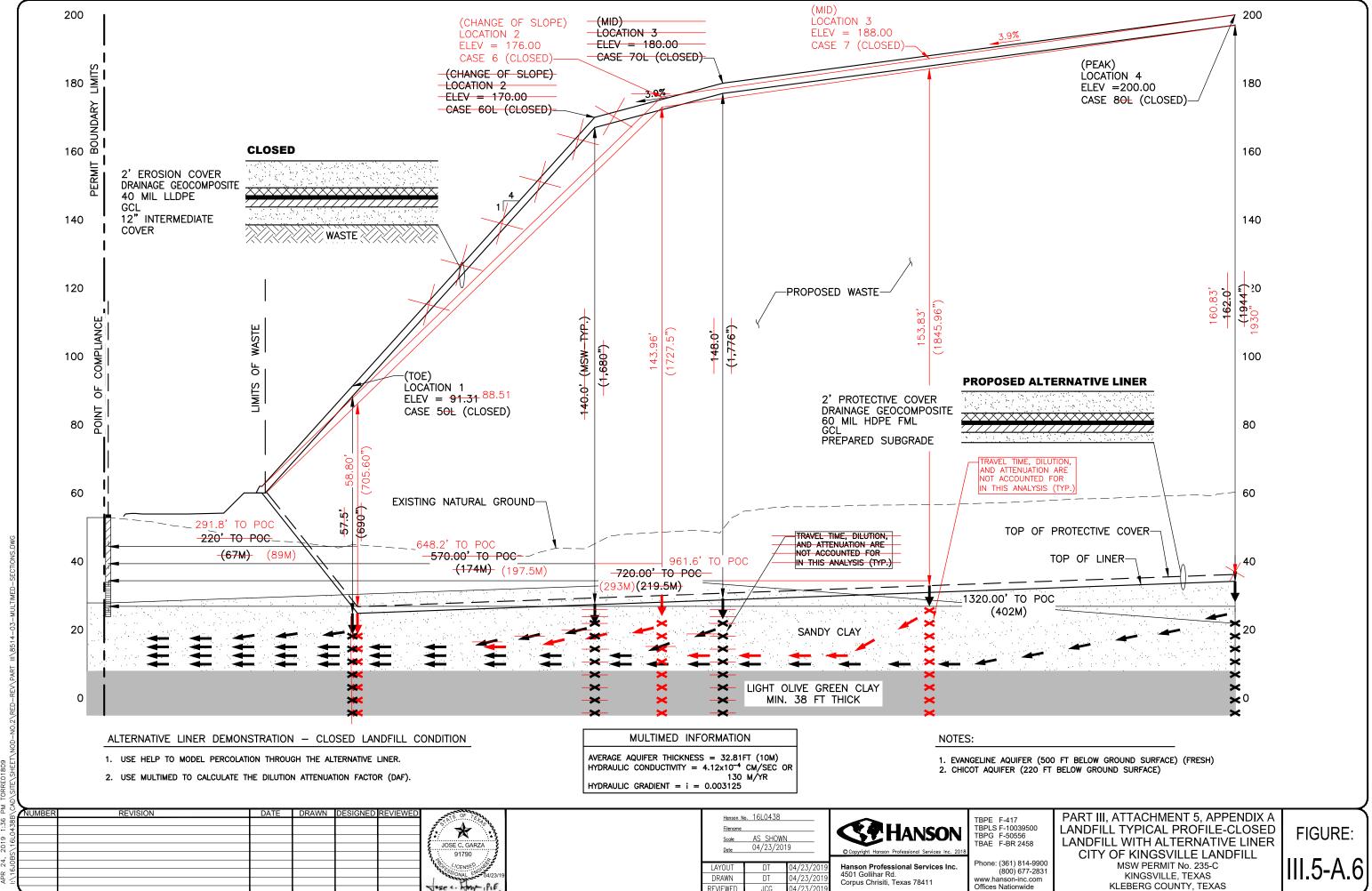
FIGURE:

KLEBERG COUNTY, TEXAS

400







APPENDIX B HELP MODEL ANALYSIS ALTERNATIVE LINER

APPENDIX B.1 HELP MODEL/MULTIMED MODEL-SUMMARY OF CASES 1-8

Project No. 8514-3 Permit Amendment

Description: HELP Model/MULTIMED Model-Summary of Cases 1-8

Date: 3/01/17

By: JCG

<u>Case 1-Interim Landfill (Location 1)</u>- An open landfill with a Geosynthetic Clay Liner (GCL), a 60 mil HDPE Flexible Membrane Liner (FML), a Geocomposite drainage layer (Geonet), a 24 inch protective soil layer (Protective Cover), <u>57.558.80</u> feet of waste with 250 foot drain length at 2%, and 6 inches of daily soil cover.

<u>Case 2-Interim Landfill (Location 2)</u>- An open landfill with a Geosynthetic Clay Liner (GCL), a 60 mil HDPE Flexible Membrane Liner (FML), a Geocomposite drainage layer (Geonet), a 24 inch protective soil layer (Protective Cover), <u>140-143.96</u> feet of waste with 500 foot drain length at 2%, and 6 inches of daily soil cover.

<u>Case 3-Interim Landfill (Location 3)</u>- An open landfill with a Geosynthetic Clay Liner (GCL), a 60 mil HDPE Flexible Membrane Liner (FML), a Geocomposite drainage layer (Geonet), a 24 inch protective soil layer (Protective Cover), <u>148-153.83</u> feet of waste with 500 foot drain length at 2%, and 6 inches of daily soil cover.

<u>Case 4-Interim Landfill (Location 4)</u>- An open landfill with a Geosynthetic Clay Liner (GCL), a 60 mil HDPE Flexible Membrane Liner (FML), a Geocomposite drainage layer (Geonet), a 24 inch protective soil layer (Protective Cover), <u>162-160.83</u> feet of waste with 500 foot drain length at 2%, and 6 inches of daily soil cover.

<u>Case 5-Closed Landfill (Location 1)</u> - A closed landfill with a Geosynthetic Clay Liner (GCL), a 60 mil HDPE Flexible Membrane Liner (FML), a Geocomposite drainage layer (Geonet), a 24 inch protective soil layer (Protective Cover), <u>57.558.80</u> feet of waste with 250 foot drain length at 2%, and 12 inches of intermediate cover, a GCL, a 40 mil LLDPE membrane, a Geocomposite drainage layer, and 24 inch erosion cover.

<u>Case 6-Closed Landfill (Location 2)</u>- A closed landfill with a Geosynthetic Clay Liner (GCL), a 60 mil HDPE Flexible Membrane Liner (FML), a Geocomposite drainage layer (Geonet), a 24 inch protective soil layer (Protective Cover), <u>140–143.96</u> feet of waste with 500 foot drain length at 2%, and 12 inches of intermediate cover, a GCL, a 40 mil LLDPE membrane, a Geocomposite drainage layer, and 24 inch erosion cover.

<u>Case7-Closed Landfill (Location 3)</u>- A closed landfill with a Geosynthetic Clay Liner (GCL), a 60 mil HDPE Flexible Membrane Liner (FML), a Geocomposite drainage layer (Geonet), a 12 inch protective soil layer (Protective Cover), <u>148–153.83</u> feet of waste with 500 foot drain length at 2%, and 12 inches of intermediate cover, a GCL, a 40 mil LLDPE membrane, a Geocomposite drainage layer, and 24 inch erosion cover.

<u>Case 8-Closed Landfill (Location 4)</u>- A closed landfill with a Geosynthetic Clay Liner (GCL), a 60 mil HDPE Flexible Membrane Liner (FML), a Geocomposite drainage layer (Geonet), a 24 inch protective soil layer (Protective Cover), <u>162–160.83</u> feet of waste with 500 foot drain length at 2%, and 12 inches of intermediate cover, a GCL, a 40 mil LLDPE membrane, a Geocomposite drainage layer, and 24 inch erosion cover.

APPENDIX B.2 HELP MODEL CASE SUMMARY

HELP MODEL CASE SUMMARY

					Peak	*Peak
Case Alternative Liner	Average	Average	Average	Average Percolation	Percolation	Percolation
Case Alternative Lines	Precipitation	Runoff	Evapotranspiration	Through Liner	Through Liner	Through Liner
	(IN/YR)	(IN/YR)	(IN/YR)	(CF/YR)	(CF/DAY)	(M/YR)
Interim Landfill HELP Information						
Location 1						
• <u>58.80</u> 57.5 feet of waste (Case 1)						
20 yr	25.74	2.391	21.632	0.004	0.000050	1.28E-07
Location 2						
• <u>143.96</u> 140 feet of waste (Case 2)						
20 yr	25.74	2.135	21.716	0.004	0.00007	1.79E-07
Location 3						
• <u>153.83</u> 148 feet of waste (Case 3)						
20 yr	25.74	2.197	21.691	0.004	0.00007	1.79E-07
Location 4						
• <u>160.83</u> feet of waste (Case 4)						
20 yr	25.74	1.907	21.787	0.005	0.00007	1.79E-07
Closed Landfill HELP Information						
Location 1						
• 58.80 57.5 feet of waste (Case 5)						
30 yr	27.20	1.880	21.749	0.001	0.00002	5.11E-08
Location 2						
• <u>143.96</u> 140 feet of waste (Case 6)						
30 yr	27.20	1.680	21.481	0.004	0.00002	5.11E-08
Location 3						
• <u>153.83</u> 148 feet of waste (Case 7)						
30 yr	27.20	1.711	21.470	0.004	0.00002	5.11E-08
Location 4						
• <u>160.83</u> 162 feet of waste (Case 8)						
30 yr	27.20	1.533	21.495	0.004	0.00002	5.11E-08

^{*} Determined Using Peak Daily Percolation/Leakage Rate Through GCL and Converted to (M/YR) Example: $((.00005 \text{ FT}^3/\text{Day-Acre})x(1 \text{ Acre}/43,560 \text{ FT}^2)/(1 \text{ Meter}/3.28 \text{ FT})) x (365 \text{ Days}/1 \text{ YR}) = 1.28 \times 10^{-7} \text{ M/YR}$

APPENDIX B.3 HELP OUTPUT FOR ALTERNATIVE LINER INTERIM CASE 1LOCATION 1

CASE1R20,OUT

PRECIPITATION DATA FILE: C:\HELP3\MDATA\KGVPR20Y.D4
TEMPERATURE DATA FILE: C:\HELP3\MDATA\KGVTE20Y.D7
SOLAR RADIATION DATA FILE: C:\HELP3\MDATA\KGVS020Y.D13
EVAPOTRANSPIRATION DATA: C:\HELP3\MDATA\KGVEV20Y.D11
SOIL AND DESIGN DATA FILE: C:\HELP3\MDATA\CASE1R.D10
OUTPUT DATA FILE: C:\HELP3\MDATA\CASE1R20.OUT

TIME: 8:28 DATE; 4/22/2019

TITLE: CITY OF KINGSVILLE SOLID WASTE LANDFILL-CASE 1 (Location 1)

NOTE: INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

LAYER 1

TYPE 1 - VERTICAL PERCOLATION LAYER MATERIAL TEXTURE NUMBER 13

6.00 INCHES **THICKNESS POROSITY** 0.4300 VOL/VOL == FIELD CAPACITY 0.3210 VOL/VOL == WILTING POINT 0.2210 VOL/VOL INITIAL SOIL WATER CONTENT 0.2393 VOL/VOL _ 0.330000003000E-04 CM/SEC EFFECTIVE SAT. HYD. COND. NOTE: SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY 3,00 FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.

LAYER 2

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18

THICKNESS 205,60 INCHES

Page 1

CASE1R20.OUT

POROSITY = 0.6710 VOL/VOL
FIELD CAPACITY = 0.2920 VOL/VOL
WILTING POINT = 0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.2905 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.100000005000E-02 CM/SEC

LAYER 3

TYPE 1 - VERTICAL PERCOLATION LAYER MATERIAL TEXTURE NUMBER 13

THICKNESS = 24.00 INCHES

POROSITY = 0.4300 VOL/VOL

FIELD CAPACITY = 0.3210 VOL/VOL

WILTING POINT = 0.2210 VOL/VOL

INITIAL SOIL WATER = 0.3244 VOL/VOL

CONTENT EFFECTIVE SAT. = 0.330000003000E-04 CM/SEC

HYD. COND.

LAYER 4

TYPE 2 - LATERAL DRAINAGE LAYER MATERIAL TEXTURE NUMBER 20

0.20 INCHES THICKNESS = 0.8500 VOL/VOL POROSITY = 0.0100 VOL/VOL FIELD CAPACITY 0.0050 VOL/VOL WILTING POINT INITIAL SOIL WATER CONTENT 0.0152 VOL/VOL EFFECTIVE SAT. HYD. COND. = 10.0000000000 CM/SEC == 2.00 PERCENT SLOPE DRAINAGE LENGTH 250.0 FEET

LAYER 5

TYPE 4 - FLEXIBLE MEMBRANE LINER MATERIAL TEXTURE NUMBER 35

THICKNESS = 0.06 INCHES

POROSITY = 0.0000 VOL/VOL

FIELD CAPACITY = 0.0000 VOL/VOL

WILTING POINT = 0.0000 VOL/VOL

INITIAL SOIL WATER CONTENT = 0.0000 VOL/VOL

EFFECTIVE SAT. HYD. COND. = 0.199999996000E-12 CM/SEC

FML PINHOLE DENSITY = 1.00 HOLES/ACRE

FML INSTALLATION DEFECTS = 2.00 HOLES/ACRE

FML PLACEMENT QUALITY = 3 - GOOD

LAYER 6

TYPE 3 - BARRIER SOIL LINER MATERIAL TEXTURE NUMBER 17

THICKNESS = 0.24 INCHES
POROSITY FIELD = 0.7500 VOL/VOL
CAPACITY = 0.7470 VOL/VOL
Page 2

WILTING POINT INITIAL SOIL WATER HYD. COND.

CASE1R20.OUT 0,4000 VOL/VOL 0.7500 VOL/VOL INITIAL SOIL WATER = 0,7500 VOL/VOL
CONTENT EFFECTIVE SAT. = 0.300000003000E-08 CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE #13 WITH A FAIR STAND OF GRASS, A SURFACE SLOPE OF 25.% AND A SLOPE LENGTH OF 100. FEET.

SCS RUNOFF CURVE NUMBER 89,50 80.0 FRACTION OF AREA ALLOWING RUNOFF PERCENT AREA PROJECTED ON HORIZONTAL = PLANE EVAPORATIVE ZONE DEPTH = 1,000 ACRES 12.0 INCHES INITIAL WATER IN EVAPORATIVE ZONE = 2.124 INCHES
UPPER LIMIT OF EVAPORATIVE = 6.606 INCHES STORAGE LOWER LIMIT OF EVAPORATIVE = 1.788 INCHES
STORAGE INITIAL SNOW WATER = 0.000 INCHES INITIAL WATER IN LAYER MATERIALS = 214.375 TOTAL INITIAL WATER = INCHES 214.375
TOTAL SUBSURFACE INFLOW = INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA -----

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM CORPUS CHRISTI TEXAS

= 27.77 DEGREES STATION LATITUDE MAXIMUM LEAF AREA INDEX = 2.00 START OF GROWING SEASON (JULIAN DATE) 0 END OF GROWING SEASON (JULIAN DATE) 367 = 12.0 INCHES EVAPORATIVE ZONE DEPTH AVERAGE ANNUAL WIND SPEED = 12.00 MPH AVERAGE 1ST QUARTER RELATIVE HUMIDITY = 76.00 % AVERAGE 2ND QUARTER RELATIVE HUMIDITY = 78.00 % AVERAGE 3RD QUARTER RELATIVE HUMIDITY = 76.00 % AVERAGE 4TH QUARTER RELATIVE HUMIDITY = 76.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	MAR/SEP APR/OCT		JUN/DEC
			~~~~		
1.63	1.69	1.20	1.57	3,29	3.12
2.26	2.78	5.31	2.92	1.61	1.17

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

Page 3

				CASE1R20.0U	T
JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
56.30	59.30	65.90	73.00	78.10	82.70
84.90	85,00	81.50	74.00	65.00	59.10

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI AND STATION LATITUDE = 27.77 DEGREES

******	******	*******	*******	******	******	*****	******
AVERAGE	MONTHLY	VALUES IN	INCHES	FOR YEARS	1 THRO	OUGH 20	
		-	-	MAR/SEP		MAY/NOV	JUN/DEC
PRECIPITATION							
TOTALS		1,15	2.02	1.05	1.42	2.41	2,71
TOTALS		2.43	2.37	5.38	2.30	1.33	1.18
STD. DEVIATI	ONS	0.63	1.18	0.55	1.20	1.88	2.04
		2.55	1.63	3.12	1.75	1.17	0.85
RUNOFF							
TOTALS		0.015	0.067	0.006	0,104	0.281	0.288
		0.380	0.193	0.784	0.181	0.073	0.020
STD. DEVIATI	ONS	0.043	0.081	0.009	0,237	0.504	0.348
		0.817	0.198	0.914	0.274	0.212	0.070
EVAPOTRANSPIRA							
TOTALS		0.939	2,086	1,297	1.241	1.988	2.114
TOTALS		2.037	1.875	3.620	2.256	1.089	1.091
STD. DEVIATI	ONS	0.543	0.911	0.701	0.915	1.322	1.388
		1.606	1.312	1.225	1.220	0.757	0.583
LATERAL DRAINA							
TOTALS		0.0661	0.0208		0.0580	0.0362	0.0534
		0.1445	0.1783	0.1018	0.4104	0.4037	0.1921
STD. DEVIATI	ONS	0.0861	0.0317	0.1423	0.1051	0.0619	0.1057
		0.2592	0.3508	3 0.2000	0.5929	0.7428	0.3262
PERCOLATION/LE		ROUGH LAYI					
TOTALS		0,0000	0.000				
		0,0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATI	ONS	0.0000					
		0,0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

## CASE1R20.OUT

DAILY AVERAGE HEAD ON	TOP OF LAY	ER 5				
""AVERAGES	0.0005	0:0002	0.0005	0.0004	0.0003	0.0004
	0.0010	0.0013	0.0007	0.0029	0.0030	0.0014
STD. DEVIATIONS	0.0006	0.0002	0.0010	0.0008	0.0004	0.0008
	0.0018	0.0025	0.0015	0.0042	0.0055	0.0023

	INCHES			CU. FEET	PERCENT	
PRECIPITATION	25.74	(	5.706)	93448.9	100.00	
RUNOFF	2.391	(	1.2854)	8679.79	9.288	
EVAPOTRANSPIRATION LATERAL	21.632	(	3.6809)	78522.88	84.028	
DRAINAGE COLLECTED FROM LAYER 4	1.73689	(	1.43661)	6304.908	6.74690	
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.00000	(	0.00000)	0.004	0.00000	
AVERAGE HEAD ON TOP OF LAYER 5	0.001 (		0.001)			
CHANGE IN WATER STORAGE	-0.016	(	0.5277)	-58 <b>.</b> 67	-0.063	

**4** 

1 THROUGH	20
(INCHES)	(CU. FT.)
5.07	18404.102
2.138	7761.3745
0.16413	595,80011
0.000000	0.00005
0.036	
0.072	
2.7 FEET	
0.00	0.0000
0.	3879
	5.07 2.138 0.16413 0.000000 0.036 0.072 2.7 FEET 0.00

CASE1R20.OUT

MINIMUM VEG. SOIL WATER (VOL/VOL)

0.1490

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner by Bruce M. McEnroe, University of Kansas ASCE Journal of Environmental Engineering Vol. 119, No. 2, March 1993, pp. 262-270.

**************************

FINAL WATER STORAGE AT END OF YEAR 2	FI	NAL	WATER	STORAGE	ΑT	END	OF	YEAR	20
--------------------------------------	----	-----	-------	---------	----	-----	----	------	----

	LAYER	(INCHES)	(VOL/VOL)
6	1	1.4211	0.2369
	2	204.7451	0.2902
	3	7.7040	0.3210
	4	0.0020	0.0100
	5	0.0000	0.0000
	6	0.1800	0.7500
	SNOW WATER	0.000	

*

# APPENDIX B.4 HELP OUTPUT FOR ALTERNATIVE LINER INTERIM CASE 2-LOCATION 2

#### CASE2R20.OUT

<b>₽</b>		
******	**********************	*******
******	*******************	******
**		**
**		**
**	HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE	**
**	HELP MODEL VERSION 3.07 (1 NOVEMBER 1997)	**
**	DEVELOPED BY ENVIRONMENTAL LABORATORY	**
**	USAE WATERWAYS EXPERIMENT STATION	**
**	FOR USEPA RISK REDUCTION ENGINEERING LABORATORY	**
**		**
**		**
******	********************	******
******	**********************	******

PRECIPITATION DATA FILE: TEMPERATURE DATA FILE: **EVAPOTRANSPIRATION DATA:** SOIL AND DESIGN DATA FILE:

C:\HELP3\MDATA\KGVPR20Y.D4 C:\HELP3\MDATA\KGVTE20Y.D7 SOLAR RADIATION DATA FILE: C:\HELP3\MDATA\KGVSO20Y.D13 C:\HELP3\MDATA\KGVEV20Y.D11

OUTPUT DATA FILE:

C:\HELP3\MDATA\CASE2R.D10 C:\HELP3\MDATA\CASE2R20.OUT

TIME: 15:24

DATE:

4/14/2019

**********************************

TITLE: CITY OF KINGSVILLE SOLID WASTE LANDFILL-CASE 2 (LOCATION 2)

*****************************

NOTE: INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

## LAYER 1

#### TYPE 1 -VERTICAL PERCOLATION LAYER MATERIAL TEXTURE NUMBER 13

6.00 INCHES **THICKNESS** 0.4300 VOL/VOL POROSITY FIELD CAPACITY 0.3210 VOL/VOL WILTING POINT 0.2210 VOL/VOL INITIAL SOIL WATER CONTENT 0.2391 VOL/VOL EFFECTIVE SAT. HYD. COND. 0.330000003000E-04 CM/SEC

NOTE: SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY 3.00 FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.

LAYER 2

TYPE 1 -VERTICAL PERCOLATION LAYER MATERIAL TEXTURE NUMBER 18

**THICKNESS** 

**INCHES** 1727.50

Page 1

Part II, Attachment 5, Appendix B.4, p.g.-1

CASE2R20.OUT

0.6710 VOL/VOL POROSITY FIELD CAPACITY 0.2920 VOL/VOL = 0.0770 VOL/VOL WILTING POINT INITIAL SOIL WATER = 0.2914 VOL/VOL

CONTENT EFFECTIVE SAT. = 0.100000005000E-02 CM/SEC

HYD. COND.

## LAYER 3

## TYPE 1 - VERTICAL PERCOLATION LAYER

MATERIAL TEXTURE NUMBER 13

**THICKNESS** = 0.4300 VOL/VOL POROSITY = = 0.3210 VOL/VOL FIELD CAPACITY WILTING POINT 0.2210 VOL/VOL INITIAL SOIL WATER = 0.3245 VOL/VOL CONTENT EFFECTIVE SAT. = 0.330000003000E-04 CM/SEC HYD. COND.

## LAYER 4

## TYPE 2 - LATERAL DRAINAGE LAYER

MATERIAL TEXTURE NUMBER 20

= 0.20 INCHES **THICKNESS** 0.8500 VOL/VOL POROSITY (E 0.0100 VOL/VOL FIELD CAPACITY WILTING POINT = 0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0205 VOL/VOL 10.0000000000 CM/SEC EFFECTIVE SAT. HYD. COND.

SLOPE 2.00 PERCENT DRAINAGE LENGTH 500.0 FEET

## LAYER 5

## TYPE 4 - FLEXIBLE MEMBRANE LINER

MATERIAL TEXTURENUMBER 35

= 0.06 **THICKNESS** INCHES 0.0000 VOL/VOL POROSITY == FIELD CAPACITY = 0.0000 VOL/VOL
WILTING POINT = 0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0000 VOL/VOL

EFFECTIVE SAT. HYD. COND. = 0.199999996000E-12 CM/SEC FML PINHOLE DENSITY = 1.00 HOLES/ACRE FML INSTALLATION DEFECTS = 2.00 HOLES/ACRE

FML PLACEMENT QUALITY = 3 - GOOD

#### LAYER 6 ------

TYPE 3 - BARRIER SOIL LINER MATERIAL TEXTURE NUMBER 17 = 0.24 INCHES THICKNESS

0.7500 VOL/VOL = POROSITY FIELD 0.7470 VOL/VOL CAPACITY

CASE2R20.OUT
WILTING POINT = 0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.7500 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.300000003000E-08 CM/SEC

## GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE #13 WITH A FAIR STAND OF GRASS, A SURFACE SLOPE OF 25.% AND A SLOPE LENGTH OF 350. FEET.

SCS RUNOFF CURVE NUMBER	=	88.80	
FRACTION OF AREA ALLOWING RUNOFF	=	80.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	12.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	2.124	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	6.606	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	1.788	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	512.775	INCHES
TOTAL INITIAL WATER	=	512.775	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

## EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM CORPUS CHRISTI TEXAS

STATION LATITUDE = 27.77 DEGREES MAXIMUM LEAF AREA INDEX 2.00 START OF GROWING SEASON (JULIAN DATE) 0 END OF GROWING SEASON (JULIAN DATE) 367 EVAPORATIVE ZONE DEPTH = 12.0 INCHES = 12.00 MPH AVERAGE ANNUAL WIND SPEED AVERAGE 1ST QUARTER RELATIVE HUMIDITY = 76.00 % AVERAGE 2ND QUARTER RELATIVE HUMIDITY = 78.00 % AVERAGE 3RD QUARTER RELATIVE HUMIDITY = 76.00 % AVERAGE 4TH QUARTER RELATIVE HUMIDITY = 76.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS

## NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
				****	(404)4040444
1.63	1.69	1.20	1.57	3.29	3.12
2.26	2.78	5.31	2.92	1.61	1.17

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

				CASE2R20.OU	T
JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
56.30	59.30	65.90	73.00	78.10	82.70
84.90	85.00	81.50	74.00	65.00	59.10

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS AND STATION LATITUDE = 27.77 DEGREES

AVERAGE MONTH	LY VALUES I	N INCHES	FOR YEARS	1 THR	OUGH 20	
		FEB/AUG	MAR/SEP		MAY/NOV	JUN/DEC
PRECIPITATION				3000000		
TOTALS			1.05			
	2.43	2.37	5.38	2.30	1.33	1.18
STD. DEVIATIONS	0.63	1.18	0.55	1.20	1.88	2.04
	2.55	1.63	3.12	1.75	1.17	0.85
RUNOFF						
TOTALS	0.012	0.055	0.003	0.092	0.254	0.252
	0.350	0.170	0.716	0.149	0.066	0.016
STD. DEVIATIONS	0.037	0.071	0.006	0.216	0.479	0.315
	0.770	0.181	0.864	0.234		
EVAPOTRANSPIRATION						
TOTALS	0.932	2.093	1,304	1.251	1.993	2,128
	2.048	1.899	3.628	2.264	1.098	1.076
STD. DEVIATIONS	0.540	0.899	0.714	0.930	1.317	1.382
	1.634	1.319	1.222	1.208	0.786	0.592
LATERAL DRAINAGE COL						
TOTALS		0.0326		0.0598	0.0433	0.068
	0.1629	0.1994	0.1144	0.4246	0.4282	0.229
STD. DEVIATIONS	0.0919	0.0521	0.1373	0.1034	0.0699	0.146
	0.3039	0.4252	0.2386	0.5907	0.7366	0.418
PERCOLATION/LEAKAGE						
TOTALS	0.0000		0.0000	0.0000	0.0000	0.000
TOTALS	0.0000	0.0000				
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.000
SID. DEVIALIONS	0.0000	0.0000				

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

#### CASE2R20.OUT

DAILY AVERAGE HEAD ON	TOP OF	LAYER					
5							
AVERAGES	0.0010	0.0005	0.0010	0.0009	0.0006	0.0010	
	0,0023-	0:0028	0.0017	0.0060	0.0063	0.0033	
STD. DEVIATIONS	0.0013	0.0008	0.0020	0.0015	0.0010	0.0021	
	0.0043	0.0061	0.0035	0.0084	0.0108	0.0060	
		to also also also also also also also als		to also also also also also also also als	to also also also also also also also als		

*****************************

	INCH	IES	CU, FEET	PERCENT
PRECIPITATION	25.74	( 5.706)	93448.9	100.00
RUNOFF	2.135	(1.1936)	7751.57	8.295
EVAPOTRANSPIRATION LATERAL	21.716	(3.6903)	78829.24	84.355
DRAINAGE COLLECTED FROM LAYER 4	1.90751	(1.54779)	6924.272	7.40969
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.00000	( 0.00000)	0.004	0.00000
AVERAGE HEAD ON TOP OF LAYER 5	0.002 (	0.002)		
CHANGE IN WATER STORAGE	-0.015	( 0.5511)	-56.18	-0.060

PEAK DAILY VALUES FOR YEARS	1 THROUGH 2	20
	(INCHES)	(CU. FT.)
PRECIPITATION	5.07	18404.102
RUNOFF	2.088	7578.4883
DRAINAGE COLLECTED FROM LAYER 4	0.15857	575.60864
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.000000	0.00007
AVERAGE HEAD ON TOP OF LAYER 5	0.070	
MAXIMUM HEAD ON TOP OF LAYER 5	0.139	
LOCATION OF MAXIMUM HEAD IN LAYER 4 (DISTANCE FROM DRAIN)	2.3 FEET	
SNOW WATER	0.00	0.0000

MAXIMUM VEG. SOIL WATER (VOL/VOL)

CASE2R20.OUT

MINIMUM VEG. SOIL WATER (VOL/VOL)

0.1490

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner by Bruce M. McEnroe, University of Kansas ASCE Journal of Environmental Engineering Vol. 119, No. 2, March 1993, pp. 262-270.

***********************

F.	INAL WATER STORA	age at end of ye	AR	20	

LAYER  1	(INCHES)  1.4393	(VOL/VOL)  0.2399	
2	503.1399	0.2913	
3	7. 7040	0.3210	
4	0.0020	0.0100	
5	0.0000	0.0000	
6	0.1800	0.7500	
SNOW WATER	0.000		

**********************

## APPENDIX B.5 HELP OUTPUT FOR ALTERNATIVE LINER INTERIM CASE 3LOCATION 3

#### CASE3R20.OUT

PRECIPITATION DATA FILE: C:\HELP3\MDATA\KGVPR20Y.D4
TEMPERATURE DATA FILE: C:\HELP3\MDATA\KGVPR20Y.D7
SOLAR RADIATION DATA FILE: C:\HELP3\MDATA\KGVS020Y.D13
EVAPOTRANSPIRATION DATA: C:\HELP3\MDATA\KGVEV20Y.D11
SOIL AND DESIGN DATA FILE: C:\HELP3\MDATA\CASE3R.D10
OUTPUT DATA FILE: C:\HELP3\MDATA\CASE3R20.OUT

TIME: 8:37 DATE: 4/22/2019

*****************************

TITLE: CITY OF KINGSVILLE SOLID WASTE LANDFILL-CASE 3 (LOCATION 3)

**************************

NOTE: INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

## LAYER 1

-----

## TYPE 1 - VERTICAL PERCOLATION LAYER MATERIAL TEXTURE NUMBER 13

THICKNESS = 6.00 INCHES

POROSITY = 0.4300 VOL/VOL

FIELD CAPACITY = 0.3210 VOL/VOL

WILTING POINT = 0.2210 VOL/VOL

INITIAL SOIL WATER CONTENT = 0.2391 VOL/VOL

EFFECTIVE SAT, HYD. COND. = 0.330000003000E-04 CM/SEC

NOTE: SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY 3.00

FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.

LAYER 2

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18

THICKNESS = 1845.90 INCHES

CASE3R20,OUT

POROSITY 0.6710 VOL/VOL 0.2920 VOL/VOL FIELD CAPACITY WILTING POINT 0.0770 VOL/VOL 0.2914 VOL/VOL INITIAL SOIL WATER CONTENT = EFFECTIVE SAT, HYD. COND. = 0.100000005000E-02 CM/SEC

#### LAYER 3 _____

#### TYPE 1 - VERTICAL PERCOLATION LAYER MATERIAL TEXTURE NUMBER 13

**THICKNESS** 24,00 INCHES 0.4300 VOL/VOL POROSITY FIELD CAPACITY 0.3210 VOL/VOL 0.2210 VOL/VOL WILTING POINT INITIAL SOIL WATER CONTENT 0.3245 VOL/VOL EFFECTIVE SAT. HYD. COND. . 0.330000003000E-04 CM/SEC

## LAYER 4

## TYPE 2 - LATERAL DRAINAGE LAYER MATERIAL TEXTURE NUMBER 20

**THICKNESS** 0.20 INCHES 0.8500 **POROSITY** 22 FIELD CAPACITY VOL/VOL 0.0100 WOLDOW VOL/VOL WILTING POINT INITIAL SOIL WATER CONTENT = 0.0205 VOL/VOL EFFECTIVE SAT, HYD. COND. 10.0000000000 CM/SEC 2.00 PERCENT SLOPE DRAINAGE LENGTH 500.0 FEET

#### LAYER 5 ------

#### TYPE 4 - FLEXIBLE MEMBRANE LINER MATERIAL TEXTURE NUMBER 35

**THICKNESS** 0.06 INCHES == POROSITY 0.0000 VOL/VOL 0.0000 VOL/VOL FIELD CAPACITY = INITIAL SOIL WATER CONTENT = 0.0000 VOL/VOL 0,0000 VOL/VOL EFFECTIVE SAT. HYD. COND. . 0.199999996000E-12 CM/SEC FML PINHOLE DENSITY = 1.00 HOLES/ACRE FML INSTALLATION DEFECTS = 2,00 HOLES/ACRE FML PLACEMENT QUALITY 3 - GOOD

## LAYER 6

#### TYPE 3 - BARRIER SOIL LINER MATERIAL TEXTURE NUMBER 17

0.24 INCHES THYCKNESS = POROSITY FIELD 0.7500 VOL/VOL 0.7470 VOL/VOL CAPACITY = Page 2 CASE3R20.OUT
WILTING POINT = 0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.7500 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.300000003000E-08 CM/SEC

## GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
SOIL DATA BASE USING SOIL TEXTURE #13 WITH A
FAIR STAND OF GRASS, A SURFACE SLOPE OF 12.%
AND A SLOPE LENGTH OF 200. FEET.

SCS RUNOFF CURVE NUMBER	=	89.00	
FRACTION OF AREA ALLOWING RUNOFF	222	80.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	12.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	- 74	2.124	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	6.606	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	1.788	INCHES
INITIAL SNOW WATER		0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	547.348	INCHES
TOTAL INITIAL WATER	=	547.348	INCHES
TOTAL SUBSURFACE INFLOW	=	0,00	INCHES/YEAR

## EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM CORPUS CHRISTI TEXAS

STATION LATITUDE = 27.77 DEGREES MAXIMUM LEAF AREA INDEX = 2.00 START OF GROWING SEASON (JULIAN DATE) = 0 END OF GROWING SEASON (JULIAN DATE) 367 = 12.0 INCHES EVAPORATIVE ZONE DEPTH AVERAGE ANNUAL WIND SPEED = 12.00 MPH AVERAGE 1ST QUARTER RELATIVE HUMIDITY = 76.00 % AVERAGE 2ND QUARTER RELATIVE HUMIDITY = 78.00 % AVERAGE 3RD QUARTER RELATIVE HUMIDITY = 76.00 % AVERAGE 4TH QUARTER RELATIVE HUMIDITY = 76.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS

## NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
			****	~~~~~	
1.63	1.69	1,20	1.57	3.29	3,12
2.26	2.78	5.31	2.92	1.61	1.17

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

				CASE3R20.OU	T
JUC/NAC	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
56,30	59.30	65.90	73.00	78.10	82.70
84.90	85.00	81.50	74.00	65.00	59.10

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS

AND STATION LATITUDE = 27.77 DEGREES

*******	******	******	*****	******	******	*****
AVERAGE MONTH	HLY VALUES I					
	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DE
RECIPITATION						******
TOTALS	1.15	2.02	1.05	1,42	2.41	2.71
TOTALS	2.43	2.37	5,38	2.30		1.18
STD. DEVIATIONS	0.63	1.18	0.55	1,20	1.88	2.04
	2.55	1.63	3.12	1.75	1.17	0.85
UNOFF						
TOTALS	0.013	0.058	0.004	0.095	0.261	0.26
	0.358	0.176	0.733	0.155	0.067	0.03
STD. DEVIATIONS	0.038	0.074	0.007	0.221	0.486	0.32
	0.783	0.186	0.879	0.241	0.202	0.05
VAPOTRANSPIRATION						
TOTALS	0.931	2.093	1.302	1.250	1.993	2.17
	2.045	1.896	3.629	2.258	1.099	1.07
STD. DEVIATIONS	0.537	0.898				
	1.629	1.315	1.227	1.202	0.786	0.59
ATERAL DRAINAGE COL						
TOTALS		0.0358		0.0581	0.0416	0.06
	0.1587	0.1953	0.1104	0.4155	0.4199	0.2
STD. DEVIATIONS	0.0917					
	0.2949	0.4190	0.2386	0.5824	0.7312	0.41
ERCOLATION/LEAKAGE						
TOTALS	0.0000	0.0000				
	0.0000	0.0000	0.0000	0.0000	0.0000	0.00
STD. DEVIATIONS	0.0000					
	0.0000	0.0000	0.0000	0.0000	0.0000	0.00

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

#### CASE3R20.OUT

DAILY AVERAGE HEAD ON TOP	OF LAYER 5					
AVERAGES0	.00100.00					
STD, DEVIATIONS 0	.0013 0.06					
*********	********	****	******	******	******	******
**************************************						
AVERAGE AMORE TOTALS OF						
PRECIPITATION	25.74	(	5,706)	9344	8.9 1	.00.00
RUNOFF	2.197	(	1.2161)	797	5.32	8.534
EVAPOTRANSPIRATION LATERAL	21.691	(	3.6830)	7873	6.87	84.257
DRAINAGE COLLECTED FROM LAYER 4	1.87134	(	1.53422)	679	2,958	7.26917
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.00006	) (	0.00000)		0,004	0.00000
AVERAGE HEAD ON TOP OF LAYER 5	0.002		0.002)			
CHANGE IN WATER STORAGE	(	(	0.5521)	-5	6.24	-0,060
*******	************ -0.01	****	*******	*******	******	******
	5					
***********	_	la ala ala al			ate ate ate ate ate ate ate ate ate	
PEAK DAILY V						****
*****************************				(ES)		
PRECIPITATION			5.07		18404.10	
RUNOFF			2.16	<del>)</del> 6	7646.43	312
DRAINAGE COLLECTED FRO	M LAYER 4		0.16	5188	587.63	L462
PERCOLATION/LEAKAGE TH	ROUGH LAYER	6	0.00	00000	0.00	9007
AVERAGE HEAD ON TOP OF	LAYER 5		0.07	71		
MAXIMUM HEAD ON TOP OF	LAYER 5		0.14	12		
LOCATION OF MAXIMUM HE (DISTANCE FROM D		4	1.9	FEET		
SNOW WATER			0.00	)	0.00	900
MAXIMUM VEG. SOIL WATE	R (VOL/VOL)			0.38	93	

CASE3R20.OUT

MINIMUM VEG. SOIL WATER (VOL/VOL)

0.1490

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner by Bruce M. McEnroe, University of Kansas ASCE Journal of Environmental Engineering Vol. 119, No. 2, March 1993, pp. 262-270.

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*****			ND OF YEAR 20	*****
22 ml (6, 14) ml (8) to 142 ml (8) to 16.	LAYER	(INCHES)	(VOL/VOL)	
	1	1.4394	0.2399	
	2	537.7128	0.2913	
	3	7.7040	0.3210	
	4	0.0020	0.0100	
	5	0.0000	0.0000	
	6	0.1800	0.7500	
	SNOW WATER	0.000		

********************************

# APPENDIX B.6 HELP OUTPUT FOR ALTERNATIVE LINER INTERIM CASE 4LOCATION 4

CASE4R20.OUT

PRECIPITATION DATA FILE: C:\HELP3\MDATA\KGVPR20Y.D4
TEMPERATURE DATA FILE: C:\HELP3\MDATA\KGVPR20Y.D7
SOLAR RADIATION DATA FILE: C:\HELP3\MDATA\KGVS020Y.D13
EVAPOTRANSPIRATION DATA: C:\HELP3\MDATA\KGVEV20Y.D11
SOIL AND DESIGN DATA FILE: C:\HELP3\MDATA\CASE4R.D10
OUTPUT DATA FILE: C:\HELP3\MDATA\CASE4R20.OUT

TIME: 15:39 DATE: 4/14/2019

*************************

TITLE: CITY OF KINGSVILLE SOLID WASTE LANDFILL-CASE 4 (LOCATION 4)

NOTE: INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

## LAYER 1

-----

## TYPE 1 -VERTICAL PERCOLATION LAYER MATERIAL TEXTURE NUMBER 13

THICKNESS = 6.00 INCHES

POROSITY = 0.4300 VOL/VOL

FIELD CAPACITY = 0.3210 VOL/VOL

WILTING POINT = 0.2210 VOL/VOL

INITIAL SOIL WATER CONTENT = 0.2210 VOL/VOL

EFFECTIVE SAT. HYD. COND. = 0.330000003000E-04 CM/SEC

NOTE: SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY 3.00

LAYER 2

FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.

TYPE 1 -VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18

THICKNESS

= 1930.00 INCHES

CASE4R20.OU

POROSITY = T 0.6710 VOL/VOL
FIELD CAPACITY = 0.2920 VOL/VOL
WILTING POINT = 0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.2914 VOL/VOL

EFFECTIVE SAT. HYD. COND. = 0.100000005000E-02 CM/SEC

## LAYER 3

#### TYPE 1 - VERTICAL PERCOLATION

LAYER MATERIAL TEXTURE NUMBER 13

THICKNESS = 24.00 INCHES

POROSITY = 0.4300 VOL/VOL

FIELD CAPACITY = 0.3210 VOL/

WILTING POINT = VOL 0.2210

INITIAL SOIL WATER CONTENT = VOL/VOL 0.3246

EFFECTIVE SAT. HYD. COND. = 0.33000000E-04 CM/SEC

## LAYER 4

## TYPE 2 - LATERAL DRAINAGE

LAYER MATERIAL TEXTURE NUMBER

THICKNESS 20 0.20 INCHES
POROSITY = 0.8500 VOL/VOL
FIELD CAPACITY = 0.0100 VOL/VOL
WILTING POINT = 0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0206 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 10.0000000000 CM/SEC
SLOPE = 2.00 PERCENT
DRAINAGE LENGTH = 500.0 FEET

## LAYER 5

## TYPE 4 - FLEXIBLE MEMBRANE LINER

#### MATERIAL TEXTURE NUMBER 35

THICKNESS = 0.06 INCHES
POROSITY = 0.0000 VOL/VOL
FIELD CAPACITY = 0.0000 VOL/VOL
WILTING POINT = 0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY = 1.00 HOLES/ACRE
FML INSTALLATION DEFECTS = 2.00 HOLES/ACRE
FML PLACEMENT QUALITY = 3 - GOOD

## LAYER 6

#### TYPE 3 - BARRIER SOIL LINER

MATERIAL TEXTURE NUMBER 17

THICKNESS = 0.24 INCHES
POROSITY FIELD = 0.7500 VOL/
CAPACITY = VOL 0.7470
VOL/VOL Page 2

CASE4R20.OUT

WILTING POINT = 0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.7500 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.300000003000E-08 CM/SEC

## GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE #13 WITH A FAIR STAND OF GRASS, A SURFACE SLOPE OF 4.% AND A SLOPE LENGTH OF 600. FEET.

SCS RUNOFF CURVE NUMBER	==	88.00
FRACTION OF AREA ALLOWING RUNOFF	=	80.0 PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000 ACRES
EVAPORATIVE ZONE DEPTH	=	12.0 INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	1.920 INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	6.606 INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	1.788 INCHES
INITIAL SNOW WATER	000	0.000 INCHES
INITIAL WATER IN LAYER MATERIALS	=	571. 702 INCHES
TOTAL INITIAL WATER	22	571.702 INCHES
TOTAL SUBSURFACE INFLOW	=	0.00 TNCHES/YEAR

## EVAPOTRANSPIRATION AND WEATHER DATA

## NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM CORPUS CHRISTI TEXAS

STATION LATITUDE	=	27.77 DEGREES
MAXIMUM LEAF AREA INDEX	=	2.00
START OF GROWING SEASON (JULIAN DATE)	=	0
END OF GROWING SEASON (JULIAN DATE)	=	367
EVAPORATIVE ZONE DEPTH	=	12.0 INCHES
AVERAGE ANNUAL WIND SPEED	=	12.00 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	76.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	78.00%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	==	76.00%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	76.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS

## NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL FEB/AUG		MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC	
1.63	1.69	1.20	1.57	3.29	3.12	
2.26	2.78	5.31	2.92	1.61	1.17	

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

			CASE4R20.OUT				
JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC		
56.30	59.30	65.90	73.00	78.10	82.70		
84.90	85.00	81.50	74.00	65.00	59.10		

## NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS AND STATION LATITUDE = 27.77 DEGREES

AVERAGE MONTHLY						*****
	JAN/JUL FE					
PRECIPITATION						
TOTALS	1 15	2 02	1 05	1.42	2 41	2 71
TOTALS	2.43	2.02 2.37	5.38	2.30	2.41 1.33	1.18
STD. DEVIATIONS		1.18	0.55	1.20	1.88	2.04
	2.55	1.63	3.12	1. 75	1.17	0.85
RUNOFF						
TOTALS	0.010	0.044	0.002	0.080	0.229	0.222
TOTALS	0.322	0.145	0.650	0.131	0.058	0.013
STD. DEVIATIONS	0.032	0.059	0.004	0.198	0.452	0.284
	0.721	0.160	0.809	0.208	0.182	0.047
EVAPOTRANSPIRATION						
TOTALS	0.926	2.091	1.307	1.259	2.002	2.140
	2.063	1.908	3.649	2.262	1.101	1.080
STD. DEVIATIONS	0.553	0.908	0.722	0.938	1.315	1.392
	1.651	1.324				0.582
LATERAL DRAINAGE COLLEC						
TOTALS		0.0392	0.0796	0.0589	0.0482	0.0756
TOTALS		0.2167	0.1255	0.4498		0.2523
STD. DEVIATIONS	0.0955	0.0557	0.1545	0.1063	0.0799	0.1563
	0.3182	0.4582	0.2771	0.6084	0.7550	0.4586
PERCOLATION/LEAKAGE TH						
TOTALS		0.0000	0.0000	0.0000	0.0000	0.0000
ISTALS		0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

## CASE4R20.OUT

DAILY AVERAGE HEAD						
AVERAGES	0.0010 0 <del>.0025</del> -	0.0006	0.0011 0.0018	0.0009 0.0064	0.0007 0.0068	0.0011 0.0036
STD. DEVIATIONS	0.0014 0.0045	0.0009	0.0022 0.0041	0.0016 0.0087	0.0011 0.0111	0.0023 0.0065

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AVERAGE ANNUAL TOTALS & (	STD. DEVIAT	ΓIC	ONS) FOR YEA	ARS 1 THROUG	GH 20
	INCHES			CU. FEET	PERCENT
PRECIPITATION	25.74			93448.9	100.00
RUNOFF	1.907	(	1.1083)	6921.00	7.406
EVAPOTRANSPIRATION LATERAL	21.787	(	3.6980)	79085.98	84.630
DRAINAGE COLLECTED FROM LAYER 4	2.05535	(	1.61445)	7460.923	7.98396
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.00000	(	0.00000)	0.005	0.00000
AVERAGE HEAD ON TOP OF LAYER 5	0.002 (		0.002)		
CHANGE IN WATER STORAGE	-0.005	(	0.5759)	-18.99	-0.020

PEAK DAILY VALUES FOR YEARS	1 THROUGH	20
	(INCHES)	(CU. FT.)
PRECIPITATION	5.07	18404.102
RUNOFF	2.016	7318.0361
DRAINAGE COLLECTED FROM LAYER 4	0.16119	585.10394
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.000000	0.00007
AVERAGE HEAD ON TOP OF LAYER 5	0.071	
MAXIMUM HEAD ON TOP OF LAYER 5	0.142	
LOCATION OF MAXIMUM HEAD IN LAYER 4 (DISTANCE FROM DRAIN)	1.6 FEET	
SNOW WATER	0.00	0.0000

MAXIMUM VEG. SOIL WATER (VOL/VOL)

0.3947

Page 5

Part II, Attachment 5, Appendix B.6, p.g.-5

CASE4R20.OUT

MINIMUM VEG. SOIL WATER (VOL/VOL)

SNOW WATER

0.1490

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner by Bruce M. McEnroe, University of Kansas ASCE Journal of Environmental Engineering Vol. 119, No. 2, March 1993, pp. 262-270.

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********		*************** STORAGE AT ENI	**********************************	******
	********			
	LAYER	(INCHES)	(VOL/VOL)	
	1	1.4410	0.2402	
	2	562.2700	0.2913	
	3	7.7040	0.3210	
	4	0.0020	0.0100	
	5	0.0000	0.0000	
	6	0.1800	0.7500	

*

0.000

## APPENDIX B.7 HELP OUTPUT FOR ALTERNATIVE LINER CLOSED CASE 5-LOCATION 1

#### CASE5R30.OUT

PRECIPITATION DATA FILE: C:\HELP3\MDATA\KGVPR30Y.D4
TEMPERATURE DATA FILE: C:\HELP3\MDATA\KGVPR30Y.D7
SOLAR RADIATION DATA FILE: C:\HELP3\MDATA\KGVS030Y.D13
EVAPOTRANSPIRATION DATA: C:\HELP3\MDATA\KGVEV30Y.D11
SOIL AND DESIGN DATA C:\HELP3\MDATA\CASE5R.D10
FILE:OUTPUT DATA FILE: C:\HELP3\MDATA\CASE5R30.OUT

TIME: 8:47 DATE: 4/22/2019

TITLE: CITY OF KINGSVILLE SOLID WASTE LANDFILL-CASE 5 (LOCATION 1)

NOTE: INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

## LAYER 1

......

## TYPE 1 - VERTICAL PERCOLATION LAYER MATERIAL TEXTURE NUMBER 13

LAYER 2

TYPE 2 - LATERAL DRAINAGE LAYER MATERIAL TEXTURE NUMBER 20

THICKNESS = 0.20 INCHES

CASESR30.OU

**POROSITY** T 0.8500 VOL/VOL 0.0100 VOL/VOL FIELD CAPACITY WILTING POINT 0.0050 VOL/VOL 0. INITIAL SOIL WATER CONTENT = 0100 VOL/VOL EFFECTIVE SAT. HYD. COND. = 10.00000000000 CM/SEC

2.00 PERCEN SLOPE == DRAINAGE LENGTH 250.0 T FEET

#### LAYER 3 -----

#### TYPE 4 - FLEXIBLE MEMBRANE LINER MATERIAL TEXTURE NUMBER 36

0.04 INCHES **THICKNESS** = 0.0000 VOL/VOL POROSITY EFFECTIVE SAT. HYD. COND. = 0.399999993000E-12 CM/SEC FML PINHOLE DENSITY = 1.00 HOLES/ACRE FML INSTALLATION DEFECTS = 2.00 HOLES/ACRE FML PLACEMENT QUALITY = 3 - GOOD

#### LAYER 4 ------

TYPE 3 - BARRIER SOIL LINER MATERIAL TEXTURE

0.24 INCHES **THICKNESS** NUMBER 17 = 0.7500 VOL/VOL POROSITY FIELD CAPACITY 22 0.7470 VOL/VOL 0.4000 VOL/VOL WILTING POINT INITIAL SOIL WATER CONTENT 0.7500 VOL/VOL

EFFECTIVE SAT. HYD. COND. = 0.300000003000E-08 CM/SEC

## LAYER 5

## TYPE 1 - VERTICAL PERCOLATION LAYER MATERIAL TEXTURE NUMBER 13

= 12.00 INCHES **THICKNESS** 0,4300 VOL/VOL POROSITY = FIELD CAPACITY 0.3210 VOL/VOL WILTING POINT =
INITIAL SOIL WATER CONTENT = 0.2210 VOL/VOL 0.3210 VOL/VOL EFFECTIVE SAT. HYD. COND. = 0.330000003000E-04 CM/SEC

## LAYER 6

#### TYPE 1 - VERTICAL PERCOLATION LAYER MATERIAL TEXTURE NUMBER 18

**THICKNESS** = 705.60 INCHES 0.6710 VOL/VOL POROSITY FIELD CAPACITY 0.2920 VOL/VOL CASE5R30.OUT
WILTING POINT = 0.0770 VOL/VOL
INITIAL SOIL WATER = 0.2920 VOL/VOL
CONTENT EFFECTIVE SAT. = 0.100000005000E-02 CM/SEC
HYD. COND.

## LAYER 7

## TYPE 1 - VERTICAL PERCOLATION LAYER MATERIAL TEXTURE NUMBER 13

THICKNES = 24.00 INCHES
S = 0.4300 VOL/VOL
PÜROBICMPACITY = 0.3210 VOL/VOL
WILTING POINT = 0.2210 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.3210 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.330000003000E-04 CM/SEC

## LAYER 8

## TYPE 2 - LATERAL DRAINAGE LAYER MATERIAL TEXTURE NUMBER 20

THICKNESS = 0.20 INCHES

POROSITY = 0.8500 VOL/VOL

FIELD CAPACITY = 0.0100 VOL/VOL

WILTING POINT = 0.0050 VOL/VOL

INITIAL SOIL WATER CONTENT = 0.0100 VOL/VOL

EFFECTIVE SAT. HYD, COND. = 10.0000000000 CM/SEC

SLOPE = 2.00 PERCENT

DRAINAGE LENGTH = 250.0 FEET

## LAYER 9

## TYPE 4 - FLEXIBLE MEMBRANE LINER MATERIAL TEXTURE NUMBER 35

THICKNESS = 0.06 INCHES
POROSITY = 0.0000 VOL/VOL
FIELD CAPACITY = 0.0000 VOL/VOL
WILTING POINT = 0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY = 1.00 HOLES/ACRE
FML INSTALLATION DEFECTS = 2.00 HOLES/ACRE
FML PLACEMENT QUALITY = 3 - GOOD

## LAYER 10

-----

## TYPE 3 - BARRIER SOIL LINER MATERIAL TEXTURE NUMBER 17

THICKNESS = 0.24 INCHES
POROSITY = 0.7500 VOL/VOL
FIELD CAPACITY = 0.7470 VOL/VOL
WILTING POINT = 0.4000 VOL/
INITIAL SOIL WATER CONTENT = VOL 0.7500
VOL/VPage 3

CASESR30.OUT
EFFECTIVE SAT. HYD. COND. = 0.300000003000E-08 CM/SEC

## GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
SOIL DATA BASE USING SOIL TEXTURE #13 WITH A
GOOD STAND OF GRASS, A SURFACE SLOPE OF 25.%
AND A SLOPE LENGTH OF 100. FEET.

SCS RUNOFF CURVE NUMBER	=	85.60	
FRACTION OF AREA ALLOWING RUNOFF	-	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	12.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	2.674	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	5.160	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	2.652	INCHES
INITIAL SNOW WATER	==	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	224,481	INCHES
TOTAL INITIAL WATER	$\Rightarrow$	224,481	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

## EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM CORPUS CHRISTI TEXAS

STATION LATITUDE = 27.77 DEGREES
MAXIMUM LEAF AREA INDEX = 3.50

START OF GROWING SEASON (JULIAN DATE) = 0
END OF GROWING SEASON (JULIAN DATE) = 367
EVAPORATIVE ZONE DEPTH = 12.0 INCHES
AVERAGE ANNUAL WIND SPEED = 12.00 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY = 76.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY = 76.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY = 76.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS

#### NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	AN/JUL FEB/AUG MAR/SEP		APR/OCT	MAY/NOV	JUN/DEC	
1.63	1.69	1.20	1.57	3.29	3,12	
2,26	2.78	5.31	2.92	1.61	1,17	

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS

#### NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL FEB/AUG MAR/SEP APR/OCT MAY/NOV JUN/DEC
Page 4

				CASESR30.UUI			
56.30	59.30	65.90	73.00	78.10	82.70		
84.90	85,00	81,50	74.00	65.00	59.10		

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS

AND STATION LATITUDE = 27.77 DEGREES

********	******	******	*****	*****	*****	*******
AVERAGE MONTHLY						
	JUC/NAC	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	1.37 2.36	1.81 2.86	1.19 5.39	1.40 2.99	2.51 1.49	2.59 1.25
STD. DEVIATIONS	0.81 2.23	1.21 2.36	0.57 2.96	1.05 1.90	1.80 1.16	1.82 0.84
RUNOFF						
TOTALS	0.007 0.342	0.022 0.218		0.051 0.191	0.188 0.067	0.174 0.007
STD. DEVIATIONS	0.022 0.789		0.026 0.822			0.243 0.028
EVAPOTRANSPIRATION				(*)		
TOTALS	1.093 1.754	1.768 2.186	1.331 3.474	1.252 2.435	1.966 1.312	2.071 1.107
STD. DEVIATIONS	0.665 1.256	0.864 1.504	0.621 1.237		1.191 0.899	1.228 0.681
LATERAL DRAINAGE COLLE						
TOTALS	0.0698 0.3318	0.2237	0.1155			
STD. DEVIATIONS		0.2604 0.5857				
PERCOLATION/LEAKAGE TH						
TOTALS	0.0000 0.0000	0.0000				
STD. DEVIATIONS	0,0000 0,0000					
LATERAL DRAINAGE COLLE						
TOTALS	0.0000 0.0000	0.0000	0.0000			
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000 Page 5		0.0000

PERCOLATION/LEAKAGE THROUG		R 10					
	-8888	0-000	90	0.0000	0.0000	0.000	0.0000
v v	.0000	0.000		0.0000	0.0000	0.000	=
	.0000	0.000		0.0000 0.0000	0.0000 0.0000	0.0000	
0	.0000	0.000	שפ	0.0000	0.0000	0.000	0.0000
~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~							
AVERAGES OF M	ONTHLY	AVERAG	SED	DAILY HEA	DS (INCH	ES)	
DAILY AVERAGE HEAD ON TOP	OF LAY	ER 3					
AVERAGES0	.0005-	0:001	17	0,0008	0.0003	0.001	0.0139
0	.0206	0.017	77	0,1061	0.0240	0.001	8 0.0006
STD, DEVIATIONS 0	.0009	0 00	20	0.0009	0.0009	0.002	0.041
	.1028	0.05		0.2641			
DAILY AVERAGE HEAD ON TOP	OF LAY	ER 9					
~~AVERAGES~~~~~0	70000-	0:000	90	0.0000	0.0000	0.000	0.000
0	.0000	0.000	90	0.0000	0.0000	0.000	0.000
STD. DEVIATIONS 0	.0000	0.000	aa	0.0000	0.0000	a aaa	0.000
	.0000	0.000		0.0000	0.0000	0.000	
	****	***	<b></b>	***	· • • • • • • • • • • • • • • • • • • •	****	****
**************************************	(STD.	DEVIA	ΓΙΟ	NS) FOR YE	ARS 1		30
	(STD.	DEVIA.	TIO H <b>E</b> S	NS) FOR YE	ARS 1	 Н СИ.	30
AVERAGE ANNUAL TOTALS &	(STD.	DEVIA	TIO HES	NS) FOR YE	ARS 1	н си <b>.</b>	30 PERCENT
AVERAGE ANNUAL TOTALS &	(STD.	DEVIA	TIO HES	NS) FOR YE	THROUG	H CU.  2.7	30 PERCENT 100.00
AVERAGE ANNUAL TOTALS & PRECIPITATION RUNOFF	(STD.	INCI	TIO HES	NS) FOR YE	THROUG FE5872	H CU.  2.7 5.49	30 PERCENT 100.00 6.914
AVERAGE ANNUAL TOTALS & PRECIPITATION RÜNOFF	(STD. 27 1	INCI .20 .880 .749	TIO HES (	NS) FOR YE 5.704) 1.2157)	THROUG FE5872 682 7894	H CU.  2.7 5.49 7.65	30 PERCENT 100.00 6.914 79.969
AVERAGE ANNUAL TOTALS & PRECIPITATION RUNOFF EVAPOTRANSPIRATION LATERAL DRAINAGE COLLECTED	27 1 21 3	INCI .20 .880 .749 .55912	HES (	5.704) 1.2157) 3.7373) 1.91851)	THROUG FE5872 682 7894 1291	H CU. 2.7 5.49 7.65	30 PERCENT 100.00 6.914 79.969 13,08676
AVERAGE ANNUAL TOTALS &  PRECIPITATION  RUNOFF  EVAPOTRANSPIRATION LATERAL  DRAINAGE COLLECTED FROM LAYER 2  PERCOLATION/LEAKAGE THROUGH	27 1 21 3	DEVIA	HES (	5.704) 1.2157) 3.7373) 1.91851)	THROUG FE5872 682 7894 1291	H CU. 2.7 5.49 7.65	30 PERCENT 100.00 6.914 79.969 13,08676
AVERAGE ANNUAL TOTALS &  PRECIPITATION  RUNOFF  EVAPOTRANSPIRATION LATERAL  DRAINAGE COLLECTED FROM LAYER 2  PERCOLATION/LEAKAGE THROUGH LAYER 4  AVERAGE HEAD ON TOP	27 1 21 3	DEVIA : INCI . 20	HES ( ( ( ( (	5.704) 1.2157) 3.7373) 1.91851) 0.00001)	THROUG FE <b>58</b> 72 682 7894 1291	H CU.  2.7 5.49 7.65 9,604 0.023	30 PERCENT 100.00 6.914 79.969 13.08676 0.00000
AVERAGE ANNUAL TOTALS &  PRECIPITATION  RUNOFF  EVAPOTRANSPIRATION LATERAL  DRAINAGE COLLECTED FROM LAYER 2  PERCOLATION/LEAKAGE THROUGH LAYER 4  AVERAGE HEAD ON TOP OF LAYER 3  LATERAL DRAINAGE COLLECTED	27 1 21 3	DEVIA  INCO .20 .880 .749 .55912 .00001 .016 ( .00001	( ( ( (	5.704) 1.2157) 3.7373) 1.91851) 0.00001) 0.026)	THROUG FE5872 682 7894 1291	H CU. 	30 PERCENT 100.00 6.914 79.969 13.08676 0.00000

CASESR30.OUT

0.0000

0.0000 0.0000 0.0000 0.0000 0.0000

Page 6

29,91

0.030

( 0.4489)

0.008

CHANGE IN WATER STORAGE

#### CASESR30.OUT

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r			

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PEAK DAILY VALUES FOR YEARS		
	(INCHES)	(CU. FT.)
PRECIPITATION	5.07	18404.102
RUNOFF	2,585	9382.1035
DRAINAGE COLLECTED FROM LAYER 2	0.91251	3312.41650
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.000012	0.04380
AVERAGE HEAD ON TOP OF LAYER 3	14.568	
MAXIMUM HEAD ON TOP OF LAYER 3	18.997	
LOCATION OF MAXIMUM HEAD IN LAYER 2 (DISTANCE FROM DRAIN)	87.9 FEET	
DRAINAGE COLLECTED FROM LAYER 8	0.00001	0.03665
PERCOLATION/LEAKAGE THROUGH LAYER 10	0.000000	0.00002
AVERAGE HEAD ON TOP OF LAYER 9	0,000	
MAXIMUM HEAD ON TOP OF LAYER 9	0.000	
LOCATION OF MAXIMUM HEAD IN LAYER 8 (DISTANCE FROM DRAIN)	0.0 FEET	
SNOW WATER	0.02	73.7433
MAXIMUM VEG. SOIL WATER (VOL/VOL)	0	,4285
MINIMUM VEG. SOIL WATER (VOL/VOL)	0	.2210

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner by Bruce M. McEnroe, University of Kansas ASCE Journal of Environmental Engineering Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL	WATER	STORAGE A	T EN	D OF	YEAR	30
LAYF	 R	(INCHES	)		VOL/V	
	-		-			
1		6.773			0.28	
						Page

		CASE5R30.OUT	
2	0.0020	0.0100	
3	0.0000	0.0000	
4	0.1800	0.7500	
5	3.8520	0.3210	
6	206,0352	0.2920	
7	7.7040	0.3210	
8	0.0020	0.0100	
9	0.0000	0.0000	
10	0.1800	0.7500	
SNOW WATER	0.000		

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## APPENDIX B.8 HELP OUTPUT FOR ALTERNATIVE LINER CLOSED CASE 6-LOCATION 2

#### CASE6R30.OUT

PRECIPITATION DATA FILE: C:\HELP3\MDATA\KGVPR30Y.D4
TEMPERATURE DATA FILE: C:\HELP3\MDATA\KGVTE30Y.D7
SOLAR RADIATION DATA FILE: C:\HELP3\MDATA\KGVS030Y.D13
EVAPOTRANSPIRATION DATA: C:\HELP3\MDATA\KGVEV30Y.D11
SOIL AND DESIGN DATA FILE: C:\HELP3\MDATA\CASEGR.D10
OUTPUT DATA FILE: C:\HELP3\MDATA\CASEGR30.OUT

TIME: 13:23 DATE: 4/18/2019

************************************

TITLE: CITY OF KINGSVILLE SOLID WASTE LANDFILL-CASE 6 (LOCATION 2)

*****************************

NOTE: INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

## LAYER 1

## TYPE 1 - VERTICAL PERCOLATION LAYER MATERIAL TEXTURE NUMBER 13

THICKNESS = 24.00 INCHES

POROSITY = 0.4300 VOL/VOL

FIELD CAPACITY = 0.3210 VOL/VOL

WILTING POINT = 0.2210 VOL/VOL

INITIAL SOIL WATER CONTENT = 0.2754 VOL/VOL

EFFECTIVE SAT. HYD. COND. = 0.330000003000E-04 CM/SEC

NOTE: SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY 4.63

FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.

LAYER 2

TYPE 2 - LATERAL DRAINAGE LAYER MATERIAL TEXTURE NUMBER 20

THICKNESS = 0.20 INCHES

CASE6R30.OUT

POROSITY 0.8500 VOL/VOL FIELD CAPACITY 0.0100 VOL/VOL WILTING POINT 0.0050 VOL/VOL INITIAL SOIL WATER CONTENT 0.0100 VOL/VOL EFFECTIVE SAT, HYD, COND, = 10.0000000000 CM/SEC 2.00 SLOPE DRAINAGE LENGTH PERCENT 500.0

FEET

#### LAYER 3 ***

#### TYPE 4 - FLEXIBLE MEMBRANE LINER MATERIAL TEXTURE NUMBER 36

0.04 INCHES **THICKNESS** 0.0000 VOL/VOL POROSITY = 0.0000 VOL/VOL FIELD CAPACITY WILTING POINT = 0.0000 VOL/VOL INITIAL SOIL WATER CONTENT = 0.0000 VOL/VOL EFFECTIVE SAT. HYD. COND. = 0.39999993000E-12 CM/SEC FML PINHOLE DENSITY = 1.00 HOLES/ACRE FML INSTALLATION DEFECTS = 2.00 HOLES/ACRE FML PLACEMENT QUALITY = 3 - GOOD

#### LAYER 4 -----

TYPE 3 - BARRIER SOIL LINER MATERIAL TEXTURE

NUMBER 17 = 9.24 INCHES 9.7500 VOL/VOL 9.7470 VOL/VOL THICKNESS POROSITY FIELD CAPACITY WILTING POINT = 0.4000 VOL/VOL INITIAL SOIL WATER CONTENT = 0.7500 VOL/VOL EFFECTIVE SAT. HYD. COND. = 0.300000003000E-08 CM/SEC

#### LAYER 5 _____

#### TYPE 1 - VERTICAL PERCOLATION LAYER MATERIAL TEXTURE NUMBER 13

= 12.00 INCHES **THICKNESS** POROSITY 0.4300 VOL/VOL = FIELD CAPACITY 0. 3210 VOL/ VOL 0.2210 WILTING POINT INITIAL SOIL WATER CONTENT == VOL/VOL 0.3210 

## LAYER 6

#### TYPE 1 - VERTICAL PERCOLATION LAYER MATERIAL TEXTURE NUMBER 18

= 1727.50 INCHES **THICKNESS** 0.6710 VOL/VOL POROSITY FIELD = CAPACITY 0.2920 VOL/VOL Page 2

#### CASE6R30.OUT

WILTING POINT = 0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.2920 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.100000005000E-02 CM/SEC

## LAYER 7

## TYPE 1 - VERTICAL PERCOLATION LAYER

#### MATERIAL TEXTURE NUMBER 13

THICKNESS
POROSITY
POROSITY
PIELD CAPACITY
WILTING POINT
INITIAL SOIL WATER CONTENT
EFFECTIVE SAT. HYD. COND.

24.00 INCHES
0.4300 VOL/VOL
0.3210 VOL/VOL
0.3210 VOL/VOL
0.330000003000E-04 CM/SEC

## LAYER 8

#### TYPE 2 - LATERAL DRAINAGE LAYER MATERIAL TEXTURE NUMBER

**THICKNESS** 20 0.20 INCHES 0.8500 VOL/VOL POROSITY = FIELD CAPACITY 0.0100 VOL/VOL WILTING POINT 0.0050 VOL/VOL INITIAL SOIL WATER CONTENT = 0.0100 VOL/VOL EFFECTIVE SAT. HYD. COND. = 10.0000000000 CM/SEC 2.00 PERCENT **SLOPE** 

DRAINAGE LENGTH = 500.0 FEET

## LAYER 9

## TYPE 4 - FLEXIBLE MEMBRANE LINER MATERIAL TEXTURE NUMBER 35

**THICKNESS** 0.06 INCHES 0.0000 VOL/VOL POROSITY 0.0000 VOL/VOL FIELD CAPACITY m WILTING POINT 0.0000 VOL/VOL WILLIAMS POINT = 0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0000 VOL/VOL EFFECTIVE SAT. HYD. COND. ■ 0.199999996000E-12 CM/SEC 1.00 HOLES/ACRE FML PINHOLE DENSITY = FML INSTALLATION DEFECTS 2.00 HOLES/ACRE = 3 - GOOD FML PLACEMENT QUALITY

## LAYER 10

#### -----

## TYPE 3 - BARRIER SOIL LINER MATERIAL TEXTURE NUMBER 17

THICKNESS = 0.24 INCHES
POROSITY = 0.7500 VOL/VOL
FIELD CAPACITY = 0.7470 VOL/VOL
WILTING POINT = 0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.7500 VOL/VOL

CASEGR30.OUT
EFFECTIVE SAT. HYD. COND. = 0.300000003000E-08 CM/SEC

# GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
SOIL DATA BASE USING SOIL TEXTURE #13 WITH A
GOOD STAND OF GRASS, A SURFACE SLOPE OF 25.
% AND A SLOPE LENGTH OF 350. FEET.

SCS RUNOFF CURVE NUMBER	=	84.60	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	12.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	2.757	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	5.160	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	2.652	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	522.959	INCHES
TOTAL INITIAL WATER	=	522.959	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

# EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM CORPUS CHRISTI TEXAS

STATION LATITUDE = 27.77 DEGREES
MAXIMUM LEAF AREA INDEX = 3.50
START OF GROWING SEASON (JULIAN DATE) = 0
END OF GROWING SEASON (JULIAN DATE) = 367
EVAPORATIVE ZONE DEPTH = 12.0 INCHES
AVERAGE ANNUAL WIND SPEED = 12.00 MPH
AVERAGE 1ST QUARTER RELATIVE = 76.00 %
HUMIDITY AVERAGE 2ND QUARTER RELATIVE = 78.00 %
HUMIDITY AVERAGE 3RD QUARTER RELATIVE = 76.00 %
HUMIDITY AVERAGE 4TH QUARTER RELATIVE = 76.00 %
HUMIDITY AVERAGE 4TH QUARTER RELATIVE = 76.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS

#### NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JUC/NAC	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
1.63	1.69	1.20	1.57	3.29	3.12
2.26	2.78	5.31	2.92	1.61	1.17

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS

#### NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL FEB/AUG MAR/SEP APR/OCT MAY/NOV JUN/DEC

56.30				CASE6R30.OUT		
	59,30	65.90	73.00	78.10	82.70	
84.90	85.00	81.50	74.00	65.00	59.10	

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS AND STATION LATITUDE = 27.77 DEGREES

AVERAGE MONTH	ILY VALUES II	N INCHES	FOR YEARS	1 THR	OUGH 30	
	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION					5-5-5-5-0-5	
TOTALS	1.37 2.36	1.81 2.86	1.19 5,39	1.40 2.99	2.51 1.49	2.59 1.25
STD. DEVIATIONS	0.81 2.23	1.21 2.36	0.57 2.96	1.05 1.90	1.80 1.16	1.82 0.84
RUNOFF						
TOTALS	0,005 0.325				0.169 0.044	
STD. DEVIATIONS	0.016 0.770		0.020 0.843		0.495 0.176	0.20 0.01
EVAPOTRANSPIRATION						
TOTALS	1.081 1.728				1.928 1.304	
STD, DEVIATIONS	0.675 1.204	0.902 1.461				
LATERAL DRAINAGE COL	LECTED FROM	LAYER 2				
TOTALS		0 <b>:240</b> 6 0:4275				
STD. DEVIATIONS		0.2996 0.6486	0,1230 0,9618			0.54 0.12
PERCOLATION/LEAKAGE	THROUGH LAY	ER 4				
TOTALS	0.0000 0.0000					
STD. DEVIATIONS	0.0000 0.0000	0.0000 0.0000				
LATERAL DRAINAGE COL	LECTED FROM	LAYER 8				
TOTALS	0.0000 0.0000					
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000 Page 5		0.00

				CA	SE6R30,0	UT	
	0.6	90 <mark>00</mark> 000	0	0.0000	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THRO	UGH LA	AYER					
TOTALS	0.0000	0.000	0	0.0000	0.0000	0.0000	0.0000
	9:0000	0:000	0	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.000	0	0.0000	0.0000	0.0000	0.0000
(	0.0000	0.000	0	0.0000	0.0000	0.0000	0.0000
AVERAGES OF 1					DS (INCH	ES)	
DAILY AVERAGE HEAD ON TO	OP OF	LAYER					
	0.0012	0.003		0.0016	0.0008	0.0104	
	0.0681	0:089	9	0.3548	0.1774	0.0241	0.0012
	0.0020	0.004		0.0017		0.0324	
(	0.2573	0.243	2	0.7287	0.4575	0.1013	0.0017
DAILY AVERAGE HEAD ON TO 9	OP OF	LAYER					
	0.0000	0.000		0.0000	0.0000		
	9:0000-	0:000	טו	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.000	0	0.0000	0.0000	0.0000	0.0000
(	0.0000	0.000	0	0.0000	0.0000	0.0000	0.0000
********	*****	*****	**	*******	*****	******	******
********	*****	******	**	******	******	******	******
AVERAGE ANNUAL TOTALS							
		INCH	IES		CU. FE	ET	PERCENT
PRECIPITATION				5.704)	9872	2.7	100,00
RUNOFF	1	.680	(	1.1902)	609	9.48	6.178
VAPOTRANSPIRATION	21	.481	(	3.7202)	7797	6.52	78,985
ATERAL DRAINAGE COLLECTED FROM LAYER 2	4	.02954	(	2.05403)	1462	7.235	14.81649
PERCOLATION/LEAKAGE THROUG LAYER 4	н 0	.00002	(	0.00003)		0.077	0.00008

0.00002 ( 0.00003) 0.00007 LATERAL DRAINAGE COLLECTED 0.073 FROM LAYER 8 0.00000 ( 0.00000) 0.004 0.00000 PERCOLATION/LEAKAGE THROUGH LAYER 10 AVERAGE HEAD ON TOP 0.000 ( 0.000)OF LAYER 9 0.020 CHANGE IN WATER STORAGE 0.005 ( 0.4311) 19.37 Page 6

0.066 (

0.096)

AVERAGE HEAD ON TOP

OF LAYER 3

#### CASEGR30, OUT

*******************************

•			
****	************	********	*****
	PEAK DAILY VALUES FOR YEARS	1 THROUGH 30	

PEAK DAILY VALUES FOR YEARS		
	(INCHES)	(CU. FT.)
PRECIPITATION		18404.102
RUNOFF	2.585	9382.0957
DRAINAGE COLLECTED FROM LAYER 2	0.45365	1646.75024
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.000023	0.08305
AVERAGE HEAD ON TOP OF LAYER 3	22.812	
MAXIMUM HEAD ON TOP OF LAYER 3	31.119	
LOCATION OF MAXIMUM HEAD IN LAYER 2 (DISTANCE FROM DRAIN)	158.8 FEET	
DRAINAGE COLLECTED FROM LAYER 8	0.00002	0.07910
PERCOLATION/LEAKAGE THROUGH LAYER 10	0.000000	0.00002
AVERAGE HEAD ON TOP OF LAYER 9	0.000	
MAXIMUM HEAD ON TOP OF LAYER 9	0.000	
LOCATION OF MAXIMUM HEAD IN LAYER 8 (DISTANCE FROM DRAIN)	0.0 FEET	
SNOW WATER	0.02	73.7433
MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.	4300
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.	2210

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner by Bruce M. McEnroe, University of Kansas ASCE Journal of Environmental Engineering Vol. 119, No. 2, March 1993, pp. 262-270.

**************************

LAYER (INCHES) (VOL/VOL)

1 6.7691 0.2820

Page 7

		CASE6R30.OUT	
2	0.0020	0.0100	
3	0.0000	0.0000	
4	0.1800	0.7500	
5	3,8520	0.3210	
6	504.4300	0.2920	
7	7.7040	0.3210	
8	0.0020	0.0100	
9	0.0000	0.0000	
10	0.1800	0.7500	
SNOW WATER	0.000		
	100		

# APPENDIX B.9 HELP OUTPUT FOR ALTERNATIVE LINER CLOSED CASE 7LOCATION 3

CASE7R30.OUT

******************************** ** HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE HELP MODEL VERSION 3.07 (1 NOVEMBER 1997) DEVELOPED BY ENVIRONMENTAL LABORATORY USAE WATERWAYS EXPERIMENT STATION FOR USEPA RISK REDUCTION ENGINEERING LABORATORY ************************* ************************************

PRECIPITATION DATA FILE: TEMPERATURE DATA FILE: SOLAR RADIATION DATA FILE: EVAPOTRANSPIRATION FILE:

C:\HELP3\MDATA\KGVPR30Y.D4 C:\HELP3\MDATA\KGVTE30Y.D7 C:\HELP3\MDATA\KGVS030Y.D13 C:\HELP3\MDATA\KGVEV30Y.D11 DATA: SOIL AND DESIGN DATA C:\HELP3\MDATA\CASE7R.D10 C:\HELP3\MDATA\CASE7R30.OUT

OUTPUT DATA FILE:

TIME: 9: 9 DATE: 4/22/2019

******************************

TITLE: CITY OF KINGSVILLE SOLID WASTE LANDFILL-CASE 7 (LOCATION 3) ******************************

NOTE: INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

## LAYER 1

#### TYPE 1 - VERTICAL PERCOLATION LAYER MATERIAL TEXTURE NUMBER 13

THICKNESS 52 24.00 INCHES 0.4300 VOL/VOL POROSITY 100 FIELD CAPACITY 22 0.3210 VOL/VOL 0.2210 VOL/VOL WILTING POINT F-1 INITIAL SOIL WATER CONTENT 0.2734 VOL/VOL EFFECTIVE SAT. HYD. COND. = 0.330000003000E-04 CM/SEC

NOTE: SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY 4.63 FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.

## LAYER 2

TYPE 2 - LATERAL DRAINAGE LAYER MATERIAL TEXTURE NUMBER 20

**THICKNESS** 

0.20 INCHES

Page 1

CASE7R30,OU POROSITY T 0.8500 VOL/VOL FIELD CAPACITY 0.0100 VOL/VOL 0.0050 VOL/VOL WILTING POINT INITIAL SOIL WATER CONTENT 0.0100 VOL/VOL EFFECTIVE SAT. HYD. COND. = 10.00000000000 CM/SEC 2,00 PERCENT SLOPE DRAINAGE LENGTH 500.0 FEET

### LAYER 3

### TYPE 4 - FLEXIBLE MEMBRANE LINER

MATERIAL TEXTURE NUMBER 36

**THICKNESS** 0.04 INCHES = POROSITY 0.0000 VOL/VOL FIELD CAPACITY = 0.0000 VOL/VOL
WILTING POINT = 0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0000 VOL/VOL EFFECTIVE SAT, HYD. COND. = 0.399999993000E-12 CM/SEC FML PINHOLE DENSITY 1.00 HOLES/ACRE FML INSTALLATION DEFECTS 2.00 HOLES/ACRE FML PLACEMENT QUALITY = 3 - GOOD

### LAYER 4

TYPE 3 - BARRIER SOIL

LINER MATERIAL TEXTURE NUMBER 17 = **THICKNESS** 0.24 INCHES POROSITY = 0.7300 VC_, ... = 0.7470 VOL/VOL = 0.4000 VOL/VOL 0.7500 VOL/VOL FIELD CAPACITY WILTING POINT INITIAL SOIL WATER CONTENT # 0.7500 VOL/VOL EFFECTIVE SAT. HYD. COND. = 0.300000003000E-08 CM/SEC

### LAYER 5

#### TYPE 1 - VERTICAL PERCOLATION LAYER MATERIAL TEXTURE NUMBER 13

= 12,00 INCHES **THICKNESS** 0.4300 VOL/VOL POROSITY = 0.3210 VOL/VOL FIELD CAPACITY WILTING POINT 0.2210 VOL/VOL INITIAL SOIL WATER CONTENT = 0.2210 VOL/VOL EFFECTIVE SAT. HYD. COND. = 0.330000003000E-04 CM/SEC

#### LAYER 6

-----

#### TYPE 1 - VERTICAL PERCOLATION LAYER MATERIAL TEXTURE NUMBER 18

**THICKNESS** = 1845.90 INCHES POROSITY FIELD 0.6710 VOL/VOL = CAPACITY 0.2920 VOL/VOL CASE7R30.OUT
WILTING POINT = 0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.2920 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.100000005000E-02 CM/SEC

LAYER 7

# TYPE 1 - VERTICAL PERCOLATION LAYER MATERIAL TEXTURE NUMBER 13

THICKNESS = 24.00 INCHES

POROSITY = 0.4300 VOL/VOL

FIELD CAPACITY = 0.3210 VOL/VOL

WILTING POINT = 0.2210 VOL/VOL

INITIAL SOIL WATER CONTENT = 0.3210 VOL/VOL

EFFECTIVE SAT. HYD. COND. = 0.330000003000E-04 CM/SEC

### LAYER 8

# TYPE 2 - LATERAL DRAINAGE LAYER MATERIAL TEXTURE NUMBER 20

= 0.20 INCHES **THICKNESS POROSITY** 0.8500 VOL/VOL = 0.0100 VOL/VOL = 0.0050 VOL/VOL FIELD CAPACITY WILTING POINT INITIAL SOIL WATER CONTENT = 0.0100 VOL/VOL EFFECTIVE SAT. HYD. COND. = 10.0000000000 CM/SEC 2.00 PERCENT **SLOPE** DRAINAGE LENGTH 500.0 FEET

# LAYER 9

# TYPE 4 - FLEXIBLE MEMBRANE LINER MATERIAL TEXTURE NUMBER 35

THICKNESS = 0.06 INCHES
POROSITY = 0.0000 VOL/VOL
FIELD CAPACITY = 0.0000 VOL/VOL
WILTING POINT = 0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY = 1.00 HOLES/ACRE
FML INSTALLATION DEFECTS = 2.00 HOLES/ACRE
FML PLACEMENT QUALITY = 3 - GOOD

# LAYER 10

# TYPE 3 - BARRIER SOIL LINER MATERIAL TEXTURE NUMBER 17

THICKNESS = 0.24 INCHES
POROSITY = 0.7500 VOL/VOL
FIELD CAPACITY = 0.7470 VOL/VOL
WILTING POINT = 0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.7500 VOL/VOL

Page 3

CASE7R30.OUT
EFFECTIVE SAT. HYD. COND. = 0.300000003000E-08 CM/SEC

# GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE #13 WITH A GOOD STAND OF GRASS, A SURFACE SLOPE OF 12.% AND A SLOPE LENGTH OF 200. FEET.

SCS RUNOFF CURVE NUMBER	=	84.80	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1,000	ACRES
EVAPORATIVE ZONE DEPTH	₩.	12.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	2,709	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	5.160	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	***	2.652	INCHES
INITIAL SNOW WATER	==	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	#	557.484	INCHES
TOTAL INITIAL WATER	==	557.484	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

## EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM CORPUS CHRISTI TEXAS

STATION LATITUDE = 27.77 DEGREES
MAXIMUM LEAF AREA INDEX = 3.50

START OF GROWING SEASON (JULIAN DATE) = 0
END OF GROWING SEASON (JULIAN DATE) = 367
EVAPORATIVE ZONE DEPTH = 12.0 INCHES
AVERAGE ANNUAL WIND SPEED = 12.00 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY = 76.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY = 76.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY = 76.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS

#### NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JUC/NAC	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
				0.000.000	
1.63	1.69	1.20	1.57	3.29	3.12
2.26	2.78	5.31	2,92	1.61	1.17

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS

#### NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL FEB/AUG MAR/SEP APR/OCT MAY/NOV JUN/DEC

			CASE7R30.OUT			
56.30	59.30	65.90	73.00	78.10	82.70	
84.90	85.00	81.50	74.00	65.00	59.10	

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS

AND STATION LATITUDE = 27.77 DEGREES

AVERAGE MONTH	ILY VALUES I	N INCHES	FOR YEARS	1 THR	OUGH 30	
	JUC/NAC		MAR/SEP	APR/OCT		JUN/DEC
PRECIPITATION						777777
TOTALC	1 27	1 01	1 10	1.40	2,51	2,59
TOTALS	2.36	2.86	1.19 5.39	2.99	1.49	1,25
STD. DEVIATIONS	0.81	1.21	0,57	1.05	1.80	1.82
	2.23	2.36		1.90	1.16	0.84
RUNOFF						
TOTALS	0.005	0.017	0.004	0.048	0.172	0.15
JOTALS	0.327					
STD. DEVIATIONS	0.017	0.034	0.021	0.172	0.495	0.21
	0.771					0.01
EVAPOTRANSPIRATIO						
N TOTALS	1,078	1.759	1,312	1.250	1.927	2.03
	1,733	2.138	3.441	2.378	1.302	1.11
STD. DEVIATIONS	0.678	0.893	0.613	0.800	1,166	1.21
	1.208	1.465	1.222	1.103	0.899	0,69
LATERAL DRAINAGE COL	LLECTED FROM	LAYER :	2			
TOTALS					0.2266	0.38
	0.3734	0.4229	0.9423	0.7940	0.2864	0.08
STD. DEVIATIONS			0.1237			
	0.6049	0.6418	0,9643	0.8378	0.4003	0.12
PERCOLATION/LEAKAGE	THROUGH LAY	ER 4				
TOTALS						
	0.0000	0.0000	0.0000	0.0000	0.0000	0.00
STD. DEVIATIONS	0.0000					
	0.0000	0.0000	0.0000	0.0000	0.0000	0.00
LATERAL DRAINAGE COL	LLECTED FROM	LAYER :	8			
TOTALS						
	0,0000	0.0000	0.0000	0.0000	0.0000	0.00
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.00
				Page 5	•	

			C	ASE7R30.O	IJТ	
	0.0	99 <b>99</b> 999	0.0000			0.0000
PERCOLATION/LEAKAGE THROU	GH LAYE	R 10				
""TOTALS"	0:0000-	0:0000	0.0000	0.0000	0.000	0.0000
	0.0000	0.0000	0.0000	0.0000	0,000	0.0000
		0.0000	0.0000	0.0000	0.000	
	0.0000	0.0000	0.0000	0.0000	0.000	0.0000
AVERAGES OF	MONTHLY	AVERAGED	DAILY HEA	DS (INCH	ES)	
DAILY AVERAGE HEAD ON T	OP OF I	LAYER				
3 AVERAGES	0.0011	0.0038	0.0016	0.0008	0.010	5 0.0584
	<del>0.0675</del> -	<del>0</del> 0853	0.3606	0.1844	0.021	5 0.0012
STD. DEVIATIONS	0.0020	0.0047	0.0018	0.0022	0.032	5 0.1892
	0.2555	0.2308	0.7392	0.4599	0.0994	4 0.0017
DAILY AVERAGE HEAD ON TOP	OF LAY	ER 9				
AVERAGES	0:0000-	0-0000	0.0000	0.0000	0.000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.000	0.0000
	0.0000 0.0000	0,0000	0,0000 0,0000	0.0000	0.000	
*******						
**************************************	& (STD.	DEVIATIO	NS) FOR YE	ARS 1	THROUGH	
		INCHES		CU. FEI		PERCENT
PRECIPITATION	-27		5:704)	9872		100.00
RUNOFF			1.1947)			
			•			
EVAPOTRANSPIRATION LATERAL	21	.470 (	3.7084)	//936	5.3/	78.945
DRAINAGE COLLECTED FROM LAYER 2	4	.00840 (	2.03256)	14550	0.508	14.73877
PERCOLATION/LEAKAGE THROUG LAYER 4	Н 0	.00002 (	0.00003)	(	0.078	0.00008
AVERAGE HEAD ON TOP OF LAYER 3	0	.066 (	0.097)			
LATERAL DRAINAGE COLLECTED FROM LAYER 8	0	.00002 (	0.00003)	(	0.073	0.00007
PERCOLATION/LEAKAGE THROUG LAYER 10	iH 0	.00000 (	0.00000)	(	0.004	0.00000
AVERAGE HEAD ON TOP OF LAYER 9	0	.000 (	0.000)			
CHANGE IN WATER STORAGE	0	.007 (	0.4345)	29 Page 6	5.43	0.026

#### CASE7R30.OUT

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PEAK DAILY VALUES FOR YEARS		
		(CU. FT.)
PRECIPITATION	5.07	18404.102
RUNOFF	2.585	9382.0957
DRAINAGE COLLECTED FROM LAYER 2	0.45365	1646.75073
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.000023	0.08307
AVERAGE HEAD ON TOP OF LAYER 3	22.816	
MAXIMUM HEAD ON TOP OF LAYER 3	31,124	
OCATION OF MAXIMUM HEAD IN LAYER 2 (DISTANCE FROM DRAIN)	158.8 FEET	
DRAINAGE COLLECTED FROM LAYER 8	0.00002	0.07912
PERCOLATION/LEAKAGE THROUGH LAYER 10	0.000000	0.00002
AVERAGE HEAD ON TOP OF LAYER 9	0.000	
MAXIMUM HEAD ON TOP OF LAYER 9	0.000	
OCATION OF MAXIMUM HEAD IN LAYER 8 (DISTANCE FROM DRAIN)	0.0 FEET	
SNOW WATER	0.02	73,7433
MAXIMUM VEG. SOIL WATER (VOL/VOL)	e	.4300
MINIMUM VEG. SOIL WATER (VOL/VOL)	e	0.2210

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner by Bruce M. McEnroe, University of Kansas ASCE Journal of Environmental Engineering Vol. 119, No. 2, March 1993, pp. 262-270.

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LAYER (INCHES) (VOL/VOL)

1 6.7714 0.2821

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		CASE7R30.OUT
2	0.0020	0.0100
3	0.0000	0.0000
4	0.1800	0.7500
5	3,8520	0.3210
6	539,0029	0.2920
7	7.7040	0.3210
8	0.0020	0.0100
9	0.0000	0.0000
10	0.1800	0.7500
SNOW WATER	0,000	

*

# APPENDIX B.10 HELP OUTPUT FOR ALTERNATIVE LINER CLOSED CASE 8LOCATION 4

#### CASE8R30.OUT

PRECIPITATION DATA FILE: C:\HELP3\MDATA\KGVPR30Y.D4
TEMPERATURE DATA FILE: C:\HELP3\MDATA\KGVPR30Y.D7
SOLAR RADIATION DATA C:\HELP3\MDATA\KGVS030Y.D13
FILE: EVAPOTRANSPIRATION C:\HELP3\MDATA\KGVEV30Y.D11
DATA:SOIL AND DESIGN DATA C:\HELP3\MDATA\CASE8R.D10
FILE:OUTPUT DATA FILE: C:\HELP3\MDATA\CASE8R30.OUT

TIME: 13:42 DATE: 4/18/2019

*******************************

TITLE: CITY OF KINGSVILLE SOLID WASTE LANDFILL-CASE 8 (LOCATION 4)

*************************************

NOTE: INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

# LAYER 1

# TYPE 1 - VERTICAL PERCOLATION LAYER MATERIAL TEXTURE NUMBER 13

THICKNESS = 24.00 INCHES
POROSITY = 0.4300 VOL/VOL
FIELD CAPACITY = 0.3210 VOL/VOL
WILTING POINT = 0.2210
INITIAL SOIL WATER = VOL/VOL 0.2733

**SONTURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY 4.63**FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.

#### LAYER 2

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 20

THICKNESS = 0.20 INCHES

Page 1

CASE8R30,0U

POROSITY = T 0.8500 VOL/VOL

FIELD CAPACITY = 0.0100 VOL/VOL

WILTING POINT = 0.0050 VOL/VOL

INITIAL SOIL WATER CONTENT = 0.0100 VOL/VOL EFFECTIVE SAT. HYD. COND. = 10.0000000000 CM/SEC SLOPE = 2.00 PERCENT

DRAINAGE LENGTH = 500.0 FEET

LAYER 3

#### TYPE 4 - FLEXIBLE MEMBRANE LINER MATERIAL TEXTURE NUMBER

THICKNESS 36 0.04 INCHES

POROSITY = 0.0000 VOL/VOL

FIELD CAPACITY = 0.0000 VOL/VOL

WILTING POINT = 0.0000 VOL/VOL

INITIAL SOIL WATER CONTENT = 0.0000 VOL/VOL EFFECTIVE SAT. HYD. COND. = 0.399999993000E-12 CM/SEC
FML PINHOLE DENSITY = 1.00 HOLES/ACRE
FML INSTALLATION DEFECTS = 2.00 HOLES/ACRE FML PLACEMENT QUALITY = 3 - GOOD

#### LAYER 4

TYPE 3 - BARRIER SOIL LINER MATERIAL TEXTURE

THICKNESS NUMBER 17 = 0.24 INCHES
POROSITY = 0.7500 VOL/VOL
FIELD CAPACITY = 0.7400 VOL/VOL
WILTING POINT = 0.4000 VOL/VOL
INITIAL SOIL WATER = 0.3000000003000E-08 CM/SEC
HYD COND HYD, COND.

LAYER 5

#### TYPE 1 - VERTICAL PERCOLATION

LAYER MATERIAL TEXTURE NUMBER 13

THICKNESS = 12.00 INCHES

POROSITY = 0.4300 VOL/VOL

FIELD CAPACITY = 0.3210 VOL/VOL

WILTING POINT = 0.2210 VOL/VOL

INITIAL SOIL WATER = 0.3210 VOL/VOL

CONTENT EFFECTIVE SAT. = 0.330000003000E-04 CM/SEC

HYD. COND.

LAYER 6

#### TYPE 1 - VERTICAL PERCOLATION

LAYER MATERIAL TEXTURE NUMBER 18

■ 1930.00 INCHES **THICKNESS** POROSITY FIELD = 0,6710 VOL/VOL CAPACITY 0.2920 VOL/VOL ===

Page 2

#### CASE8R30.OUT

WILTING POINT = 0.0770 VOL/VOL
INITIAL SOIL WATER = 0.2920 VOL/VOL
CONTENT EFFECTIVE SAT, = 0.100000005000E-02 CM/SEC
HYD. COND.

# LAYER 7

#### TYPE 1 - VERTICAL PERCOLATION LAYER

#### MATERIAL TEXTURE NUMBER 13

THICKNESS = 24.00 INCHES

POROSITY = 0.4300 VOL/VOL

FIELD CAPACITY = 0.3210 VOL/VOL

WILTING POINT = 0.2210 VOL/VOL

INITIAL SOIL WATER CONTENT = 0.3210 VOL/VOL

EFFECTIVE SAT. HYD. COND. = 0.330000003000E-04 CM/SEC

### LAYER 8

# TYPE 2 - LATERAL DRAINAGE LAYER MATERIAL TEXTURE NUMBER

THICKNESS	20=	0.20 INCHES
POROSITY	=	0.8500 VOL/VOL
FIELD CAPACITY	=	0,0100 VOL/VOL
WILTING POINT	=	0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT	==	0.0100 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	10.0000000000 CM/SEC
SLOPE	=	2.00 PERCENT
DRATNAGE   FNGTH	==	500.0 FEET

# LAYER 9

# TYPE 4 - FLEXIBLE MEMBRANE LINER MATERIAL TEXTURE NUMBER 35

THICKNESS	=	0.06 INCHES
POROSITY	=	0.0000 VOL/VOL
FIELD CAPACITY	-	0.0000 VOL/VOL
WILTING POINT	=	0.0000 VOL/VOL
INITIAL SOIL WATER	=	
CONTENT EFFECTIVE SAT.	==	0.199999996000E-12 CM/SEC
HYD. COND. FML PINHOLE	=	1,00 HOLES/ACRE
DENSITY	=	2,00 HOLES/ACRE
FML INSTALLATION DEFECTS	=	3 - GOOD
FML PLACEMENT QUALITY		

#### LAYER 10

# TYPE 3 - BARRIER SOIL LINER MATERIAL TEXTURE NUMBER 17

THICKNESS	=	0.24 INCHES
POROSITY	==	0.7500 VOL/VOL
FIELD CAPACITY	=	0.7470 VOL/VOL
WILTING POINT	==	0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.7500 VOL/VOL

CASERR30.OUT
EFFECTIVE SAT. HYD. COND. = 0.300000003000E-08 CM/SEC

# GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
SOIL DATA BASE USING SOIL TEXTURE #13 WITH A
GOOD STAND OF GRASS, A SURFACE SLOPE OF
4.% AND A SLOPE LENGTH OF 600. FEET.

SCS RUNOFF CURVE NUMBER	=	83.40	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	270	12.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	2.708	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	20	5.160	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	2.652	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	582.040	INCHES
TOTAL INITIAL WATER	=	582.040	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

# EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM CORPUS CHRISTI TEXAS

STATION LATITUDE

MAXIMUM LEAF AREA INDEX

START OF GROWING SEASON (JULIAN DATE)

END OF GROWING SEASON (JULIAN DATE)

EVAPORATIVE ZONE DEPTH

AVERAGE ANNUAL WIND SPEED

AVERAGE 1ST QUARTER RELATIVE HUMIDITY

AVERAGE 2ND QUARTER RELATIVE HUMIDITY

AVERAGE 3RD QUARTER RELATIVE HUMIDITY

AVERAGE 4TH QUARTER RELATIVE HUMIDITY

AVER

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR CORPUS CHRISTI TEXAS

#### NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JUC/NAC	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
1.63	1.69	1.20	1.57	3,29	3.12
2.26	2.78	5,31	2.92	1.61	1.17

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS

#### NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL FEB/AUG MAR/SEP APR/OCT MAY/NOV JUN/DEC

				CASE8R30.OU	Ŧ
56.30	59.30	65.90	73.00	78.10	82.70
84.90	85.00	81.50	74.00	65,00	59.10

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR CORPUS CHRISTI TEXAS AND STATION LATITUDE = 27.77 DEGREES

AVERAGE MONTH	LY VALUES IN					
	JUC/NAC	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DE
PRECIPITATION				No.		
TOTALS	1 27	1.81	1,19	1 40	2,51	2.59
TOTALS	2.36		5.39			1.25
STD. DEVIATIONS	0.81	1.21	0.57	1.05	1.80	1.82
	2.23	2.36	2.96	1.90	1.16	0.84
RUNOFF						
TOTALS	0.003	0,011	0.003	0,043	0.154	0.11
	0.320	0.167	0.536	0.138	0.039	0.00
STD. DEVIATIONS	0.012	0.024				
	0.765	0.317	0.853	0.285	0.166	0.03
EVAPOTRANSPIRATION						
TOTALS	1.075	1.755	1.316	1.246	1.943	2.0
	1.740	2.149	3.445	2.375	1,304	1.1
STD. DEVIATIONS	0.680					
	1.225	1.476	1,225	1.098	0.904	0.69
LATERAL DRAINAGE COL						
TOTALS	0.0871					
	0.3740	0.4325	0.9802	0.8286	0.2979	0.0
STD. DEVIATIONS		0.3090				
	0.6004	0.6575	0.9888	0.8731	0.4168	0.1
PERCOLATION/LEAKAGE						
TOTALS	0.0000					
	0.0000	0,0000	0.0000	0.0000	0.0000	0.0
STD. DEVIATIONS		0.0000				
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0
LATERAL DRAINAGE COL						
TOTALS	0.0000	0.0000	0.0000			
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0
STD, DEVIATIONS	0.0000	0,0000	0,0000	0.0000	0.0000	0.0

					•			
		ASE8R30,0	UT					
	0.6	0000000	0.0000		0.0000	0.0000		
PERCOLATION/LEAKAGE TH	IRUNGH I AVER	10						
FERCOLATION, ELAKAGE TI	MOOGIT LATER	. 10						
""TOTALS"	0-0000	-0.0000	0.0000	0.0000	0,0000	0.0000		
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
SIDI DEVIATIONS	0.0000	0,0000	0.0000	0.0000	0,0000	0.0000		
	OF MONTHLY							
DAILY AVERAGE HEAD O	N TOP OF L	_AYER						
3			0.0046		0.0404	0 0740		
AVERAGES			0.0016			0.0748		
		0.0824	0.3/0/	0,2120	0.0248	0.0012		
	0.0022	0.0048	0.0017	0.0024	0.0323	0. 2328		
STD. DEVIATIONS	0.0023 0.2719		0.7766	0.4906	0.1168	0.0017		
	0.2/19	0,2347	0.7700	0.4300	0.1100	0.0017		
DATIV AVERAGE HEAD ON	DAILY AVERAGE HEAD ON TOP OF LAYER 9							
DAILY AVERAGE HEAD ON	TOP OF LATE	-N 2						
AVERAGES	0:0000	0:0000	0.0000	0.0000	0.0000	0.0000		
710 210 1023	0.0000	0.0000	0.0000	0.0000	0.0000	0,0000		
STD, DEVIATIONS	0,0000	0.0000	0.0000	0,0000	0.0000	0.0000		
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
*******	******	******	*****	*******	*****	*****		
********	******	******	******	******	******	******		
					TUDOUGU	20		
AVERAGE ANNUAL TOTA	•		•		THROUGH	30		
						DEDCENT		
		INCHES		CU. FE		PERCENT		

AVERAGE ANNUAL TOTALS & (	STD. DEVIA				GH 30
	INC	HES		CU. FEET	
PRECIPITATION				98722.7	
RUNOFF	1.533	(	1,1930)	5565.96	5.638
EVAPOTRANSPIRATION LATERAL	21.495	(	3.7381)	78026.06	79.036
DRAINAGE COLLECTED FROM LAYER 2	4.16123	(	2.10988)	15105.281	15.30072
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.00002	(	0.00003)	0.083	0.00008
AVERAGE HEAD ON TOP OF LAYER 3	0.071 (		0.104)		
LATERAL DRAINAGE COLLECTED FROM LAYER 8	0.00002	(	0.00003)	0.079	0.00008
PERCOLATION/LEAKAGE THROUGH LAYER 10	0.00000	(	0.00000)	0.004	0.00000
AVERAGE HEAD ON TOP OF LAYER 9	0.000 (		0.000)		
CHANGE IN WATER STORAGE	0.007	(	0.4342)	25,30 Page 6	0.026

#### CASE8R30.OUT

******								**********
*******	*****	*****	****	****	****	****	****	*****
PEA	K DAILY	VALUES	FOR	YEARS	1	THROUGH	30	
						INCHES)		FT.)
					6236			

	(INCHES)	(CU. FT.)
PRECIPITATION		18404.102
RUNOFF	2,585	9382.0947
DRAINAGE COLLECTED FROM LAYER 2	0.45365	1646.74548
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.000023	0.08285
AVERAGE HEAD ON TOP OF LAYER 3	22.774	
MAXIMUM HEAD ON TOP OF LAYER 3	31.078	
LOCATION OF MAXIMUM HEAD IN LAYER 2 (DISTANCE FROM DRAIN)	158.7 FEET	
DRAINAGE COLLECTED FROM LAYER 8	0.00002	0.07933
PERCOLATION/LEAKAGE THROUGH LAYER 10	0.000000	0.00002
AVERAGE HEAD ON TOP OF LAYER 9	0.000	
MAXIMUM HEAD ON TOP OF LAYER 9	0.000	
LOCATION OF MAXIMUM HEAD IN LAYER 8 (DISTANCE FROM DRAIN)	0.0 FEET	
SNOW WATER	0.02	73.7433
MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.0	4300
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.	2210

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner by Bruce M. McEnroe, University of Kansas ASCE Journal of Environmental Engineering Vol. 119, No. 2, March 1993, pp. 262-270.

FINAL WATER STORAGE AT END OF YEAR 30

LAYER (INCHES) (VOL/VOL)

6.7694

1

Page 7

0.2821

		CASE8R30.OUT
2	0.0020	0.0100
3	0.0000	0.0000
4	0.1800	0.7500
5	3.8520	0.3210
6	563.5601	0.2920
7	7,7040	0.3210
8	0.0020	0.0100
9	0.0000	0.0000
10	0.1800	0.7500
SNOW WATER	0.000	

*

# APPENDIX C MULTIMED MODEL ANALYSIS

# APPENDIX C.3 MULTIMED SOURCE-SPECIFIC DATA

#### **MULTIMED SOURCE - SPECIFIC DATA**

Variable Name	Units	Value	Comments
Infiltration rate	m/yr	varies	See table below.
Area of waste disposal unit	m ²	485,623	120 acres
Spread of contaminant source	m	0	Derived by MULTIMED
Recharge rate	m/yr	0.0368	Five percent of average annual precipitation (1.45 inches/yr)
Initial concentration at landfill (C ₀ )	mg/L	1.0	Set at 1.0 to find DAF
Length scale of facility	m		Derived by MULTIMED
Width scale of facility	m		Derived by MULTIMED

Case	Infiltration	Comments
5335	Rate (m/yr)	30
Interim cases with Alternative Liner	,,,,	
• <u>58.80</u> <del>57.5</del> feet of waste (Case 1)	7	Calculated using peak daily percolation/
20 yr	*1.28 x 10 ⁻⁷	leakage rate through GCL. See Appx. B.2
• 143.96140 feet of waste (Case 2)		Calculated using peak daily percolation/
20 yr	1.79 x 10 ⁻⁷	leakage rate through GCL. See Appx. B.2
• <u>153.83</u> 148 feet of waste (Case 3)	7	Calculated using peak daily percolation/
20 yr	1.79 x 10 ⁻⁷	leakage rate through GCL. See Appx. B.2
• 160.83162 feet of waste (Case 4)		Calculated using peak daily percolation/
20 yr	1.79 x 10 ⁻⁷	leakage rate through GCL. See Appx. B.2
Closed cases with Alternative Liner		
• <u>58.80</u> <del>57.5</del> feet of waste (Case 5)		Calculated using peak daily percolation/
30 yr	5.11 x 10 ⁻⁸	leakage rate through GCL. See Appx. B.2
• <u>143.96</u> 140 feet of waste (Case 6)		Calculated using peak daily percolation/
30 yr	5.11 x 10 ⁻⁸	leakage rate through GCL. See Appx. B.2
• <u>153.83</u> 148 feet of waste (Case 7)		Calculated using peak daily percolation/
30 yr	5.11 x 10 ⁻⁸	leakage rate through GCL. See Appx. B.2
450 02452 (524 5		
• <u>160.83</u> 162 feet of waste (Case 8)	- 44 40-8	Calculated using peak daily percolation/
30 yr	5.11 x 10 ⁻⁸	leakage rate through GCL. See Appx. B.2

^{*} Determined Using Peak Daily Percolation/Leakage Rate Through GCL and Converted to (M/YR) Example:  $((.00005 \, \text{FT}^3/\text{Day-Acre})x(1 \, \text{Acre}/43,560 \, \text{FT}^2)/(1 \, \text{Meter}/3.28 \, \text{FT})) \times (365 \, \text{Days}/1 \, \text{YR}) = 1.28 \, \text{x} \, 10^{-7} \, \text{M/YR}$ 

# APPENDIX C.4 MULTIMED SOURCE-SPECIFIC DATA

#### **MULTIMED SOURCE - SPECIFIC DATA**

#### **Overliner Demonstration**

Variable Name	Units	Value	Comments
Infiltration rate	m/yr	varies	See table below.
Area of waste disposal unit	m ²	485,623	120 acres
Spread of contaminant source	m	0	Derived by MULTIMED
Recharge rate	m/yr	0.0368	Five percent of average annual precipitation (1.45 inches/yr)
Initial concentration at landfill (C ₀ )	mg/L	1.0	Set at 1.0 to find DAF
Length scale of facility	m		Derived by MULTIMED
Width scale of facility	m		Derived by MULTIMED

Case	Infiltration	Comments
	Rate (m/yr)	
Interim Cases with Overliner		
Location 1 (Case 1OL)		
• 12 feet of waste above liner		
• 15.5 feet of waste below liner		Calculated using peak daily percolation/
20 yr	*1.79 x 10 ⁻⁷	leakage rate through GCL. See Appx. B.12
20 yi	1.79 % 10	leakage rate tillough GCL. See Appx. B.12
Location 2 (Case 2OL)		
82.5 feet of waste above liner		
34 feet of waste below liner		Calculated using peak daily percolation/
20 yr	1.53 x 10 ⁻⁷	leakage rate through GCL. See Appx. B.12
25 7.	2.55 X 25	leanage rate amough occioes Apple 212
Location 3 (Case 3OL)		
85.5 feet of waste above liner		
• 37 feet of waste above below liner		Calculated using peak daily percolation/
20 yr	1.53 x 10 ⁻⁷	leakage rate through GCL. See Appx. B.12
Location 4 (Case 4OL)		
• 119.5 feet of waste above liner		
• 16 feet of waste above below liner		Calculated using peak daily percolation/
20 yr	1.53 x 10 ⁻⁷	leakage rate through GCL. See Appx. B.12
Closed cases with Overliner		
Location 1 (Case 5OL)		
• 12 feet of waste above liner		
• 15.5 feet of waste below liner	8	Calculated using peak daily percolation/
30 yr	5.11 x 10 ⁻⁸	leakage rate through GCL. See Appx. B.12
Lagation 2 (Casa COL)		
Location 2 (Case 6OL)  • 82.5 feet of waste above liner		
34 feet of waste below liner		Calculated using peak daily percelation/
	F 11 10 ⁻⁸	Calculated using peak daily percolation/
30 yr	5.11 x 10 ⁻⁸	leakage rate through GCL. See Appx. B.12
Location 3 (Case 7OL)		
• 85.5 feet of waste above liner		
• 37 feet of waste below liner		Calculated using peak daily percolation/
30 yr	5.11 x 10 ⁻⁸	leakage rate through GCL. See Appx. B.12
30 yi	J.11 X 10	reakage rate tillough OCL. See Appx. D.12
Location 4 (Case 8OL)		
• 119.5 feet of waste above liner		
16 feet of waste below liner		Calculated using peak daily percolation/
30 vr	5.11 x 10 ⁻⁸	= ' ' '
,		0
16 feet of waste below liner     30 yr	5.11 x 10 ⁻⁸	Calculated using peak daily percolation/ leakage rate through GCL. See Appx. B.12

^{*} Determined Using Peak Daily Percolation/Leakage Rate Through GCL and Converted to (M/YR) Example:  $((.00007 \text{ FT}^3/\text{Day-Acre})x(1 \text{ Acre}/43,560 \text{ FT}^2)/(1 \text{ Meter}/3.28 \text{ FT})) \times (365 \text{ Days}/1 \text{ YR}) = 1.79 \times 10^{-7} \text{ M/YR}$ 

# APPENDIX C.6 MULTIMED SOURCE-SPECIFIC DATA

#### **MULTIMED AQUIFER - SPECIFIC DATA**

Variable Name	Units	Value	Comments
Particle Diameter*	cm	0.0381	From Permit 235-B Amendment Volume II of V
			Pages 36-39 (PDF)-1998
			Reference Appendix C.7.2
			Material ranges from fine to coarse. Use an average
			for medium sand (0.010-0.020 in); 0.015 in or 0.0381 cm
Aquifer porosity*	unitless	0.43	From Permit 235-B Amendment Volume V of V
			Pages 467-473 (PDF)-1998
			Reference Appendix C.7.1
Bulk density	g/cc	1.65	From Permit 235-B Amendment Volume V of V
			Pages 467-473 (PDF)-1998
			Reference Appendix C.7.1
Aquifer thickness	m	10	From Permit 235-B Amendment Volume V of V Pgs.
			467-473 (PDF)-1998 Avg depth of uppermost aquifer
			Reference Appendix C.7.1
Mixing zone depth	m		Derived by MULTIMED
Hydraulic conductivity	m/yr	130	From Permit 235-B Amendment Volume V of V
			Pages 467-473 (PDF)-1998
			Reference Appendix C.7.1
			Average hydraulic conductivity of 4.12 x 10 ⁻⁴ cm/sec
Hydraulic gradient	unitless	0.0031	From Groundwater Contour Map (January 2016)
Groundwater seepage velocity	m/yr		Derived by MULTIMED
Retardation coefficient	unitless		Derived by MULTIMED
Longitudinal dispersivity	m		Derived by MULTIMED
Transveral dispersivity	m		Derived by MULTIMED
Vertical dispersivity	m		Derived by MULTIMED
Organic carbon content	%	0.003	From Permit 235-B Amendment Volume V of V
			Pages 467-473 (PDF)-1998
			Reference Appendix C.7.1
Receptor distance from well	m	Varies	Distance from analysis location to point of
			compliance.
Z-distance from water table	m	0	Assume water table is at bottom of liner.

Note: According to Amendment Application (1998) the Evangeline Aquifer is the principal-aquifer in the region and is considered one of the most prolific aquifers in the Texas Coastal Plain. The aquifer is composed of at least the Goliad Sand and includes sections of sand in the Fleming Formation. The Goliad consists of fine-to coarse, mostly gray calcareous sand interbedded with sandstone and varicolored clay. (assume medium sand (0.015 in) particle diamter or (0.0381 cm)

^{*} If Aquifer porosity is known MULTIMED will not use particle diameter.

# APPENDIX C.7 MULTIMED SOURCE-SPECIFIC DATA

#### **MULTIMED AQUIFER - SPECIFIC DATA**

#### **Overliner Demonstration**

Variable Name	Units	Value	Comments
Particle Diameter*	cm	0.0381	From Permit 235-B Amendment Volume II of V
			Pages 36-39 (PDF)-1998
			Reference Appendix C.7.2
			Material ranges from fine to coarse. Use an average
			for medium sand (0.010-0.020 in); 0.015 in or 0.0381 cm
Aquifer porosity*	unitless	0.43	From Permit 235-B Amendment Volume V of V
			Pages 467-473 (PDF)-1998
			Reference Appendix C.7.1
Bulk density	g/cc	1.65	From Permit 235-B Amendment Volume V of V
			Pages 467-473 (PDF)-1998
			Reference Appendix C.7.1
Aquifer thickness	m	10	From Permit 235-B Amendment Volume V of V Pgs.
			467-473 (PDF)-1998 Avg depth of uppermost aquifer
			Reference Appendix C.7.1
Mixing zone depth	m		Derived by MULTIMED
Hydraulic conductivity	m/yr	130	From Permit 235-B Amendment Volume V of V
			Pages 467-473 (PDF)-1998
			Reference Appendix C.7.1
			Average hydraulic conductivity of 4.12 x 10 ⁻⁴ cm/sec
Hydraulic gradient	unitless	0.002	From Groundwater Contour Map (January 2016)
Groundwater seepage velocity	m/yr		Derived by MULTIMED
Retardation coefficient	unitless		Derived by MULTIMED
Longitudinal dispersivity	m		Derived by MULTIMED
Transveral dispersivity	m		Derived by MULTIMED
Vertical dispersivity	m		Derived by MULTIMED
Organic carbon content	%	0.003	From Permit 235-B Amendment Volume V of V
			Pages 467-473 (PDF)-1998
			Reference Appendix C.7.1
Receptor distance from well	m	Varies	Distance from analysis location to point of
			compliance.
Z-distance from water table	m	0	Assume water table is at bottom of liner.

Note: According to Amendment Application (1998) the Evangeline Aquifer is the principal-aquifer in the region and is considered one of the most prolific aquifers in the Texas Coastal Plain. The aquifer is composed of at least the Goliad Sand and includes sections of sand in the Fleming Formation. The Goliad consists of fine-to-coarse, mostly gray calcareous sand interbedded with sandstone and varicolored clay. (assume medium sand (0.015 in) particle diamter or (0.0381 cm)

^{*} If Aquifer porosity is known MULTIMED will not use particle diameter.

# APPENDIX D CALCULATIONS OF THE DILUTION ATTENUATION FACTOR (DAF)

#### **CALCULATIONS OF THE DILUTION ATTENUATION FACTOR**

Example Calculation for the Interim Case with Alternative Liner

Result from MULTIMED model:

Chemical concentration at the point of compliance =  $0.2449 \times 10^{-4} = 0.2943 \times 10^{-4}$ 

To find the resulting DAF, take the recipricol:

DAF=  $1/\frac{0.2449 \times 10^{-4}}{0.2943 \times 10^{-4}}$  mg/1

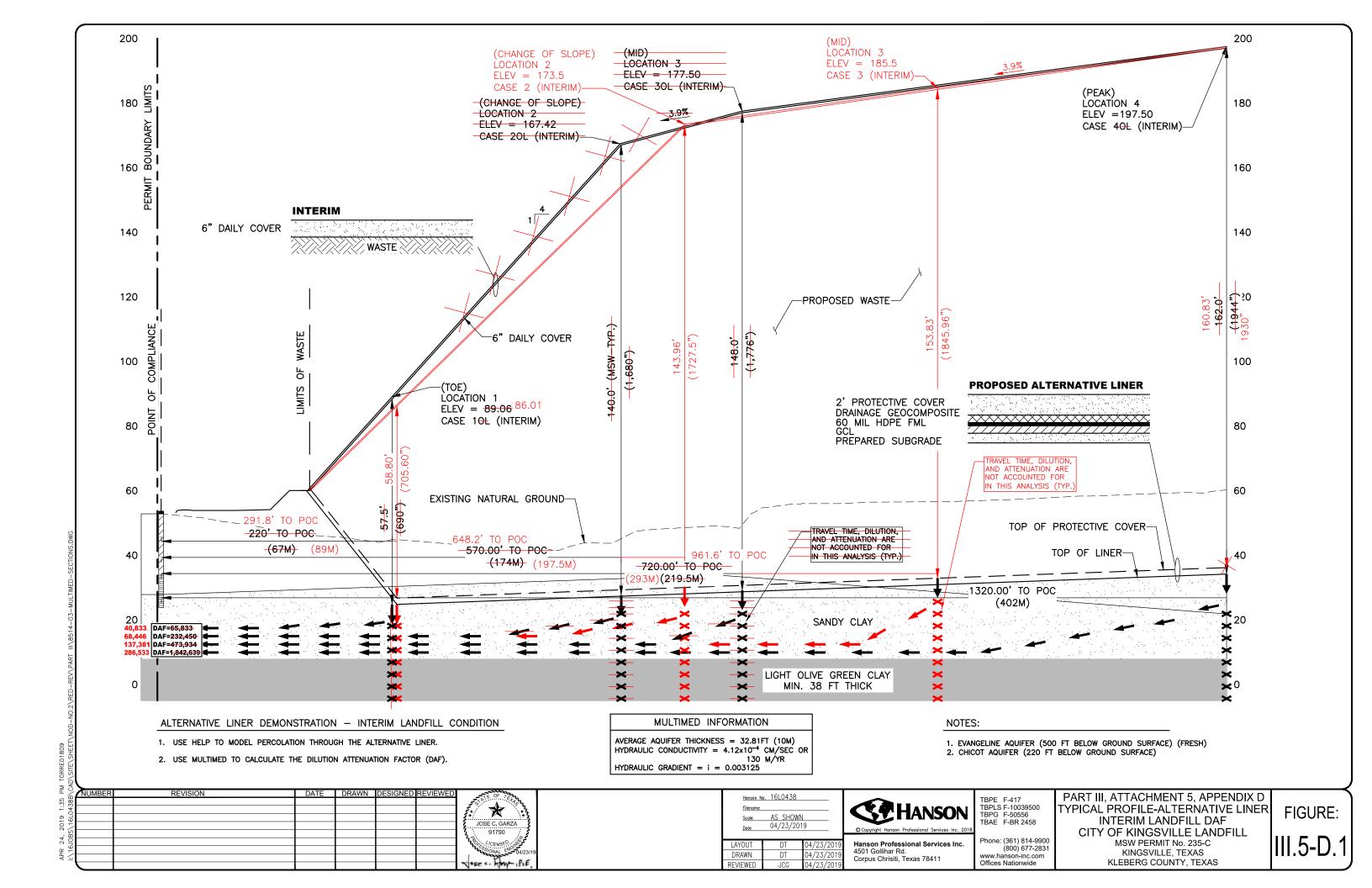
DAF= 40,833 33,979

Table 1

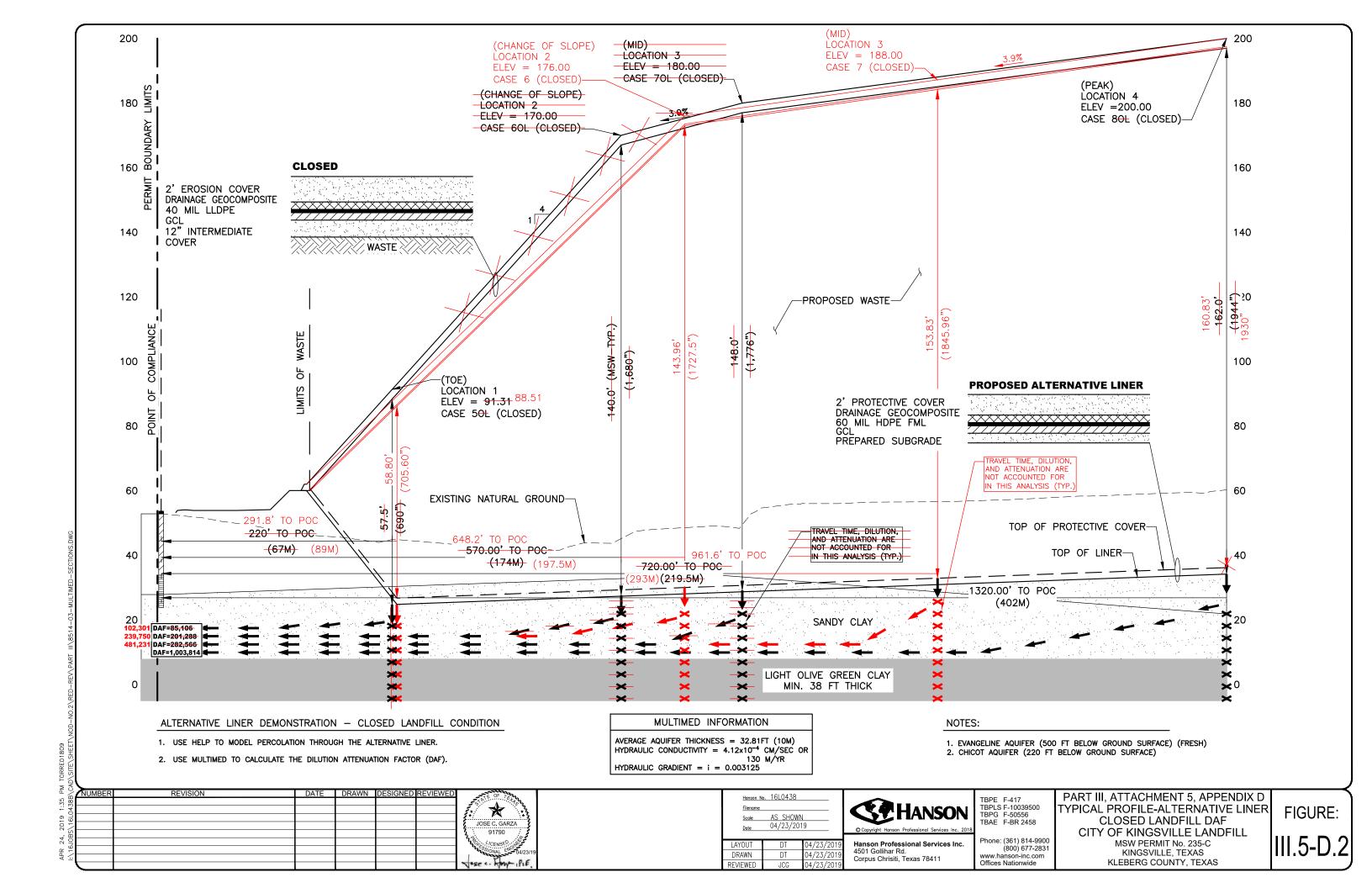
Location	Interim Case DAF	Closed Case DAF
Alternative Liner Location 1	<u>40,833</u> <u>33,979</u>	<u>102,301</u> <del>85,106</del>
Alternative Liner Location 2	<u>68,446 57,471</u>	239,750 <del>201,288</del>
Alternative Liner Location 3	<u>137,381</u> <del>80,645</del>	<u>481,231 <del>282,566</del></u>
Alternative Liner Location 4	286,533	1,003,814

Location	Interim Case DAF	Closed Case DAF
Overliner Location 1	18,797	65,833
Overliner Location 2	77,640	232,450
Overliner Location 3	158,253	473,934
Overliner Location 4	615,385	1,842,639

# APPENDIX D.1 TYPICAL PROFILE-ALTERNATIVE LINER INTERIM LANDFILL DAF



### APPENDIX D.2 TYPICAL PROFILE-ALTERNATIVE LINER CLOSED LANDFILL DAF



### APPENDIX F MULTIMED MODEL OUTPUT

# APPENDIX F.1 MULTIMED OUTPUT FOR ALTERNATIVE LINER INTERIM CASE 1LOCATION 1

0.100E+11

0.000E+00 -999. 0.000E+00 -999. 0.000E+00 -999.

CONSTANT

mm Hg atm-m^3/M

Vapor pressure of solute Henry's law constant Mole fraction of solute

CONSTANT

MAX

LIMITS

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CASE1R

ESSMENT MODEL S MULTIMEDIA N N EXPOSURE

MULTIMED (Version 1.01, June 1991)

1 Run options

Case 1

Saturated zone model DETERMIN

Wasiltration input by user

Chosen Run

Run was steady-state

Location 1 Chemical simulated is DEFAULT CHEMICAL

CHEMICAL SPECIFIC VARIABLES

VARIABLE NAME	UNITE	DISTRIBUTION	PARAMETERS MEAN STD DEV	LIMIT
Solid phase decay coefficient Dissolved	1/yr	CONSTANT	0.000E+00	0.000E+00
phase decay coefficient Overall	1/yr	CONSTANT	-999. 0.000E+00	0.000E+00
chemical decay coefficient Acid	1/yr	CONSTANT	09.9800E+00 -999.	0.000E+00
catalyzed hydrolysis rate	1/M-yr	CONSTANT	0.000E+00 -999.	0.000E+00
Neutral hydrolysis rate constant	1/yr	CONSTANT	0.000E+00 -999.	0.000E+00
Base catalyzed hydrolysis rate	1/M-yr	CONSTANT	0.000E+00 -999.	0.000E+00
Reference temperature	Ú	CONSTANT	20.0 -999.	0.000E+00
Normalized distribution coefficient	m1/g	CONSTANT	_	0.000E+00
Distribution coefficient Biodegradation	1	DERIVED	-999.	0.000E+00
coefficient (sat. zone) Air diffusion	1/yr	CONSTANT	0.000E+00 -999.	0.000E+00
coefficient	cm2/s	CONSTANT	0.000E+00 -999.	0.000E+00
Reference temperature for air diffusion	U	CONSTANT	0.000E+00 -999.	0.000E+00
Molecular weight	M/g	CONSTANT	0.000E+00 -999.	0.000E+00
	•			

Part II, Attachment 5, Appendix F.1, p.g.-1

Gaussian source used in saturated zone model Reject runs if Y coordinate outside plume Reject runs if Z coordinate outside plume

> Hanson Professional Services Inc. Submittal Date: September 2018 Revision: 3 - April 2019Revision: 0

age 2

# APPENDIX F.2 MULTIMED OUTPUT FOR ALTERNATIVE LINER INTERIM CASE 2LOCATION 2

										LINITS N MAX	0.000E+00 0.100E+11 0.000E+00 0.100E+11 0.000E+00 0.100E+11 0.000E+00-999. 0.000E+00-999. 0.000E+00-999. 0.000E+00-999. 0.000E+00 100. 0.000E+00 100. 0.000E+00 100. 0.000E+00 100. 0.000E+00 100. 0.000E+00 100. 0.000E+00 100. 0.000E+00 100. 0.000E+00 100.
	A G E NC Y								v	PARAMETE RS MEAN STD DEV MI	0.000E+00 -999. 0.000E+00 -999.
CASE2R	PROTECTON	SSESMENT	M ODE L	MU LTIME D (Version 1.01, June 1991)					CHBICALSPECFIC VARIABLE 9	DISTRIBUTI ON	CONSTANT CO NSTANT CO NSTANT CO NSTANT CO NSTANT CONSTANT
	NTAL	U RE A	LTIME DIA	) (Version				ne model	CHBI CAL	UNITS	1/yr 1/yr 1/yr 1/yr 1/yr C m1/g  1/yr Cm2/s C C mm Hg
	U.S. ENIR ON MEN	E XP 0S	אט גד	MU LTIME (	21.		Location 2 Ch emical simulated is DEFA ULT CH EMI <u>G</u> l.	Option Ch osen  Run was  Infiltration input by user  Reject runs if Y coordinate outside plume  Reject runs if Z coordinate outside plume  Gaussian source used in saturated zone model		Щ	Solid phase decay coefficient Dissolved phase decay coefficient Overall chemical decay coefficient Acid catalyzed hydrolysis rate Neutral hydrolysis rate constant Base catalyzed hydrolysis rate Normalized distribution coefficient Distribution coefficient Biodegradation coefficient Air diffusion coefficient Mo lecular weight Mo lecular weight Mo le fraction of solute Vapor pressure of solute Henry's law constant
,	4			•	Run options	Case 2	Location 2 Ch emical CH EMI 🛍	Option Ch osen Run was Infiltration: Run was steady Reject runs if Reject runs if	1 ਜ		

Part II, Attachment 5, Appendix F.2, p.g.-1

						t t		9														
0.000E+00 1.00 0.000E+00 1.00 0.000E+00 1.00		LIMITS MIN MAX	0.100E-09 0.100E+11 0.100E-01-999. 0.100E-08-999. 0.100E-08 0.100E+11	0.000E+00-999. 0.000E+00-999. 0.100E-080.100E+11	0.100E-08 0.100E+11 0.000E+00 1.00		LIMITS MIN MAX	0.100E-08100.	0.100E-08 0.990	0.100E-08 0.100E+06	0.100E-08 0.100E+06	0.100E-06 0.100E+09	0.100E-07 -999. 0 100E-09 0 100E±00	1.00 0.1005+09	.666666-	-999.		E+00 0		9.100E-051 1.00	.88 8 888E±88 8 3 58	
0.000E+00 0.000E+00 -999999. -999.		PARAMETERS MEAN STD DEV	0.179E-06 -999. 0.486E+06 -999. -999999. -999999.	0.000E+00-999. 1.00-999. -999999.			PARAMETERS MEAN STD DEV	0.3815-01 -999.	0.430 -999.1.65	. 666 - 6.61 - 666 -		130999.	0.310E-02 ~999. -000		-666-		131. 999.	-999. 21.0 -999.		- 62	19/. P PPP - 000	
CASE2R DERIVED CONSTANT CONSTANT	SOURCE SPECIFIC VARIABLES	DISTRIBUTION	CONSTANT CONSTANT CONSTANT DERIVED CONSTANT	CONSTANT CONSTANT DERIVED	DERIVED DERIVED	AQUIFER SPECIFIC VARIABLES	DISTRIBUTION	CONSTANT	CONSTANT	CONSTANT	DERIVED	CONSTANT	CONSTANT	DERIVED	FUNCTION OF X	FUNCTION OF X	FUNCTION OF X	CONSTANT	CONSTANT	CONSTANT	CONSTANT	CONSTANT
1/yr	SOURCE	UNITS	m/yr m^2 yr m m/yr	1/yr mg/l m	E	AQUIFER	ONITS	5	1	8/ LL	E	m/yr	47/4	1 1	E	E	æ	U		1		E E
Overall 1st order decay sat. zone Not currently used Not currently used		VARIABLE NAME	Infiltration rate Area of waste disposal unit Duration of pulse Spread of contaminant source Rechange rate	Source decay constant Initial concentration at landfill Length scale of facility	Width scale of facility Near field dilution		VARIABLE NAME	Particle diameter	Aquifer porosity	Buik density Aquifer thickness	Source thickness (mixing zone depth)	Conductivity (hydraulic)	Gradient (hydraulic)	Groundwarer seepage verocity Retardation coefficient	Longitudinal dispersivity	Transverse dispersivity	Vertical dispersivity	Temperature of aquifer	Hd.	Organic carbon content (+raction)	Neil distance Trom Site	well vertical distance

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# APPENDIX F.3 MULTIMED OUTPUT FOR ALTERNATIVE LINER INTERIM CASE 3LOCATION 3

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M ODEL MULTREDIA

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E XP OSURE

MULTI MED (Version 1.01, June 1991)

1 Run options

Case 3

C H EMICA ISPECT FIC VARABLES

Saturated zone model

Location 3 C h emical simulated is DEFAULT

DETE RMIN

Infiltration input by user Run was steady-state

Option Chosen

Run was

CHEMICA L

VARIABLE NAME	NIS	DETR IBUTION	PARAMETER MEN STD DEV	SIWIT NIW	МАХ
S&id phase decay coefficient	1/yr	CONSTANT	0.000E+00 -999.	0.000E+000.100E+11	0E+11
Dissolved phase decay coefficient	1/yr	CONSTA NT	0.000E+00-999.	0.000E+00 0.100E+11	0E+11
Overall chemical decay coefficient	1/yr	C O NSTA NT	0.000E+00 -999.	0.000E+00 0.100E+11	3E+11
Acid catalyzed hydrolysis rate	1/M-yr	CO NSTA NT	0.000E+00 -999.	0.000E+00-999.	
Netral hydrolysis rate constant	1/yr	C O NSTA NT	0.000E+00 -999.	0.000E+00-999.	
Base catalyzed hydrolysis rate	1/M-yr	C O NSTA NT	0.000E+00-999.	0.000E+00-999.	
Reference temperature	U	C O NSTA NT	20.0 -999.	0.000E+00100.	
Nomalized distribution coefficient	m1/g	C O NSTA NT	0.000E+00-999.	0.000E+00-999.	
Distribution coefficient	1	DERIVED	.999.	0.000E+00 0.100E+11	0E+11
Biodegradation coefficient (sat. zone)	1/yr	C O NSTA NT	0.00 <b>B</b> +00 -999.	0.000E+00-999.	
Air diffusion coefficient	cm2/s	C O NSTA NT	0.000E+00 -999.	0.000E+00 10.0	9.
Reference temperature for air diffusion	u	C ONSTANT	0.000E+00 .999.	0.000E+00 10	
Molecular weight	M/M	C O NSTA NT	0.000E+00 -999.	0.000E+00 -999.	0
Mole fraction of solute	; ;	C O NSTA NT	0.000E+00 -999.	0.100E-08 1.0	1.00
Vapor pressure of solute	mm Hg	CO NSTA NT	0.000E+00 -999.	0.000E+00 10	.0
Henry's law constant	atm~m^3/M	C O NSTA NT	0.000E00 -999.	0.100E-09 1.0	1.00

Part II, Attachment 5, Appendix F.3, p.g.-1

Reject runs if Z coordinate outside plume Gaussian source used in saturated zone model Rejectruns if Y coordinate outside plume

	Source decay constant Initial concentration at landfill Length scale of facility Width scale of facility Near field dilution  VARIABLE NAME  Particle diameter Aquifer porosity Bulk density Aquifer thickness Source thickness (mixing zone depth) Conductivity (hydraulic) Gradient (hydraulic) Gradient (hydraulic)	CM C	DISTRIBUTION  CONSTANT  CONSTANT  CONSTANT  CONSTANT  CONSTANT  CONSTANT  CONSTANT  CONSTANT  CONSTANT  CONSTANT	.E-01 -999 10.0	
1Ly	Groundwater seepage velocity Retardation coefficient	:. :: ::	DERIVED PINCTION OF X		1.00 0.100E+09 1.00 0.100E+09
t DERIVED -999, -999, 1.000.100E; t	Conductivity (hydraulic) Gradient (hydraulic) Groundwater seepage velocity	m/yr m/yr	CONSTANT CONSTANT DERIVED	130999. 0.310E~02 -999. -999999.	0.100E-06 0.100E+09 0.100E-07 -999. 0.100E-09 0.100E+09
ity m FUNCTION OF X -9999999999999999999999999999999999999999999999999999999999999999999999999999999999999999999999999999999999999999999999999999999999999999999999999999999999999999999999999996E+009999999999996E+009999999996E+009999999996E+0099999999999999999999999999999999999999999999999999999999999999	Conductivity (hydrallic) Gradiant (hydrallic) Groundwater seepage velocity Betandation coefficient	ny/m ry/m	CONSTANT CONSTANT DERIVED	- 05 -	0.100E-05 0.100E+0 0.100E-07 -999. 0.100E-09 0.100E+0
FUNCTION OF X   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999   -999	ordation (190 majors) Groundwater seepage velocity Retardation coefficient Constitutinal dispersivity	m/yr	DERIVED DERIVED FUNCTION OF X		0.100E-09 0.100E+0 1.00 0.100E+09 -999.
y	Groundwater seepage velocity Retardation coefficient Longitudinal dispersivity	, , , , , ,	DERIVED DERIVED FUNCTION OF X		0.100E-09 0.100E+0 1.00 0.100E+09 -999999.
(fraction) C CONSTANT 21.0 -999. 0.000E+00 0 CONSTANT 7.20 -999. 300 300 300E+00 0 CONSTANT 0.300E-02 0.100E-051 0.00E+00 0 CONSTANT 299. 0.000E+00 0 CONSTANT 0.000E+00 0.000E+00 0 CONSTANT 0.000E+00 0.000E	Longitudinal dispersivity Transverse dispersivity Vertical dispersivity	e e e	FUNCTION OF X FUNCTION OF X		
(fraction) CONSTANT 0.300E-02 0.100E-05.1 CONSTANT -99900 0.000E+00 0 m CONSTANT 293999000E+00 0 m CONSTANT 0.000E+00 -999000E+00	Vertical dispersivity Temperature of aquifer pH	ευ¦	FUNCTION OF X CONSTANT CONSTANT		, 3E+00 0
	pn Organic carbon content (fraction) Well distance from site Angle off center Well vertical distance	deggne e gne e e	CONSTANT CONSTANT CONSTANT CONSTANT	9E-02	

Page 2

# APPENDIX F.5 MULTIMED OUTPUT FOR ALTERNATIVE LINER CLOSED CASE 5LOCATION 1

										LIMITS MIN MAX	0.000E+00 0.100E+11 0.000E+00 0.100E+11 0.000E+00 -100E+11 0.000E+00 -999. 0.000E+00 -999. 0.000E+00 -999. 0.000E+00 -999. 0.000E+00 -999. 0.000E+00 -999. 0.000E+00 -999. 0.000E+00 100. 0.000E+00 100. 0.000E+00 100.
	AGENCY									PARAMETERS MEAN STD DEV	0.000E+00-999. 0.000E+00-999. 0.000E+00-999. 0.000E+00-999. 0.000E+00-999. 0.000E+00-999. 0.000E+00-999. 0.000E+00-999. 0.000E+00-999. 0.000E+00-999. 0.000E+00-999. 0.000E+00-999. 0.000E+00-999. 0.000E+00-999.
CASESR	PROTECTION	SSESSMENT	MODEL	MULTIMED (Version 1.01, June 1991)					CHEMICAL SPECIFIC VARIABLES	DISTRIBUTION	CONSTANT
	AL	Б	MULTIMEDIA	(Version 1.6				ne model	CHEMICAL	UNITS	1/yr 1/yr 1/yr 1/m-yr 1/m-yr C m1/g  1/yr cm2/s C c
	ENVIRONMENTAL	EXPOSUR	MULT	MULTIMED			EMICAL	Saturated zone model DETERMIN ide plume ide plume d zone model		NAME	icient cefficient oefficient is rate coefficient t t ent (sat. zone) nt or air diffusion
	0.5.				ns -		Location 1 Chemical simulated is DEFAULT CHEMICAL	Option Chosen Run was Infiltration input by user Run was steady-state Reject runs if Y coordinate outside plume Reject runs if Z coordinate outside plume Gaussian source used in saturated zone model		VARIABLE NAME	Solid phase decay coefficient Dissolved phase decay coefficient Overall chemical decay coefficient Acid catalyzed hydrolysis rate Neutral hydrolysis rate constant Base catalyzed hydrolysis rate Normalized distribution coefficient Distribution coefficient Biodegradation coefficient Reference temperature for air diffusion Molecular weight Mole fraction of solute Vapor pressure of solute Henry's law constant
	K			,	Run options	Case 5	Location 1 Chemical s	Option Chosen Run was Infiltration Run was stead Reject runs if Reject runs if	Г <del>г</del>		

		CONSTANT	-666-	-999.	0.000E+00	1.00
	SOURCI	SOURCE SPECIFIC VARIABLES	10			
VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN STD	ETERS STD DEV	LIMITS	TS MAX
	m/yr	CONSTANT		511E -999.	0.100E-09	0.100E+11
Area of waste disposal unit	ш^2	CONSTANT	-07		0.100E-01	-066-
Duration of pulse	r	CONSTANT	86		0.100E-08	-666-
Spread of contaminant source	E	DERIVED		666-	0.100E-08	0.100E+110
Recharge rate	m/yr	CONSTANT	3. 999.	.999999.	0.000E+00	.100E+11
Source decay constant	1/yr	CONSTANT	0.368E-01 0999.	. 666 0	0.000E+00	.999.
Initial concentration at landfill	mg/1	CONSTANT	.000E+00	-989.	0.000E+00	-666-
	Ë	DERIVED	1.00	- 666	0.100E-08	0.100E+11.0
congent socate of facturated	: E	DERTYED	000	500	0 100E-08	1 DOF +1 1
אייביים	<b>=</b>	DEBIVED		יטטייים אים אים	A ABBETBB	1 99
			ĕ			
	AQUIFE	AQUIFER SPECIFIC VARIABLES		1		1 1 1 1 1 1 1 1 1
VAKTABLE NAME	SITNO	DISTRIBUTION	PAKAMELEKS	in in S	SITWIT	
			MEAN	STD DEV	MEN	MAX
Partícle diameter	E)	CONSTANT	0.381E-01	-999.	0.100E-08	100.
Aguifer porosity	1	CONSTANT	0.430	-666-	0.100E-08	0.990
Bulk density	g/cc	CONSTANT	1.65	-666-	0.100E-01	5.00
Annifer thickness	jε	CONSTANT	10.0	-666-	0.100E-08	0.100E+06
ince thickness (mixing zone denth)	Ε	DERIVED	- 666	-999.	0.100E-08	0.100E+06
Conductivity (bydnaulic)	m//r	FNATANOO	130	666-	0.100F-06	0 100F+09
Gradiant (bydrailic)		TNATANO	9.310F-02		0 100F-07	-666
windinton connections	477	DEPTYED	000		0 100E-00	0 1005.00
di oundwa rei seepage verooriy	11/3/1	DENTAGO	.000	. 666-	0.1001-03	0.1000.0
Ketardation coetticient	į		- 777-	-888-	1.88	0. T00E+09
Longitudinal dispersivity	Ε	FUNCTION OF X	-666-	-666-	-666~	-999.
Transverse dispersivity	E	FUNCTION OF X	-666-	-666-	-999.	-989.
Vertical dispersivity	E		-999999. 21.0	1. 21.0	-989	-999.
Temperature of aquifer	U		-999.7.20	0	E+00	0 100.
1	1	CONSTANT	~999. 0.300F-02	300F-02	.300	14.0
Pri	ľ	TNOTONO	0 08 000	100	0 100F-05 1	
	F	TNATANO	ססס מיים	901.00	99	
WELL WISCONICE   ON SICE	= 1	CONSTANT	000 0 0001100	905-100	000	
The Off Center	ממבמם	CONSTANT	2, 2, 555.	221122	2211222	
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# APPENDIX F.6 MULTIMED OUTPUT FOR ALTERNATIVE LINER CLOSED CASE 6LOCATION 2

CASEGR U.S. ENVIRONMENTAL PROTECTION AGENCY	EXPOSURE ASSESSMENT	MULTIMEDIA MODEL	MULTIMED (Version 1.01, June 1991)			ed is DEFAULT CHEMICAL	Saturated zone model  DETERMIN  tate coordinate outside plume coordinate outside plume sed in saturated zone model	CHEMICAL SPECIFIC VARIABLES	VARIABLE NAME UNITS DISTRIBUTION PARAMETERS  MEAN STD DEV MIN MAX	Solid phase decay coefficient         1/yr         CONSTANT         0.000E+00         -999.         0.000E+00         1.00E+11           Dissolved phase decay coefficient         1/yr         CONSTANT         0.000E+00         -999.         0.000E+00         100E+11           Overall chemical decay coefficient         1/yr         CONSTANT         0.000E+00         -999.         0.000E+00         100E+11           Acid catalyzed hydrolysis rate         1//r         CONSTANT         0.000E+00         -999.         0.000E+00         -999.           Neutral hydrolysis rate constant         1//r         CONSTANT         0.000E+00         -999.         0.000E+00         -999.           Reference temperature         C         CONSTANT         0.000E+00         -999.         0.000E+00         -999.           Normalized distribution coefficient         ml/g         CONSTANT         0.000E+00         -999.         0.000E+00         -999.           Distribution coefficient
t.			,	I Run options	Case 6	Location 2 Chemical simulated is DEFAULT CHEMI	Option Chosen Run was Infiltration input by user Run was steady-state Reject runs if Y coordinate outside plume Reject runs if Z coordinate outside plume Gaussian source used in saturated zone model	<del>1</del> ਜ਼-1	VARIABLE NA	Solid phase decay coefficient Dissolved phase decay coeffict Overall chemical decay coeffictory coeffic actalyzed hydrolysis rate Neutral hydrolysis rate consta Base catalyzed hydrolysis rate Reference temperature Normalized distribution coefficient Distribution coefficient Biodegradation coefficient Reference temperature for air Molecular weight Mole fraction of solute Vapor pressure of solute Henry's law constant

Overall 1st order decay sat. zone Not currently used Not currently used	1/yr	CASEGR DERIVED CONSTANT CONSTANT	0.000E+00 0.000E+00 -999999.	0.000E+00 1.00 0.000E+00 1.00 0.000E+00 1.00
	SOURCI	SOURCE SPECIFIC VARIABLES		
VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN STD DEV	LIMITS MIN MAX
Infiltration rate Area of waste disposal unit	m/yr m^2	CONSTANT	0.511E-07 -999. 0.486E+06 -999.	0.100E-09 0.100E+11 0.100E-01 ~999.
Duration of pulse	yr	CONSTANT	-999999.	0.100E-08-999.
Spread of contaminant source Recharge rate	E E	DERIVED	-999, -999. 0 3686,01 -999	0.100E-08 0.100E+11 0 000E-08 0.100E+11
Source decay constant	1/yr	CONSTANT	0.000E+00-999.	0.000E+00 -999.
Initial concentration at landfill	mg/l	CONSTANT	.666	0.000E+00 -999.
Length scale of facility	Ei	DERIVED		0.100E-08 0.100E+11
Width Scale of Facility Near field dilution	E	DERIVED	1.00 0.000E+00	0.000E+001.00
	AQUIFE	AQUIFER SPECIFIC VARIABLES		
VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN STD DEV	LIMITS
Particle diameter	튭	CONSTANT	1.381E-01-999.	
Aquifer porosity	E	CONSTANT	0.430 -999.1.65	0
Bulk density	8/cc	CONSTANT	-999.10.0 -999.	0.100E-01 5.00
Aquiter chickness Source thickness (mixing zone depth)	Ξ ε	DERTVED	• 666-	0.100E-08 0.100E+05
Conductivity (hydraulic)	u/∧L	CONSTANT	0.310E-02 -999.	0.100E-06 0.100E+09
Gradient (hydraulic)		CONSTANT	.999.	0.100E-07 -999.
Groundwater seepage velocity	m/yr	DERIVED		0.100E-09 0.100E+09
Retardation coefficient	<b>:</b>	DERIVED		0.100
Longitudinal dispersivity	E I	FUNCTION OF X	.999999.	.999.
Transverse alspersion Ventional dispensionity	≣ 8	FUNCTION OF X	00 00 00 10 00 00 00 00 00 00 00 00 00 0	
Vertackats days and the Temperature of addition	≣ C	CONSTANT	-999 B 300F-02	F+00
T.C. T.C. T.C. T.C. T.C. T.C. T.C. T.C.	,	CONSTANT	-999	
Organic carbon content (fraction)		CONSTANT	197999.	E-05 1
Well distance from site	E	CONSTANT	0.000E+00 -999.	
Angle off center	degnee	CONSTANT	0.000E+00 -999.	9 0
Well vertical distance	٤	CONSTANT		.000E+00 1.00
INTRATION AFTER SATURATED ZONE MODEL 0.4171E-05	71E-05			
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# APPENDIX F.7 MULTIMED OUTPUT FOR ALTERNATIVE LINER CLOSED CASE 7LOCATION 3

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CASE7R

ASSESSMENT MODEL MULTIMEDIA EXPOSURE

MULTIMED (Version 1.01, June 1991)

1 Run options

CHEMICAL SPECIFIC VARIABLES

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X	

Saturated zone model DETERMIN

Location 3 Chemical simulated is DEFAULT CHEMICAL

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS	SS	LIMITS	TS
			MEAN	STD DEV	MIN	MAX
Solid phase decay coefficient	1/yr	CONSTANT	0.000E+00 -999.	999.	0.000E+00	).000E+00 0.100E+11
Dissolved phase decay coefficient	1/yr	CONSTANT	0.000E+00 -999.	.666	0.000E+00	0.100E+11
Overall chemical decay coefficient	1/yr	CONSTANT	0.000E+00 -999.	.66	0.000E+00	
Acid catalyzed hydrolysis rate	1/M-yr	CONSTANT	0.000E+00 -999.	.666	0.100E+11 0.000E+00	9.000E+00
Neutral hydrolysis rate constant	1/yr	CONSTANT	0.000E+00 -999.	.66	-666-	
Base catalyzed hydrolysis rate	1/M-yr	CONSTANT	0.000E+00 -999.	. 66	0.000E+00	-666-
Reference temperature	U	CONSTANT	20.0 -999.	99.	0.000E+00	-999.
Normalized distribution coefficient	m1/g	CONSTANT	0.000E+00 -5	.666	0.000E+00	100.
Distribution coefficient	t 1	DERIVED	- 666-	.666	0.000E+00	-666-
Biodegradation coefficient (sat. zone)	1/yr	CONSTANT	0.000E+00 -999.	.666	0.000E+00	0.100E+11
Air diffusion coefficient	cm2/s	CONSTANT	0.000E+00 -999.	999.	0.000E+00	06 <b>06</b> -
Reference temperature for air diffusion	U	CONSTANT	0.000E+00 -999.	. 666	0.000E+00	100.
Molecular weight	B/M	CONSTANT	0.000E+00	-666-	0.000E+00	-666-
Mole fraction of solute	1	CONSTANT	0.000E+00	-999.	0.100E-08	1.00
Vapor pressure of solute	mm Hg	CONSTANT	0.000E+00	-666-	0.000E+00	100.
	atm-m^3/M	CONSTANT	0.000E+00 -999.	. 66	0.100E-09	1.00

Part II, Attachment 5, Appendix F.7, p.g.-1

Reject runs if Y coordinate outside plume Reject runs if Z coordinate outside plume Gaussian source used in saturated zone model

Matiltration input by user Run was steady-state

Chosen Run

Hanson Professional Services Inc. Submittal Date: September 2018 Revision: 3 - April 2019Revision: 0

35	
0.2078E-0	
MODEL	
ZONE	
SATURATED	
AFTER	
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0.000E+00 -999. -999.	S	PARAMETERS MEAN STD	0.511E-07 0.486E+06	.666	0.368E-01	€++96	1.00	.000-	1.00	v		MEAN	0.381E-01	0.430	1.65	10.0	.999.	130.	0.310E-02	. 66	. 666	.666	-666~	21.0	7.20	0.300E-02	293.	0.000E+00-999.	0.000E+00 -999
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1/yr	SOURCE	UNITS	m/yr m^2	ا کر	m/yr	1/yr	mg/1	€ E	ŧ	AQUIFER	UNITS		5	E	g/cc	E	E	m/yr	17.7		E	E	E	U	t t		ш	degree	E
Overall 1st order decay sat. zone Not currently used Not currently used		VARIABLE NAME	Infiltration rate Area of waste disposal unit	Duration of pulse	Spread of contaminant source Recharge rate		Initial concentration at landfill	Width scale of facility	Near field dilution		VARIABLE NAME		Particle diameter	Aquifer porosity	Bulk density		Source thickness (mixing zone depth)	Conductivity (hydraulic)	Gradient (hydraulic)	droundwarer seepage verocity Retardation coefficient	Longitudinal dispersivity	Transverse dispersivity	Vertical dispersivity	Temperature of aquifer	Ha	Organic carbon content (fraction)	Well distance from site	Angle off center	Well vertical distance

## THE CITY OF KINGSVILLE LANDFILL TCEQ PERMIT MSW 235C

## PERMIT AMENDMENT APPLICATION Volume 5 of 6



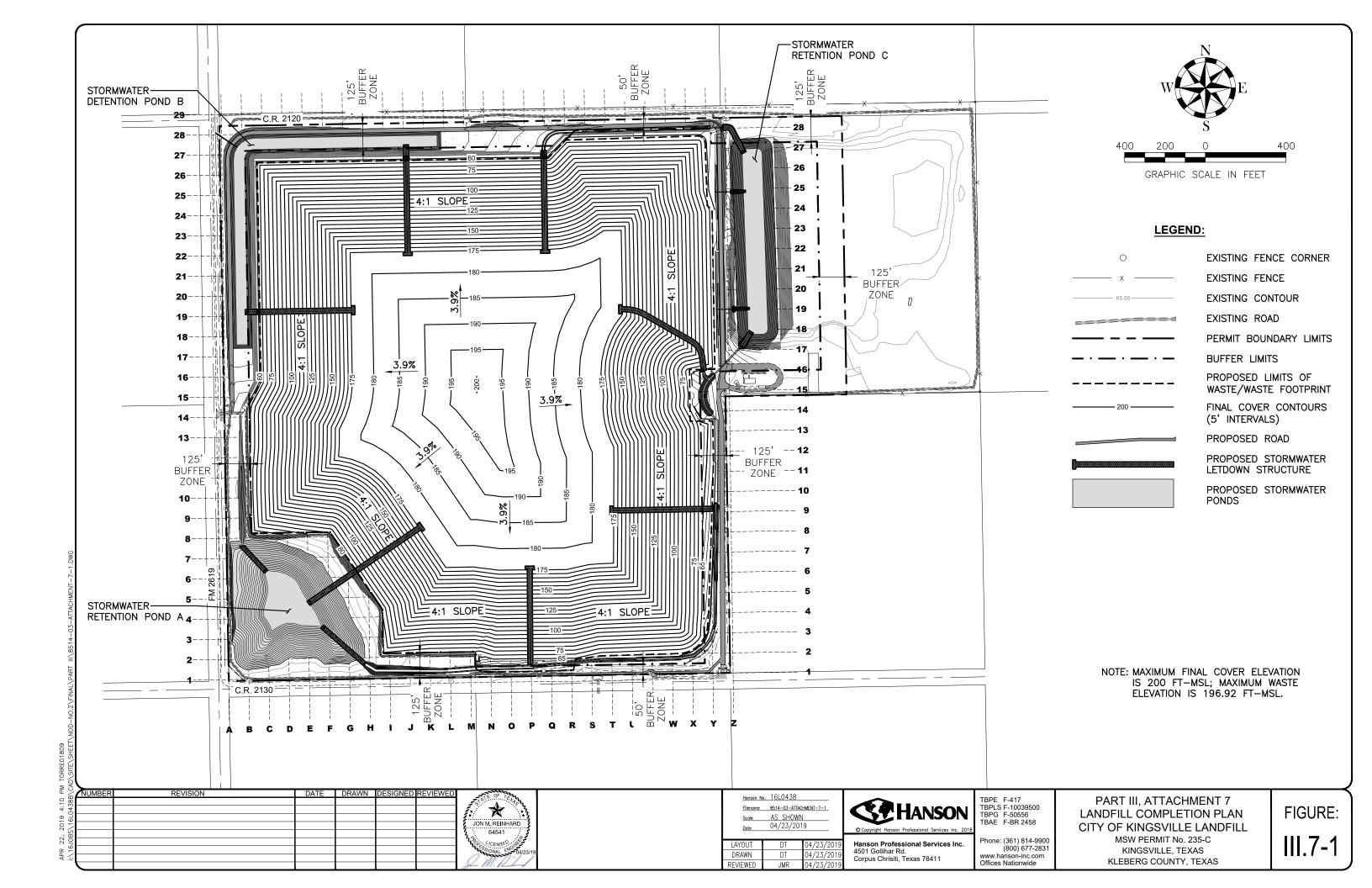
#### CITY OF KINGSVILLE, KLEBERG COUNTY, TEXAS

September 2018
Revision 1 – November 2018
Revision 2 – February 2019
Revision 3 – April 2019

HANSON
Engineering | Planning | Allied Services
TBPE F-417

HANSON PROJECT NO. 16L0438-0003

# PART III ATTACHMENT 7 LANDFILL COMPLETION PLAN



# PART III ATTACHMENT 10 LINER QUALITY CONTROL PLAN

## THE CITY OF KINGSVILLE LANDFILL TCEQ PERMIT MSW 235C

## PERMIT AMENDMENT APPLICATION Part III

#### Attachment 10 Liner Quality Control Plan



#### CITY OF KINGSVILLE, KLEBERG COUNTY, TEXAS

September 2018
Revision 1 – November 2018
Revision 2 - February 2019
Revision 3 - April 2019

Prepared by



HANSON PROJECT NO. 16L0438-0003

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#### 1. GENERAL

#### 1.1. Scope and Purpose

This Liner Quality Control Plan (LQCP) is applicable to the construction of all landfill liner systems at the City of Kingsville Landfill, a Municipal Solid Waste (MSW) disposal facility in Kleberg County, Texas. This LQCP shall govern the material characteristics, installation and testing for the various construction components for the landfill liners at the facility. Qualifications for quality control personnel are also identified in this LQCP. The provisions of this LCQP were developed based on the latest technical guidelines of the TCEQ, including quality control of construction, testing frequencies and procedures, and quality assurance of sampling and testing procedures.

#### 1.2. Lining and Cover Systems Used for the Landfill

The lining and cover systems that will be used at this facility will be alternative liner designs. Alternative liner design demonstrations can be found in Part III, Attachment 5. The following lining and/or cover systems will be used at the facility:

#### 1.2.1. Landfill Lining System

The landfill lining system to be used in Sectors 4C, 5, 6 and 7 will consist of (from bottom to top):

- A prepared subgrade;
- A geosynthetic clay liner (GCL);
- A geomembrane liner consisting of sixty mil (0.06 inch) thick HDPE;
- A leachate collection layer consisting of a drainage geocomposite (a synthetic drainage net with geotextile fabric on one or both sides), gravel, collection piping, and geotextile separation fabric;
- A two (2) foot protective cover soil layer.

#### 1.2.2. Landfill Cover System

The landfill cover system will consist of (from bottom to top):

- A six (6) inch thick (minimum) prepared soil subgrade layer;
- A geosynthetic clay liner (GCL) layer;
- A forty mil (0.04 inch) thick LLDPE geomembrane layer;
- A geocomposite drainage layer consisting of a synthetic drainage net and geotextile fabric;
- A twenty five (25) inch thick protective cover soil layer, the top seven (7) inches of which must be capable of supporting vegetation.

#### 1.2.3. Piggyback Liner System

This liner system will be used in areas of the landfill where disposal development will occur over existing unlined MSW fill locations and will include components that will provide additional geotechnical stability. The piggyback lining system will consist of (from bottom to top):

D 5261	Standard Test Method for Measuring Mass per Unit Area of Geotextiles
D 5321	Standard Test Method for Determining the Shear Strength of Soil-
	Geosynthetic and Geosynthetic-Geosynthetic Interfaces by Direct Shear
D 5596	Standard Test Method for Microscopic Evaluation of the Dispersion of
	Carbon Black in Polyolefin Geosynthetics
D 5887	Standard Test Method for Measurement of Index Flux Through Saturated
	Geosynthetic Clay Liner Specimens Using a Flexible Wall Permeameter
D 5890	Standard Test Method for Swell Index of Clay Mineral Component of
	Geosynthetic Clay Liners
D 5891	Standard Test Method for Fluid Loss of Clay Component of Geosynthetic
	Clay Liners
D 5993	Standard Test Method for Measuring Mass Per Unit of Geosynthetic Clay
	Liners
D 5994	Standard Test Method for Measuring Core Thickness of Textured
	Geomembranes
D 6392	Standard Test Method for Determining the Integrity of Nonreinforced
	Geomembrane Seams Produced Using Thermo-Fusion Methods
D 6241	Standard Test Method for Static Puncture Strength of Geotextiles and
	Geotextile-Related Products Using a 50-mm Probe
D 6243	Standard Test Method for Determining the Internal and Interface Shear
	Strength of Geosynthetic Clay Liner by the Direct Shear Method
D 6496	Standard Test Method for Determining Average Bonding Peel Strength
	Between Top and Bottom Layers of Needle-Punched Geosynthetic Clay
	Liners
D 6768	Standard Test Method for Tensile Strength of Geosynthetic Clay Liners
D 7176	Standard Specification for Non-Reinforced Polyvinyl Chloride (PVC)
	Geomembranes Used in Buried Applications
D 7179	Standard Test Method for Determining Geonet Breaking Force
F 480	Standard Specification for Thermoplastic Well Casing Pipe and Couplings
	Made in Standard Dimension Ratios (SDR), SCH 40 and SCH 80
F 714	Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on
	Outside Diameter

#### 1.7.2. Geosynthetics Research Institute

- GM13 Standard Specification for Test Methods, Test Properties and Testing Frequency for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes
- GM17 Test Methods, Test Properties and Testing Frequency for Linear Low Density
  Polyethylene (LLDPE) Smooth and Textured Geomembranes
- GM19 Seam Strength and Related Properties of Thermally Bonded Polyolefin
  Geomembranes

#### 1.8. Material Conformance Tests for Soils and Gravel

Soil materials used for construction at the facility shall be subjected to the following conformance tests to demonstrate compliance with the LQCP. Unless otherwise specified, one

set of tests shall be performed for each material type. If there is a visually distinguishable change in the soil characteristics or a change in the soils Liquid Limit (LL) or Plasticity Index (PI) by more than 10 points, the soil shall be considered a separate borrow source and shall require an additional set of tests. In any condition, a minimum of one (1) complete set of tests must be performed for each type of soil material used. Conformance testing will be conducted by the party identified in sections 2.4. The results of these tests shall be used for field quality control. The Contractor shall ensure that the required samples are collected and tested in a timely manner to be available for field quality control. Not all tests will be required for all soils; only those tests for which the individual components specify a required material property.

#### 1.8.1. Soil Classification

All soil materials used shall be classified in accordance with the Unified Soil Classification System (USCS - ASTM D 2487).

#### 1.8.2. Gradation

All soil materials used shall be tested to determine the particle size gradation, including the percentage passing the #200 sieve. Gradation shall be determined in accordance with ASTM D 1140. Gravel materials used shall be tested to determine the gradation in accordance with ASTM C 136 or ASTM D 422.

#### 1.8.3. Atterberg Limits

All soil materials used shall be tested to determine the Atterberg Limits (Liquid Limit and Plastic Limit) and the Plasticity Index (ASTM D 4318).

#### 1.8.4. Soil Moisture-Density

The soil moisture/density relationship shall be determined using the Standard Proctor method (ASTM D 698).

#### 1.8.5. Coefficient of Permeability/Hydraulic Conductivity

Where the LQCP indicates to determine the coefficient of permeability or the hydraulic conductivity (in centimeters per second [cm/sec]), use one of the following test procedures:

Constant Head Permeability

Permeability of Granular Soils (Constant Head) – ASTM D 2434

Hydraulic Conductivity

Flexible Wall Permeameter (back pressure saturation) ASTM D 5084.

#### 1.8.6. Calcium Carbonate Content

All gravel materials used shall be tested to determine the calcium carbonate content in accordance with ASTM D 3042.

#### 1.9.5. Thickness

Smooth HDPE geomembrane sheet and HDPE drainage net shall be tested for thickness in accordance with ASTM D 5199. Textured HDPE geomembrane sheet shall be tested for thickness in accordance with ASTM D 5994.

#### 1.9.6. Tear Resistance

The geomembrane sheet shall be tested for tear resistance in accordance with ASTM D 1004.

#### 1.9.7. Puncture Resistance

The geomembrane and geotextile materials shall be tested for puncture resistance in accordance with ASTM D 4833 and ASTM D 6241, respectively.

#### 1.9.8. Apparent Opening Size

Geotextile shall be tested for apparent opening size (AOS) in accordance with ASTM D 4751.

#### 2. SUBGRADE PREPARATION AND CONTROLLED FILL

The following requirements govern the subgrade preparation for liners and covers used at the facility:

#### 2.1. Subgrade Description

Subgrade materials shall not exhibit excessive cohesion and shall be free of large particles, rocks or other foreign material. The finished subgrade should be smooth, with no large or protruding items that may damage liner materials placed on the subgrade. Soil materials used as fill to finish the subgrade shall be obtained either from on-site or off-site sources.

#### 2.2. Required Material Properties

Soil materials used for fill to construct subgrade shall be free of sod, trash, roots, and organic matter. The materials shall meet the following minimum requirements which are also summarized in Table 10-1:

#### 2.2.1. Soil Materials

#### 2.2.1.1. Classification

Soil materials shall be classified using the USCS. Acceptable classifications are CH CL, ML, SW, SP, SM, or SC.

#### **2.2.1.2.Gradation:**

The soil material shall be composed of particles of which no more than ninety six percent (96%) pass the #200 sieve.

#### 2.2.1.3. Atterberg Limits

The soil material used shall have a Liquid Limit of no greater than seventy five percent (75%) and a Plasticity Index (Liquid Limit minus Plastic Limit) of no greater than forty five percent (45%).

#### 2.2.2. Moisture Density for Subgrade Materials Placed as Fill

Subgrade materials placed as fill shall be compacted to at least ninety five percent (95%) of the maximum dry density, Standard Proctor Basis, as per ASTM D698. The moisture content shall range from optimum moisture to five percent (5%) above the optimum moisture content.

Table 10-1
Required Testing for Subgrade Soil Materials Used as Fill

included in country for constitution and country in the country in												
<u>Property</u>	<u>Frequency</u>	<u>Test Method</u>	<u>Value</u>									
Sieve Analysis	1 test per each 100,000 s.f. per lift, minimum of 1 test/lift	ASTM D 1140	96% maximum									
Atterberg Limits	1 test per each 100,000 s.f. per lift, minimum of 1 test/lift	ASTM D 4618	LL = 75% maximum PI = 45% maximum									
Field Density and Moisture Content	1 test per each 10,000 s.f. per lift	ASTM D 698	95% maximum dry density; optimum to optimum plus 5% above moisture content									

#### 2.3.Installation Procedures

The subgrade installation procedures shall be conducted by the Earthwork Contractor and observed by QAO. The installation procedures shall conform to the following requirements:

#### 2.3.1. Excavation

Overlying materials shall be excavated and removed to achieve the required subgrade lines and grades as indicated in the project plans and specifications. The Earthwork Contractor shall exercise care and provide sufficient grade control during the excavation process to minimize or eliminate the placement of fill to meet the required subgrade lines and grades. Soil overburden shall be excavated using standard mobile construction equipment. Where the bedrock is encountered within the planned excavation and cannot be removed using this equipment, it will be removed either through rock saw or blasting. For areas requiring rock removal, the rock will be removed at least 1 foot beyond the lines and grades shown

to accommodate the construction of a soil subgrade layer. In the event voids in bedrock are discovered intersecting the limits of the planned excavation, these voids will be hydro or vacuum excavated to remove any loose material and will be filled with cement grout or concrete to align with the limits of the planned excavation. Once allowed to properly cure and set, these filled voids will be covered with subgrade material.

#### 2.3.2. Subgrade Preparation

The subgrade shall be excavated and/or graded to the appropriate lines and grades as shown in the project contract documents. Where subgrade materials are placed as fill, the in-situ material shall be properly scarified and prepared to receive the subgrade material. Any soft areas shall be excavated and replaced with compacted materials to provide a solid working base. In areas where bedrock has been removed to accommodate a subgrade layer, the subgrade may be constructed from on-site soils, off-site soils, millings from the rock saw process or a combination of these sources, with the subgrade material meeting the requirements of this section.

#### 2.3.3. Placement

The subgrade soil materials shall be broken down such that all material is uniformly hydrated. The finished material shall not contain clods that exceed one (1) inch in diameter or that total more than ten percent (10%) by weight. Any gravel size particles shall not be of sufficient number or size to be a detriment to the integrity of the overlying component. When placed as fill, the subgrade material shall be placed in loose lifts as required to obtain compacted lift thickness of six (6) to eight (8) inches, or the pad or prong length of the compactor feet, whichever is less.

#### 2.3.4. Hydration

Prior to compaction, the soil material shall be hydrated so that proper moisture can be maintained during the compaction process. Once water has been added, the soil material shall be worked to provide proper mixing. Soil hydration is allowed either on a stockpile or in-place. The soil material shall be hydrated to a moisture content wet of optimum.

#### 2.3.5. Compaction

The soil material shall be compacted using a pad or tamping foot roller or a prong foot ("sheepsfoot") roller. Bulldozers and/or pneumatic tired compactors will not be used. The lift thickness shall be controlled, as outlined above, such that the compactor feet penetrate through the entire lift under compaction into the top of the previously compacted lift. Therefore, the compacted lift thickness must not be greater than the pad or prong length of the compactor feet. Adequate cleaning devices shall be used to prevent clogging of the compactor from excess soil material. Sections of re-compacted subgrade that do not pass both the density and moisture requirements shall be re-worked and re-tested until the section in question does pass, and to the extent that the re-worked area(s) tie-in to an area which passed the testing. The re-worked area shall be re-worked and re-tested until passing tests are achieved.

#### 2.3.6. Finishing

The subgrade shall be prepared and finished in a manner consistent with proper subgrade preparation techniques for the installation of geosynthetics materials and as recommended by the GCL manufacturer. The subgrade shall be properly compacted to a minimum of 95% Standard Proctor Density per ASTM D698, so as not to settle and cause excessive strains in the GCL or other synthetic liner materials. Prior to installation, ensure a surface free of debris, roots, or angular stones larger than 0.5-inch. The subgrade must be rolled with a smooth-wheeled roller. During installation, ensure rutting or raveling is not caused by installation equipment.

#### 2.3.7. Proof rolling

The top surface of the completed subgrade must be proof rolled with a smooth-wheel roller prior to final grade/thickness surveying and placement of overlying layers. Additional proof-rolling may be employed if it is necessary to minimize desiccation and cracking of the subgrade.

#### 2.3.8. Protection of Subgrade Surface

Prior to and during the installation of overlying components, the Earthwork Contractor shall preserve and protect the exposed surface of the subgrade from desiccation and cracking, rutting, erosion, and ponding using regular watering and proof rolling.

#### 2.4. Quality Assurance Quality Control Requirements

The Earthwork Contractor shall conduct material conformance tests and the QAO shall monitor the placement and finishing of the subgrade, and coordinate the necessary surveys with the project surveyor. Prior to placement of any overlying layers, the QAO shall coordinate with the GMI to execute a subgrade acceptance form for all areas of completed subgrade. In addition, the Earthwork Contractor shall employ testing personnel to conduct the following QC verification activities:

#### 2.4.1. Field Density

A minimum of one (1) field density test per 10,000 square feet (ft²), or less, for each lift. A minimum of three (3) field density tests are required for each lift.

#### 2.4.2. Sieve Analysis (Percent Passing #200)

A minimum of one (1) test for each 100,000 ft² or less, for each lift, shall be performed in accordance with ASTM D 1140. A minimum of one (1) test shall be performed for each lift regardless of the area.

#### 2.4.3. Atterberg Limits

A minimum of one (1) test for each 100,000 ft² per lift shall be performed in accordance with ASTM D 4318. A minimum of one (1) test shall be performed for each lift regardless of the area.

#### 2.4.4. Survey Verification

A minimum of one (1) survey verification shall be made per 5,000 ft² of surface area. Reference locations will be noted on a drawing of the area.

#### 2.4.5. Repair of Test Holes

All holes in the subgrade created from tests and test samples shall be completely backfilled with soil and shall be tamped into place.

#### 3. GEOGRID

The following requirements govern the geogrid used at the facility:

#### 3.1.Geogrid Description

A geogrid is a reinforcing geosynthetic structure formed by a regular network of tensile members with appropriate apertures to allow interlocking with surrounding soil or aggregate. Geogrid materials shall be High Density Polyethylene (HDPE). Geogrid material will be placed on a prepared subgrade and will underlie the GCL layer. The geogrid shall be stored, handled and installed in accordance with the manufacturer's recommendations.

#### 3.2. Required Material Properties

The geogrid shall have a minimum tensile strength of 2500 pounds per foot at an allowable stress of 5% or less over 50 years. Properties, test methods and minimum values are listed below and summarized in Table 10-2.

Ultimate Tensile Strength (ASTM D6637)	7810 lb/ft
Tensile Strength @ 5% Strain (ASTM D6637)	3560 lb/ft
Junction Strength (ASTM D7737)	7200 lb/ft
Maximum Allowable Strength for 120 yr Design Life (GRI-GG4)	2860 lb/ft

Table 10-2
Required Testing for Uniaxial Geogrid

nequired resting for ornaxial deogra									
<u>Property</u>	<u>Frequency</u>	Test Method	<u>Value</u>						
Ultimate Tensile Strength	MARV based on 95% confidence level	ASTM D 6637	<u>7810 lb/ft</u>						
Tensile Strength @ 5% Strain	MARV based on 95% confidence level	ASTM D 6637	<u>3560 lb/ft</u>						
Junction Strength	MARV based on 95% confidence level	<u>ASTM D 7737</u>	<u>7200 lb/ft</u>						
Maximum Allowable Strength for 120-yr Design Life	MARV based on 95% confidence level	<u>GRI – GG4</u>	<u>2860 lb/ft</u>						

The manufacturer shall certify that the geogrid has been quality control tested during the manufacturing process and that the liner meets all strength requirements for the intended use.

### 3.3.Installation Procedures

The geogrid installation procedures shall be conducted by the GMI and observed by the QAO. The installation procedures shall conform to the following requirements:

# 3.3.1. Surface Preparation

The surface to receive the geogrid shall be prepared in accordance with the requirements specified in Section 2, Subgrade Preparation and Controlled Fill. Prior to placing geogrid materials, the GMI shall execute a subgrade acceptance form. This form shall be submitted to the QAO and signed by the QAE and the Owner. A copy of the form is included in Appendix A.

## 3.3.2. Delivery and Storage

All rolls of geogrid delivered to the site shall be marked with the name of the manufacturer, the product type, the manufacturing batch code, roll number, date of manufacture and roll dimensions. The QAO must inspect the delivered materials for damage and defects. Pushing, sliding, or dragging of rolls or pallets can cause damage and must be avoided. The geogrid rolls shall be dept free of dirt and debris, must be protected from soft or wet ground and rocky or rough ground and must not be stacked more than five (5) rolls high to avoid crushing the cores of the rolls. A sacrificial cover must be used to protect the geogrid if stored on site for more than six (6) months.

# 3.3.3. Geogrid Anchor Trench

A geosynthetic materials anchor trench shall be completed along the perimeter of the area to be lined where indicated on the project contract documents. The anchor trench may be excavated in sections, as necessary. Loose soil shall be removed from the anchor trench and shall not underlie the geosynthetic materials to be placed in the anchor trench. The excavated anchor trench shall have rounded corners in order to help protect the geosynthetic materials. The anchor trench shall conform to the dimensions and requirements shown on the project contract documents.

# 3.3.4. Geogrid Deployment

The geogrid shall be deployed in accordance with the procedures recommended by the manufacturer and as outlined below:

- Only those geogrid panels which can be anchored and connected in one (1) day should be deployed.
- Each geogrid panel shall be inspected for damage and manufacturing defects prior to anchoring or connecting to other panels.
- Geogrid panels shall be placed in a controlled manner, such as pulling, hoisting, or rolling and shall be pulled taut to remove slack. Geogrid shall be deployed from a top to bottom direction on slopes.
- Adjacent geomembrane panels shall not be overlapped but shall be deployed side by side. Panel end connections shall be made using a Bodkin connection.
- Geogrid panels shall be anchored in place after placement so as to remain in the deployed alignment. Anchoring can be accomplished using stakes, sandbags, or small quantities of fill soil. Sandbag anchorage must be removed as the

- subsequent GCL layer is placed. Stakes must be driven flush with the subgrade as the subsequent GCL layer is placed.
- The geogrid panels shall be placed and aligned such that endroll connections on slopes are minimized. Connections should be located as close to the bottom of the slope as possible.
- o No construction equipment traffic shall be allowed on the geogrid.
- Personnel working on the geogrid shall not smoke, wear damaging shoes, throw
  equipment or engage in other activities which could damage the geogrid.

# 4. GEOSYNTHETIC CLAY LINER (GCL)

### 4.1.General

This section includes the requirements for selection, installation, and protection of GCL.

### 4.2.Submittals

### **1.**A. Pre-installation

Submit the following to the QAO for approval prior to GCL deployment.

- 1. Supplier of the GCL manufacturer results for standard tests described in Table C.10-3.
- 2. Written certification the GCL meets the properties listed in Table C.110-3.
- 3. Written certification that GCL manufacturer has continuously inspected each roll of GCL for the presence of needles and other defects and found GCL defect-free.
- 4. Written certification from the GCL manufacturer the bentonite will not shift during transportation or installation thereby causing thin spots in the body of the GCL.
- 5. QC certificates signed by a responsible party of the GCL manufacturer for each roll delivered to the site. Each certificate shall include roll identification numbers and results of all QC tests. At a minimum, results shall be given for tests corresponding to Table C.110-3. The bentonite and textile suppliers shall each certify the respective properties under Manufacturer's Quality Control. The GCL manufacturer shall also perform the bentonite tests described under Manufacturer's Quality Control and third party tests.

Table C.I <u>I</u>	Item	Type of Test	Standard Test	Frequency of Testing	
Test			Method	Trequency of Testing	
		Swell Index(A)	ASTM D5890	per 100,000-lbs and every truck or	
				railcar	
	Bentonite ^(A)	Moisture Content ^(A)	ASTM D4643	per 100,000-lbs and every truck or railcar	
		Fluid Loss ^(A)	ASTM D5891	per 100,000-lbs and every truck or railcar	
Manufacturer's Quality	Geotextile	Grab Tensile Strength ^(B)	ASTM D4632	per 200,000-ft ²	
Control		Mass/Unit Area	ASTM D5261	per 200,000-ft ²	
		Grab Tensile	ASTM D6768	man 200 000 ft ²	
		Strength ^(B)	ASTM D4632	per 200,000-ft ²	
	GCL	Peel Strength(H)	ASTM D 6496	per 40,000-ft ²	
	Product		ASTM D 4632	per 40,000-it	
		Clay Mass/Unit Area ^(C)	ASTM D5993	per 40,000-ft ²	
		Permeability ^(D)	ASTM D5887	per week for each production line ^(E)	
		Lap Joint Permeability ^{(D)(F)}	ASTM D5887	per each material and lap type	
Conformance Testing by 3 rd Party Independent	GCL Product	Clay Mass/Unit Area ^(C)	ASTM D5993	at least one (1) test per 100,000-ft ² and ASTM D4254 procedure A	
Laboratory		Permeability ^{(D)(F)}	ASTM D5084	per 100,000-ft ²	
Laboratory		Direct Shear ^{(F)(G)(I)}	ASTM D5321 ASTM D6243	Per GCL/adjoining material type	

### Table C.110-3 - STANDARD TESTS ON GEOSYNTHETIC CLAY LINER MATERIAL

### Notes:

- A Tests performed on bentonite before incorporation into GCL. Free swell shall have a minimum test value of 24-ml. Fluid loss shall have a maximum value of 18-mil.
- B Geotextiles shall meet minimum manufacturer criteria.
- C Minimum Test value 0.75-lb/sq. ft. MARV at 0% moisture content
- D  $5 \times 10^{-9}$  cm/ sec max or as required by the permit.
- E Report last twenty (20) permeability values, ending on production date of supplied GCL.
- F Test at confining/consolidating pressures simulating field conditions.
- G Not applicable for slopes of 7H:IV or flatter. Testing must be on material in hydrated state unless GCL includes geomembrane on both side of GCL.
- H Peel strength for unreinforced GCL 1 lb/in (1.75 N/cm) min. Peel strength for reinforced GCL 3.5 lbs/in (6.1 N/cm) min.
- I Hydrated internal shear strength for unreinforced GCL 150 psf. Hydrated internal shear strength for reinforced GCL 500 psf.

### 4.3.Installation

The GCL installation Contractor shall submit to the QAI a Subgrade Surface Acceptance Form, signed by the GCL installation Contractor, for each area covered directly by GCL as installation proceeds.

# 4.4.Delivery, Storage, and Handling

**1.A.** Packing and Shipping

The GCL shall be supplied in rolls wrapped individually in relatively impermeable and opaque protective covers. The GCL rolls shall be marked or tagged with the following information:

- 1. Manufacturer's name.
- 2. Product identification.
- 3. Roll number.
- 4. Roll dimensions.
- 1.5.Roll weight.

# 5.B. Storage and Protection

An onsite storage area for GCL rolls from the time of delivery until installed as recommended by the GCL Manufacturer shall store and protect GCL from dirt, water, ultraviolet light exposure, and other sources of damage. Contractor shall preserve integrity and readability of GCL roll labels. Rolls must not be stacked higher than recommended by the manufacturer to preclude thinning of bentonite at contact points.

Use wooden pallets for above ground storage of GCL and heavy, waterproof tarpaulin for protecting unused GCL unless otherwise specified by GCL manufacturer.

#### 4.5.Materials

The active ingredient of the GCL shall be natural sodium bentonite and encapsulated between two (2) geotextiles. The geotextile-backed GCL shall provide sufficient internal shear strength of the slopes to be lined. The GCL shall have a coefficient of permeability of 5 x  $10^{-9}$ -centimeters/second (cm/sec) or less and an index flux of 1 x  $10^{-8}$ - (m³/m²/sec).

The bentonite shall be continuously adhered to both geotextiles to ensure the bentonite will not be displaced during handling, transportation, storage, and installation, including cutting, patching, and fitting around penetrations. The bentonite sealing compound or bentonite granules used to seal penetrations and make repairs shall be made of the same natural sodium bentonite as the GCL and recommended by the GCL manufacturer. The permeability of the GCL seams shall be equal to or less than the permeability of the body of the GCL sheet.

#### 4.6.Manufacturer

# A. Manufacturing Experience

The GCL manufacturer shall have a minimum of two (2) years of continuous experience in the manufacture of similar CGL products. The Manufacturer must demonstrate, by submitting a list of previous projects, a minimum of 5-million sq.ft. of manufacturing experience of similar GCL products.

# 4.7.Warranty

The Manufacturer shall provide a 5-year warranty to the Owner against manufacturing defects. The warranty shall include the supply of the replacement GCL material and

shall not include the cost of re-installation, defects, or failures due to improper installation.

### 4.8.Execution

### A. Examination

The QAE or his representative will collect samples of material delivered to the site for conformance testing. Alternatively, the QAE may coordinate the collection and shipping of samples collected by the manufacturer and shipped directly to the QAL.

# **B.** Installation

# i. GCL Deployment

Handle GCL in a manner to ensure it is not damaged as recommended by the GCL Manufacturer. At a minimum, comply with the following:

- 1. On slopes, anchor the GCL securely and deploy it down the slope in controlled manner.
- 2. Weight the GCL with sandbags or equivalent in the present of wind.
- 3. Cut GCL with a cutter (hook blade), scissors, or other approved device.
- 4. Prevent damage to underlying layers during placement of GCL.
- 5. During GCL deployment, do not entrap in or beneath GCL stones, trash, or moisture that could damage GCL.
- 6. Visually examine entire GCL surface. Ensure no potentially harmful foreign objects such as needles are present.
- 7. Do not place GCL in the rain or a times of impending rain.
- 8. Do not place GCL in areas of ponded water.
- 9. Replace GCL that is hydrated before placement of overlying geomembrane and cover soil.
- 10. In general, only deploy GCL that can be covered during the day by geomembrane.
- 11. Prepare seam overlap areas as specified by the manufacturer.
- 12. Protective soil cover (including leachate collection media) shall be placed over the liner as soon as practicable.
- 13. Avoid dragging GCL on the subgrade.
- 14. Vehicular traffic other than low contact pressure vehicles such as UTV/ATV's or golf carts are not allowed on deployed GCL.
- 15. Installation personnel shall not smoke or wear damaging shoes when working on GCL.

### ii. Overlaps

Overlap GCL to the manufacturer's recommendations that will vary according to seam location and climatic conditions. Prepare the overlap area as required by the manufacturer. At sumps, overlapped GCL shall be a minimum of 1-foot. At bottom of collection and leak detection sumps, unroll an extra layer of GCL on top of

previously installed GCL. Avoid placing seams on top of underlying seams. Horizontal seams and mid-slope anchor trenches are not allowed on side slopes.

# iii Defects and Repairs

Repair all flaws or damaged areas by placing a patch of the same material extending at least 1-foot beyond the flaw or damaged area. Add granular bentonite to the overlapped edges of the patch at the manufacturer's specified rate.

# iv Interface with Other Products

Ensure the following when deploying overlying material:

- 1. GCL and underlying materials are not damaged.
- 2. Minimal slippage of GCL on underlying layers occurs.
- 3. No excess tensile stresses occur in GCL.
- 4. If necessary, bond overlap seams and patches in place prior to placement of overlying materials to prevent dislocating the GCL seam or patch.

# 4.9.Equipment

### A. Installation

- 1. Use front-end loader, crane, or similar equipment for GCL deployment with a spreader bar and spindle to prevent slings from damaging edges.
- 2. Use 3-inch wide grips for moving GCL panels into place for each installation technician.
- 3. Use sealing and securing materials as required by specifications and drawings at attachment or penetration locations.
- 4. Use sand bags for securing tarpaulin when being stored and to secure GCL prior to placement of GML.

## 5. GEOMEMBRANE LINERS

The following requirements govern the geomembrane liners used at the facility:

## 5.1. Geomembrane Description

Geomembrane materials shall be High Density Polyethylene (HDPE) or Linear Low Density Polyethylene (LLDPE). The thicknesses of these geomembrane materials will vary based on project documents. Geomembrane sheets will be placed on a prepared subgrade and will be continuously seamed in accordance with the manufacturer's instructions to provide a water-tight seam.

# 5.2. Required Material Properties

The geomembrane shall be made of new, first quality materials with no more that 10% re-grind manufactured specifically for the purpose of liquid containment.

### 5.2.1. All HDPE Geomembrane Materials

Minimum specifications for all HDPE materials, including geomembrane and extrudate (welding rods):

Density (ASTM D 1505) 0.94 gm/cm³ Percent Carbon Black (ASTM D 1603 or 2.0% to 3.0%

ASTM D 4218)

Minimum specifications for all HDPE geomembrane sheet:

Carbon Black Dispersion (ASTM D 5596) Only near spherical agglomerates, for 10

different view: 9 in Categories 1 or 2 and

1 in Category 3

### 5.2.2. Smooth HDPE Geomembrane

Thickness (ASTM D 5199) 60 mils (average of all measurements)

54 mils (lowest of any 10 measurements)

Tensile strength @ yield (ASTM D 6693) 126 pounds per inch (ppi)

Tensile strength @ break (ASTM D 6693)

Elongation @ yield (ASTM D 6693)

Elongation @ break (ASTM D 6693)

Tear resistance (ASTM D 1004)

Puncture resistance (ASTM D 4833)

228 ppi
12%
700%
42 pounds
108 pounds

### 5.2.3. Textured HDPE Geomembrane

Thickness (ASTM D 5994) 60 mils (average of all measurements)

54 mils (lowest for 8 out of 10)

51 mils (lowest of any 10)

Tensile strength @ yield (ASTM D 6693)

Tensile strength @ break (ASTM D 6693)

Elongation @ yield (ASTM D 6693)

Elongation @ break (ASTM D 6693)

Tear resistance (ASTM D 1004)

Puncture resistance (ASTM D 4833)

120 ppi
90 ppi
12%
100%
42 pounds
90 pounds

### 5.2.4. All LLDPE Geomembrane Materials

Minimum specifications for all LLDPE materials, including geomembrane and extrudate (welding rods):

Density (ASTM D 1505) 0.939 gm/cm³ Percent Carbon Black (ASTM D 1603 or 2.0% to 3.0%

ASTM D 4218)

Minimum specifications for all LLDPE geomembrane sheet:

Carbon Black Dispersion (ASTM D 5596) Only near spherical agglomerates, for 10

different view: 9 in Categories 1 or 2 and

1 in Category 3

**5.2.5.** Smooth LLDPE Geomembrane

Thickness (ASTM D 5199) 40 mils (average of all measurements)

36 mils (lowest of any 10 measurements)

Tensile strength @ break (ASTM D 6693) 152 pounds per inch (ppi)

Elongation @ break (ASTM D 6693) 800% Tear resistance (ASTM D 1004) 22 pounds Puncture resistance (ASTM D 4833) 56 pounds

5.2.6. Textured LLDPE Geomembrane

Thickness (ASTM D 5994) 40 mils (average of all measurements)

36 mils (lowest for 8 out of 10)

Tensile strength @ break (ASTM D 6693) 60 ppi Elongation @ break (ASTM D 6693) 250% Tear resistance (ASTM D 1004) 22 pounds Puncture resistance (ASTM D 4833) 44 pounds

The manufacturer shall certify that the geomembrane has been quality control tested during the manufacturing process and that the materials are first quality and free of holes, blisters, undispersed raw materials, and contamination by foreign materials. In addition, the manufacturer shall certify that the liner meets all strength and resistance requirements for the intended use.

<u>Properties</u>, test methods, testing frequencies, and required values are summarized in Tables 10-4 and 10-5 for HDPE geomembranes, and Tables 10-6 and 10-7 for LLDPE geomembranes.

<u>Table 10-4</u>

<u>Required Testing for 60-mil HDPE Geomembrane (Smooth and Textured)¹</u>

<u>Test</u>	<u>Property</u>	<u>Frequency</u>	<u>Test Method</u>
Resin	Specific Gravity/Density	Per 200,000 lbs and	ASTM D 1505 or ASTM D 792
	Melt Flow Index	every resin lot Per 100,000 ft² and every resin lot	ASTM D 1238
Manufacturer's	<u>Thickness</u>	Per roll of geomembrane	ASTM D 5199 (smooth), and ASTM
Quality Control	Specific Gravity/Density	Per 200,000 lbs and every resin lot	D 5994 (textured) ASTM D 1505 or ASTM D 792
	Carbon Black Content	Per 20,000 lbs	ASTM D 4218 or ASTM D 1603
	Carbon Black Dispersion	<u>Per 45,000 lbs</u>	<u>ASTM D 5596</u>
	Tensile Properties	<u>Per 20,000 lbs</u>	ASTM D 6693
	<u>Tear Resistance</u>	Per 45,000 lbs	<u>ASTM D 1004</u>
	<u>Puncture Resistance</u>	<u>Per 45,000 lbs</u>	ASTM D 4833
	Stress Crack Resistance	Per GRI-GM10	<u>ASTM D 5397</u>
	Oxidative Induction Time	<u>Per 200,000 lbs</u>	ASTM D 3895 or ASTM D 5885
	Oven Aging @ 85°C  (a) Standard OIT, or (b) High Pressure OIT UV Resistance	Per each formulation  Per each formulation	ASTM D 5721 ASTM D 3895 ASTM D 5885 ASTM D 7238
	High Pressure OIT  Asperity Height ²	Every second roll of geomembrane	ASTM D 7236 ASTM D 5885 ASTM D 7466
Conformance	<u>Thickness</u>	Per 100,000 ft ² and every	ASTM D ASTM D 5199 (smooth),
Testing by 3 rd Party	Specific Gravity/Density	resin lot	and ASTM D 5994 (textured) ASTM D 1505 or ASTM D 792
Independent	Carbon Black Content		ASTM D 4218 or ASTM D 1603
Laboratory	Carbon Black Dispersion		ASTM D 5596
	Tensile Properties		ASTM D 6693
Destructive	Shear & Peel	Various for field, lab &	ASTM D 6392
Seam Field Testing		archive	
Non-	<u>Air Pressure</u>	All dual-track fusion weld	<u>ASTM D 5820</u>
Destructive Seam Field Testing	<u>Vacuum</u>	All non-air pressure tested seams when	ASTM D 4437
100000000000000000000000000000000000000	to the minimum requirements set fort	possible h by GRI testing standard GM13 Ri	equired values for the properties are listed in

¹ All tests will conform to the minimum requirements set forth by GRI testing standard GM13. Required values for the properties are listed in Table 10-5.

 $^{{\}color{red}{\underline{^{2}}}} \textbf{This testing is for textured geomembrane only. } \textbf{Measurement side will be alternated for double-sided textured sheet.}$ 

<u>Table 10-5</u>

<u>Minimum Required Property Values for 60-mil HDPE Geomembrane (Smooth and Textured)¹</u>

Dropoute	Took Makhad	Minimum Required Value	
<u>Property</u>	<u>Test Method</u>	<u>Smooth</u>	<u>Textured</u>
Thickness, mils  Minimum average  Lowest individual reading  Lowest individual of 8 of 10 readings	ASTM D 5199 ASTM D 5994 (textured)	60 54 NA	57 51 54
Density, g/cc	ASTM D 1505/ D 792	0.94	0.94
Asperity Height, mils	ASTM D 7466	NA	10
Tensile Properties ¹ 1. Yield Strength, lb/in 2. Break Strength, lb/in 3. Yield Elongation, % 4. Break Elongation, %	ASTM D 6693	126 228 12 700	126 90 12 100
Tear Resistance, lb	ASTM D 1004	42	42
Puncture Resistance, lb	ASTM D 4833	<u>108</u>	<u>90</u>
Stress Crack Resistance ² , hrs	ASTM D 5397	<u>300</u>	<u>300</u>
Carbon Black Content, %	ASTM D 4218 or ASTM D 1603	<u>2.0 − 3.0</u>	<u>2.0 – 3.0</u>
Carbon Black Dispersion ³ , Category	ASTM D 5596	1 or 2 and 3	1 or 2 and 3
Oxidative Induction Time (OIT) ⁴ (min. avg) Standard OIT, minutes High Pressure OIT, minutes	ASTM D 3895 ASTM D 5885	100 400	100 400
Oven Aging @ 85°C Standard OIT, % retained after 90 days High Pressure OIT, % retained after 90 days	ASTM D 5721 ASTM D 3895 ASTM D 5885	<u>55</u> <u>80</u>	<u>55</u> <u>80</u>
UV Resistance ⁵ High Pressure OIT ⁶ , % retained after 1600 hrs	ASTM D 7238 ASTM D 5885	<u>50</u>	<u>50</u>
Seam Properties (4 out of 5 specimens,  5 th specimen can be as low as 80%)  1. Shear Strength, lb/in  2. Peel Strength, lb/in	<u>ASTM D 6392</u>	<u>120</u> <u>91 &amp; FTB</u> (78, ext. weld)	<u>120</u> <u>91 &amp; FTB</u> (78, ext. weld)

¹Machine direction (MD) and cross machine direction (XMD) average values will be on the basis of 5 test specimens each direction. Yield elongation is calculated using a gauge length of 1.3 inches; break elongation is calculated using a gauge length of 2.0 inches.

²The yield stress used to calculate the applied load for the Single Point Notched Constant Tensile Load (SP-NCTL) test will be the mean value via MQC testing

³ Carbon Black Dispersion for 10 different views; 9 in Categories 1 and 2 and 1 in Category 3.

⁴The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.

⁵The condition of the test will be 20 hr UV cycle at 75°C followed by 4 hr condensation at 60°C.

⁶ UV resistance is based on percent retained value regardless of the original HP-OIT value.

⁷Required values are based on GRI GM13, except for the seam properties which are based on GRI GM19.

<u>Table 10-6</u>

Required Testing for 40-mil LLDPE Geomembrane (Textured)¹

<u>Test</u>	<u>Property</u>	<u>Frequency</u>	<u>Test Method</u>
Resin	Specific Gravity/Density	Per 200,000 lbs and every resin lot	ASTM D 1505 or ASTM D 792
	Melt Flow Index	Per 100,000 ft ² and every resin lot	ASTM D 1238
Manufacturer's	<u>Thickness</u>	Per roll of geomembrane	<u>ASTM D 5994</u>
Quality Control	Specific Gravity/Density	Per 200,000 lbs and every resin lot	ASTM D 1505 or ASTM D 792
	Carbon Black Content	Per 20,000 lbs	ASTM D 4218 or ASTM D 1603
	Carbon Black Dispersion	Per 45,000 lbs	ASTM D 5596
	Tensile Properties	Per 20,000 lbs	ASTM D 6693 Type IV
	<u>Tear Resistance</u>	<u>Per 45,000 lbs</u>	<u>ASTM D 1004</u>
	Puncture Resistance	<u>Per 45,000 lbs</u>	<u>ASTM D 4833</u>
	Axi-Symmetric Break Resistance Strain	Per each formulation	ASTM D 5617
	Oxidative Induction Time	Per 200,000 lbs	ASTM D 3895 or ASTM D 5885
	Oven Aging @ 85°C  (a) Standard OIT, or  (b) High Pressure OIT	Per each formulation	ASTM D 5721 ASTM D 3895 ASTM D 5885
	UV Resistance High Pressure OIT	Per each formulation	ASTM D 7238 ASTM D 5885
	Asperity Height ²	Every second roll of geomembrane	ASTM D 7466
Conformance	Thickness ²	Per 100,000 ft ² and every	ASTM D 5994
Testing by 3 rd Party	Specific Gravity/Density	resin lot	ASTM D 1505 or ASTM D 792
Independent	Carbon Black Content		ASTM D 4218 or ASTM D 1603
Laboratory	Carbon Black Dispersion		ASTM D 5596
	Tensile Properties		ASTM D 6693 Type IV
Destructive Seam Field Testing ³	Shear & Peel	Various for field, lab & archive	ASTM D 6392
Non-	<u>Air Pressure</u>	All dual-track fusion weld	ASTM D 5820
Destructive Seam Field Testing	<u>Vacuum</u>	seams All non-air pressure tested seams when	ASTM D 4437
101111111111111111111111111111111111111	Lather with a second for the second	possible	equired values for the properties are listed in

¹ All tests will conform to the minimum requirements set forth by GRI testing standard GM17. Required values for the properties are listed in Table 10-7.

² Field thickness measurements for each roll must be conducted. The lowest 8 out of 10 values will not be less than 10% below the nominal thickness and no single measurement will be less than 15% below the nominal thickness for the roll to be acceptable.

³ Passing criteria for the geomembrane materials are listed in Table 10-7. Passing criteria for seams are listed in Section 5.4.8.3.3

<u>Table 10-7</u>

<u>Minimum Required Property Values for 40-mil LLDPE Geomembrane (Textured)¹</u>

<u>Property</u>	<u>Test Method</u>	Minimum Required Value
Thickness, mils	ASTM D 5994	
Minimum average		<u>38</u>
Lowest individual reading		<u>34</u>
Lowest individual of 8 of 10 readings		<u>36</u>
Density, g/cc (max.)	ASTM D 1505/ D 792	<u>0.939</u>
Asperity Height, mils ¹	ASTM D 7466	<u>10</u>
Tensile Properties ²	ASTM D 6693 Type IV	
<ol> <li>Break Strength, lb/in</li> </ol>		<u>60</u>
2. Break Elongation, %		<u>250</u>
<u>Tear Resistance, lb</u>	ASTM D 1004	<u>22</u>
Puncture Resistance, lb	ASTM D 4833	<u>44</u>
Break Resistance Strain, % (min.)	ASTM D 5617	<u>30</u>
Carbon Black Content, %	ASTM D 4218 or ASTM D 1603	<u>2.0 – 3.0</u>
Carbon Black Dispersion ³ , Category	ASTM D 5596	<u>1 or 2 and 3</u>
Oxidative Induction Time (OIT) ⁴ (min. avg)		
Standard OIT, minutes	ASTM D 3895	<u>100</u>
High Pressure OIT, minutes	<u>ASTM D 5885</u>	<u>400</u>
Oven Aging @ 85°C	ASTM D 5721	
Standard OIT, % retained after 90 days	ASTM D 3895	<u>35</u>
High Pressure OIT, % retained after 90 days	<u>ASTM D 5885</u>	<u>60</u>
UV Resistance ⁵	<u>ASTM D 7238</u>	
High Pressure OIT ⁶ , % retained after 1600 hrs	<u>ASTM D 5885</u>	<u>35</u>
Seam Properties (4 out of 5 specimens, 5 th		
specimen can be as low as 80%)		
Shear Strength, lb/in	ASTM D 6392	<u>60</u>
Peel Strength, lb/in		<u>50 &amp; FTB</u>
1 Measurement side will be alternated for double sided toytur		<u>(44, ext. weld)</u>

 $^{{}^{\}underline{1}} \text{Measurement side will be alternated for double-sided textured sheet.}$ 

#### 5.3.Installation Procedures

The geomembrane liner installation procedures shall be conducted by the GMI and observed by QAO. The installation procedures shall conform to the following requirements:

² Machine direction (MD) and cross machine direction (XMD) average values will be on the basis of 5 test specimens each direction. Break elongation is calculated using a gauge length of 2.0 inches.

 $[\]underline{^3}$  Carbon Black Dispersion for 10 different views; 9 in Categories 1 and 2 and 1 in Category 3.

⁴The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.

⁵The condition of the test will be 20 hr UV cycle at 75°C followed by 4 hr condensation at 60°C.

 $^{^6\,\}text{UV}$  resistance is based on percent retained value regardless of the original HP-OIT value.

⁷Required values are based on GRI GM17, except for the seam properties which are based on GRI GM19.

# 5.3.1. Surface Preparation

The surface to be lined shall be prepared so as to provide a surface which is relatively free of irregularities, loose earth, desiccation cracks, and abrupt changes in grade. This preparation shall consist of the removal of loose scale materials which might damage the geomembrane. Prior to placing geomembrane materials, the GMI shall execute a subgrade acceptance form unless installed over a GCL. This form shall be submitted to the QAO and signed by the QAE and the Owner. A copy of this form has been included in Appendix A.

# 5.3.2. Delivery and Storage

All rolls of geomembrane delivered to the site shall be marked with the name of the manufacturer, the product type, the nominal thickness, the manufacturing batch code, roll number, date of manufacture, and roll dimensions. The QAO must inspect the delivered materials for damage and defects. Pushing, sliding or dragging or rolls or pallets can cause damage and must be avoided. The geomembrane rolls shall be kept free of dirt and debris, must be protected from soft or wet ground and rocky or rough ground, and must not be stacked more than five (5) rolls high to avoid crushing the cores of the rolls. A sacrificial cover must be used to protect the geomembrane if stored on site for more than six (6) months. The rolls shall be stored on level ground in such a manner as to avoid shifting, abrasion, or other adverse movements that can damage the geomembrane materials.

# 5.3.3. Geosynthetic Materials Anchor Trench

A geosynthetic materials anchor trench shall be completed along the perimeter of the area to be lined where indicated on the project contract documents. The anchor trench may be excavated in sections, as necessary. Loose soil shall be removed from the anchor trench and shall not underlie the geosynthetic materials to be placed in the anchor trench. The excavated anchor trench shall have rounded corners in order to help protect the geosynthetic materials. The anchor trench shall conform to the dimensions and requirements shown on the project contract documents.

# 5.3.4. Geomembrane Deployment

### **5.3.4.1.**Weather Conditions

Geomembrane deployment shall not proceed:

- During precipitation events;
- o In the presence of excessive moisture (humidity);
- o In areas of ponded water; or,
- In the presence of excessive wind.

# 5.3.4.2. Temporary Geomembrane Anchoring

All unseamed edges of geomembrane panels shall be temporarily anchored each day using sand bags, rubber tires or a comparable means that does not damage the material, and does

not degrade during the time it is in use. Similar procedures may be used to temporarily anchor the geomembrane in the anchor trench. Penetrating anchors shall not be used for temporary anchorage unless the penetrations will be beyond the inside wall of the anchor trench and will not require repair. Anchorage shall be sufficient to prevent loss or damage.

## 5.3.4.3. Panel Placement and Alignment

The geomembrane shall be deployed in accordance with the procedures outlined below:

- Only those geomembrane panels which can be seamed in one (1) day should be deployed.
- Each geomembrane panel shall be inspected for damage and manufacturing defects prior to seaming.
- Geomembrane panels shall be placed in a controlled manner, such as pulling, hoisting, or rolling. The geomembrane panels shall be installed such that there will be neither excessive tension nor wrinkles that could cause creasing in the final use condition. Wrinkles shall be walked out or removed as much as possible prior to field seaming.
- o Panels shall be placed in such a manner that the geomembrane is not scratched or crimped. Any such damage shall be repaired or removed and replaced in accordance with the procedures described in Section 5.3.7.
- Adjacent geomembrane panels shall be overlapped a minimum of three (3) inches (HDPE) after seaming is completed. The QAI shall visually inspect the placement and overlap of the geomembrane to verify that the material is placed with sufficient overlap. Geomembrane seams with insufficient overlap shall be repaired or replaced.
- o Geomembrane panels shall be placed such that there are no horizontal or crosspanel seams on the side slopes unless approved by the QAE and the owner. In addition, geomembrane panels placed on the bottom shall be overlapped from top to bottom in the downslope direction. In this configuration the upslope geomembrane panel will overlie the immediately adjacent downslope panel. This overlap shall be a minimum of three (3) inches.
- The geomembrane panels shall be placed and aligned such that seam joining of the sidewalls and bottom sections must be located in the bottom and at least five (5) feet from the sidewall. In corners and odd-shaped geometric locations, the number of field seams should be minimized.
- No vehicular traffic shall be allowed on the geomembrane. Only low-ground pressure supporting equipment may be allowed to traverse the geomembrane. The equipment used for placement and seaming shall not damage the geomembrane by leaking fluids or other means. Areas which are damaged in this manner shall be removed or repaired.
- Personnel working on the geomembrane shall not smoke, wear damaging shoes, throw equipment or engage in other activities which could damage the geomembrane.

### 5.3.4.4.Panel Identification

As each geomembrane panel is placed, it shall be labeled in bold print visible from a distance of approximately thirty (30) feet. In general, these markings shall be placed in an area which will remain un-obscured until subsequent layers are placed. Panel numbers shall be sequential based on the placement order. The roll number from which the panel is from shall be included with the panel number.

# **5.3.5.** Field Seaming

All field seaming shall be performed using method(s) approved by the manufacturer of the geomembrane sheet. For HDPE geomembrane, this will include fusion and extrusion welding.

### 5.3.5.1. Weather Conditions

Field seaming of the geomembrane shall not be performed at ambient temperatures below 40° Fahrenheit (F) [5° Celsius (C)] unless the geomembrane seam area is preheated, by sun or hot air device, to a temperature in excess of 50°F (5°C). However, in any case, field seaming of the geomembrane shall not be performed at ambient temperatures below 34°F (1°C). The GMI shall consult with the QAE if it is anticipated that seaming will be attempted or performed above 113°F (45°C) ambient air temperature. The QAE shall establish and the GMI shall implement agreed-upon measures to prevent liner stretching and thickness reduction or no seaming shall be performed above 113°F (45°C) ambient air temperature. The temperature shall be recorded at regular, periodic intervals by the GMI.

### 5.3.5.2.Trial Seams

All personnel responsible for seaming shall perform a trial seam prior to the start of seaming with each apparatus used that day. The beginning of each seaming period is considered to be the morning, and immediately after a break. Whenever seaming with a particular apparatus is discontinued for more than one hour or turned off more than ten (10) minutes, a new trial seam shall be performed. An additional trial seam shall be performed for each seaming period for each apparatus used that day, and for each six (6) hours if a break is not taken. In any instance, a minimum of one (1) trial seam shall be performed for each six (6) hours of operation for each seaming apparatus used.

An additional trial seam shall also be performed for each occurrence of significantly different environmental conditions (i.e., temperature, humidity, dust, etc.), and when fusion seaming different geomembranes (tie-ins and smooth to textured). Both the welder and the machine must be tested for each trial seam when extrusion welding. Only the machine needs to be tested for each new trial seam when fusion welding, since the machine is not as operator dependent. Each individual seaming shall make at least one (1) trial seam each day they actually perform seaming.

Trial seams shall be performed on "fragment" pieces of geomembrane and shall be a minimum of twelve (12) inches in width by three (3) feet in length. A minimum three (3) inch overlap shall be provided and the seam shall be approximately centered throughout the length of the geomembrane fragment used. All trial seams shall be performed under the same conditions as production seaming. Trial seams shall be tested in the field by the GMI for peel and shear performance, as outlined in Sections 5.4.6 and 4.4.7.

## **5.3.5.3.General Seaming Requirements**

All geomembrane seams shall extend to the end of each panel to be anchored. All geomembrane seams shall be clean and free of moisture, oil, dust, dirt, debris of any kind, and foreign matter at the time of welding. No folds, large wrinkles, or fish mouths shall be allowed in the seam. Only normal factory-induced creasing from the blown film process may be acceptable. Where wrinkles or folds occur, the material shall be cut and overlapped, and an extrusion weld applied, in accordance with the procedures outlined in this LQCP. Areas of insufficient overlap shall be repaired in accordance with the procedures detailed in Section 5.3.7. All complete seams shall be tightly bonded and sealed.

If geomembrane seaming operations are performed at night, adequate lighting shall be provided for seaming as well as for inspection of the seaming conditions and the seams.

# **5.3.5.4.Extrusion Seaming Requirements**

The extrusion welding apparatus shall have a temperature gauge which indicates the temperature of the extrudate. Additionally, the temperature of the extrudate at the nozzle will be monitored at the time of trial seaming using a probe (pyrometer). A significant difference (greater than 15°C) in the indicated vs. monitored temperature shall result in investigation and repair of the seaming apparatus. The QAI may request that the GMI check extrudate temperatures at other times as well.

The extruder shall be purged to remove heat-degraded material prior to the beginning of seaming and whenever the extruder is stopped for an appreciable length of time.

Grinding in preparation for extrusion welding should be done carefully. Grinding beyond the area to be covered with extrudate is unnecessary, and will be minimized. Grinding shall not extend more than one-eighth (1/8) inch beyond the edge of the seam.

## 5.3.5.5. Fusion Seaming Requirements

The fusion welding apparatus shall be a vehicular mounted, automated device. The temperature, pressure and welding speed shall be independently adjustable and the apparatus shall be equipped with a gauge which displays the actual internal temperature.

# 5.3.6. Nondestructive Seam Continuity Testing

The GMI shall conduct the following nondestructive seam continuity testing:

# 5.3.6.1.General

Continuous non-destructive testing shall be performed on all seams by the GMI. Air pressure testing shall be performed on all dual track fusion welds and vacuum-box testing for extrusion welds are the only acceptable methods for geomembrane seams. All leaks identified during testing must be isolated and repaired by the following procedures described in this LQCP.

Areas thought to be potentially inaccessible to nondestructive continuity testing equipment shall be brought to the QAE's attention prior to the start of work.

Nondestructive continuity testing of field seams, including repairs, shall be performed by the GMI as the work progresses to provide the opportunity for immediate rewelding and retesting as necessary. All defects discovered shall be marked, repaired and retested.

# **5.3.6.2.**Testing Procedures

The GMI shall submit the proposed specific nondestructive testing procedures to be employed on this project to the QAE. The testing procedures shall be consistent with the requirements of this specification. The testing procedures must be approved by the QAE.

For vacuum box testing, a suction value of approximately three (3) to five (5) inches of gauge vacuum shall be applied to all extrusion seams that can be tested in this manner. The seam that has been wetted with soapy water must be observed for leaks a minimum of five (5) seconds while subjected to this vacuum. Areas where soap bubbles appear shall be marked, repaired and re-tested. The GMI shall record the test results, including technician ID, date, time and pass/fail condition on the geomembrane near the test location.

For air pressure testing, the air space created by the fusion weld shall be tested for continuity. The ends of the air channel of the dual track fusion weld must be sealed and pressured to a minimum of 30 psi. The air pump must then be shut off and the air pressure observed after five minutes. A loss of less than four (4) psi is acceptable, if it is determined that the air channel is not blocked between the sealed ends. A loss of more than four (4) psi indicates the presence of a seam leak which must then be marked, isolated, repaired and re-tested. The GMI shall record the test results, including technician ID, date, the before and after times and pressures and pass/fail condition at a minimum on the geomembrane near the test location. All openings in air channels must be sealed subsequent to testing.

### 5.3.7. Defects and Repairs

#### 5.3.7.1.General

All seam and non-seam areas of the geomembrane shall be visually inspected for signs of defective seams, blisters, punctures, undispersed raw materials, and any sign of contamination by foreign matter. Any problems discovered shall be marked, repaired and

retested or reevaluated in accordance with this document. The geomembrane surface shall be clean at the time of these inspections.

Any sheets which become seriously damaged (torn or twisted permanently) shall be replaced. Less serious damage (inadvertent punctures during installation) shall be repaired by welding a piece of geomembrane over the damaged area. The repairs must comply with the LQCP to be considered adequate.

#### 5.3.7.2.Evaluation

Each suspect location in both seam and non-seam areas shall be inspected and, where appropriate, tested using the methods described in this document. Work shall not proceed with any materials which will cover the locations which require repair or which have been repaired but require testing with passing results.

# 5.3.7.3. Procedures for Repair

Grinding and welding procedures may be used to repair small sections of deficient extrusion seams and small surface blemishes which do not penetrate the entire thickness of the geomembrane. The geomembrane surfaces requiring repair shall be abraded no more than one hour prior to the repair being made. The allowable time between abrading the surface and making the repair may be reduced if determined necessary by the QAI. Grinding shall be performed only within the area requiring repair and shall not significantly damage the liner.

Defects which do not require replacement of the sheet shall be repaired and covered with a patch or a cap (a patch with an extended length). Patches and caps shall extend a minimum of six (6) inches beyond the limits of the defect and all corners of patches and caps shall be rounded with a radius of approximately two inches. All seaming for patches and caps shall be accomplished by extrusion welding.

The GMI shall record repair information, including technician and seaming apparatus ID, date, and time on the repair or on the geomembrane near the repair.

# 5.3.8. Permanent Anchorage in Anchor Trench

Following completion of the seaming activities as determined by the GMI, the geomembrane (and any other geosynthetic materials) shall be permanently anchored in the anchor trench. A detail indicating proper anchoring procedures is included in the project contract documents. The anchor trench shall be backfilled and compacted using hand-operated or rubber-tired equipment. Care should be used when backfilling and compacting the anchor trench to prevent damage to the geosynthetic materials. The final configuration of the anchor trench shall conform to the dimensions and requirements shown on the project contract documents.

# **5.4. Quality Assurance Requirements**

The QAO shall review quality control documents, conduct material conformance tests and inspect the placement and installation of the geomembrane, and coordinate necessary surveys. In addition, the QAI shall ensure the following QA verification activities are performed:

## **5.4.1.** Inspection Upon Delivery

The QAI shall inspect the geomembrane material delivered to the site. All rolls of geomembrane shall be marked with the name of the manufacturer, the product type, the nominal thickness, the manufacturing batch code and/or roll number, date of manufacture, and roll dimensions. The QAI shall document that the quality control and conformance data has been received and is acceptable for each roll. The QAI shall also verify that the geomembrane rolls are being stored in a manner to protect them from the elements.

#### **5.4.2.** Thickness Determination

The QAI shall check the thickness of each roll of geomembrane delivered to the site. Thickness shall be checked with a micrometer on the leading edge at five (5) locations. The geomembrane shall meet the required material properties. See Section 5.2, except that thickness criteria are for five (5) measurements or four of five as appropriate. Geomembrane rolls which fail this thickness determination shall be removed from the site. The OAI shall document the thickness determinations taken for each roll.

## 5.4.3. Inspection During Deployment

The QAI shall visually inspect the deployment of the geomembrane to ensure that the panels are properly placed and that each seam will have sufficient overlap.

### **5.4.4.** Observation of Non-Destructive Testing

The GMI shall coordinate the non-destructive testing with the QAE to ensure that a QAI is present for non-destructive testing. The QAE or QAI will verify that all non-destructive testing is successfully completed and will document the testing on data forms.

# 5.4.5. Survey Documentation

The QAE shall locate all seams, destructive test locations and patches for the geomembrane and may coordinate a survey for such purposes if appropriate. Reference locations will be noted on a drawing of the area.

# 5.4.6. Trial Seam Testing

Each trial test seam shall be at least three (3) feet long by one (1) foot wide. Four (six when possible if using dual track fusion welding) adjoining one (1) inch wide specimens shall be cut in a controlled manner, by die or template from the test seam sample. Two (2) specimens shall be tested in the field for shear, and two (2) for peel (four [4] when possible

if testing both inner and outer welds for dual track fusion welding) using testing procedures outlined in the following paragraph. Specimens cut in an uncontrolled fashion to a random width shall not be used.

All trial seam specimens shall be tested by the GMI and observed by a QAI in the field for shear and peel using an electrically operated tensiometer, with the capability of registering the force imparted on a geomembrane test specimen. Hand operated tensiometers shall not be used. The trial seam specimens shall be tested at a cross-head rate of two (2) inches per minute. The GMI shall provide a calibration certificate for each load cell within the tensiometer. Calibration shall have been conducted within 90 days of the start of installation.

The GMI's seaming and testing technician(s) shall record the following information on a remnant portion of the trial seam sample. The remnant portion will be retained until project completion and may then be stored by the Owner. The QAI will log the information on a data form and assign each sample a number.

- Date and time of test;
- The name of the welder and identification of the apparatus used in performing the test;
- The failure mode: either "Pass" indicating a film-tear bond not in the weld or "Fail" for each specimen; and,
- The peak yield load in pounds per inch for each specimen.

### 5.4.7. Trial Seam Evaluation Criteria

The criteria for evaluating trial seams is as follows:

### 5.4.7.1.Shear

Two (2) trial seam specimens shall be tested in shear. Each must fail at a strength equal to or greater than ninety five percent (95%) of the rated yield strength of the parent sheet material as indicated on the manufacturer's quality control certifications, but in no instance at less than the specified yield strength for sheet material. Neither trial seam test shall fail in the weld. If both of these criteria are not met, the entire trial seam shall be considered failing.

### 5.4.7.2.Peel

Two (2) trial seam specimens (four if necessary to test both inner and outer welds) shall be tested in peel and neither shall fail in the weld area. If this criteria is not met, the entire trial seam shall be considered failing. The peel strength of the geomembrane outside of the weld shall be equal to or greater than sixty two percent (62%) of the rated yield strength of the parent sheet material as indicated on the manufacturer's quality control certifications, but in no instance less than 90 ppi for fusion seams and 78 ppi for extrusion seams. Peel seams must exhibit a Film Tear Bond (FTB) failure.

If a trial seam fails, the entire procedure shall be repeated after the appropriate adjustments to the welding apparatus or procedures have been made. This process shall be repeated until two (2) consecutive successful trial seam tests have been achieved. Alternatively, if a successful trial seam is not achieved, the welding apparatus and/or the operator shall not be used for seaming until such time as the deficiencies are resolved.

# **5.4.8.** Destructive Seam Testing

## **5.4.8.1.Testing Location and Frequency**

Destructive seam samples will be obtained at an average minimum frequency of one (1) per five hundred (500) lineal feet of weld. Destructive seam-testing locations shall be cap-stripped and the cap completely seamed by extrusion welding to the geomembrane. Capped sections shall be non-destructively tested. The seam destructive test sampling frequency may be increased by the QAE beyond the specified minimum based upon actual welding conditions and the results of other samples obtained.

The sample locations will be selected by the QAI as welding progresses. Additional sample locations may be prompted by suspicion of a poor quality weld.

The GMI will not be informed in advance of seam destructive test locations but will be required to physically obtain the samples from the geomembrane no later than twenty four (24) hours after the location has been selected.

The total footage of individual repairs of leaks of more than ten (10) feet and individual repairs of more than ten (10) feet for failed seams must also be counted and destructively tested using the same frequency of testing described above.

### **5.4.8.2. Sample Size**

The location for the destructive samples shall be marked by the QAI. The dimensions for the destructive samples shall, as a minimum, be twelve (12) inches wide by thirty six (36) inches long with the seam centered widthwise. Sample lengths may be increased at the request of the QAL. The GMI shall obtain two specimens from each end of the marked seam destructive sample, each a minimum of one inch in width for preliminary field testing as described in Section 5.4.8.3.1. If the preliminary field testing exceeds the pass/fail criteria, the sample shall be cut and divided into two parts as described below:

- One portion of the sample, measuring twelve (12) inches by fifteen (15) inches, to be sent by the QAO to the QAL for testing.
- One portion of the sample, measuring twelve (12) inches by twelve (12) inches to be retained by the owner for archiving.
- The sample length shall be increased to accommodate the additional length required by the GMI for laboratory testing or archiving.

# **5.4.8.3. Testing Procedure**

## **5.4.8.3.1.**Preliminary Field Testing

Four (4) specimens, two (2) from each end of the destructive sample seam, are to be removed and tested by the GMI while in the field. One (1) specimen from each end of the original sample is to be tested in shear and the other in peel. Specimen and test procedures shall be the same as described for trial seams in Section 5.4.6. Field testing shall include testing on both tracks on dual track fusion welded seams for each specimen tested for peel.

# **5.4.8.3.2.** Laboratory Seam Destructive Testing

The destructive seam testing will be performed by QAO in an off-site laboratory. This testing is to be completed within seventy two (72) hours of the time the samples are removed from the geomembrane installation. The Contractor may test samples in the field with observation by the QAI.

The testing shall be performed on a total of ten (10) specimens obtained from the field sample described in Section 5.4.8.2. Five (5) specimens shall be tested in each of the shear and peel modes. For the dual-tracked fusion welds, five (5) peel tests shall be performed for each track of weld. These shear and peel specimens shall be selected from the sample alternately so that no two (2) immediately adjacent specimens are tested in the same mode.

The specimens shall be tested in accordance with ASTM D 6392.

### 5.4.8.3.3. Seam Evaluation Criteria

Each seam sample must meet both the shear and peel criteria before being considered passing. Field tested specimens are determined as passing if the specimen tested in peel fails in FTB and all test specimens meet the criteria listed in this LQCP. The QAL testing must confirm these field results.

### 5.4.8.3.3.1.Shear

The shear strength must be at least ninety-five percent (95%) of the manufacturer's parent sheet yield strength, but no less than required material properties 120 lb/in for HDPE geomembrane and 60 lb/in for LLDPE geomembrane. The minimum passing criteria for independent laboratory testing are all of the following: (1) at least four of the five specimens shall not fail in the weld, (2) at least four of the five specimens must meet the minimum specified value, and (3) the average value from all the specimens must meet the minimum specified value. The above criteria apply to both tracks from each dual track fusion welded seam before it is considered passing. If these criteria are not met then the entire seam destructive sample is considered failing.

# 5.4.8.3.3.2.Peel

The peel strength must be at least 62% of manufacturer's parent sheet yield strength, but no less than the required material properties 91 lb/in for HDPE geomembrane (78 lb/in for extrusion welds) and 50 lb/in for LLDPE geomembrane (44 lb/in for extrusion welds). The minimum passing criteria for laboratory testing are all of the following: (1) at least four of the five specimens shall not fail in the weld, (2) at least four of the five specimens must meet the minimum specified value, and (3) the average value from all five specimens must meet the minimum specified value. The above criteria apply to both tracks from each dual track fusion welded seam before it is considered as passing. If these criteria are not met, then the entire seam destructive sample is considered failing.

#### **5.4.8.3.4.**Seam Destructive Test Failure Procedures

In the instance of the dual-tracked fusion weld, both tracks of the weld will be tested in peel. If either peel test performed on specimens of this weld type fails, the entire specimen is considered failing.

The GMI shall reconstruct the failing seam bound by two passing seam destructive tests. The GMI shall have the option of obtaining additional destructive test samples at a minimum of ten (10) foot intervals in both directions along the failing seam from the failure location. The minimum interval may be increased by the QAE if test failures become excessive.

If both of these samples pass the laboratory seam destructive test then the seam can be reconstructed between them. If one (1) or both of these samples fail the laboratory seam destructive test, then the procedure is repeated until passing laboratory results are obtained. (Note: The tracking procedure described may be extended beyond the limits of an individual seam.)

If a seam is reconstructed to a length in excess of fifty (50) feet, a seam destructive sample may be obtained from the reconstruction zone which must meet the requirements described above.

# 6. LEACHATE COLLECTION SYSTEM

The following requirements govern the leachate collection system used in the landfill units:

# **6.1.Leachate Collection System Description**

The leachate collection system (LCS) used consists of layers of geotextile fabric, HDPE drainage net, gravel and piping, as described in conjunction with the lining systems in Section 1.2. In general, the LCSs will be sloped to drain to one or more collector pipes running through each landfill unit. The underlying lining system will be sloped to the collector pipe, and along the line of the collector pipe toward the sump. The sump will have a riser pipe for the removal

of collected liquids. Detailed design descriptions and drawings of the leachate collection system and geocomposite drainage layer are provided in the project construction documents.

# **6.2.Required Material Properties**

The LCS and geocomposite drainage layer materials shall be new, first quality materials manufactured specifically for the purpose of liquid conveyance and collection. All LCS and geocomposite drainage layer materials shall have sufficient strength and resistance to chemical or ultraviolet radiation attack for the intended use. <u>Properties</u>, test methods, testing frequencies, and required values are summarized in Table 10-8 below for geotextiles, drainage nets and drainage geocomposites.

<u>rable 10-8</u> Required Testing for Geotextile and Drainage Geocomposite¹

Required Testing for Geotextile and Drainage Geocomposite ¹				
Responsible Party	<u>Material</u>	<u>Property</u>	<u>Test Method</u>	<u>Value</u>
	Geotextile for <u>Drainage</u> Geocomposite	Unit Weight Apparent Opening Size	ASTM D 5261 ASTM D 4751	<u>8 oz/sy</u> <u>0.15 mm</u>
		Grab Strength	ASTM D 4632	<u>220 lb</u>
<u>Manufacturer</u>		Grab Elongation	ASTM D 4632	<u>50%</u>
		CBR Puncture Strength	ASTM D 6241	<u>575 lb</u>
		<u>Permittivity</u>	ASTM D 4491	1.3 sec ⁻¹
	Geotextile for leak detection trench wrap	<u>Unit Weight</u>	ASTM D 5261	<u>12 oz/sy</u>
		Apparent Opening Size	ASTM D 4751	<u>0.15 mm</u>
NA		Grab Strength	ASTM D 4632	<u>320 lb</u>
<u>Manufacturer</u>		Grab Elongation	ASTM D 4632	<u>50%</u>
		CBR Puncture Strength	<u>ASTM D 6241</u>	<u>925 lb</u>
		<u>Permittivity</u>	ASTM D 4491	0.8 sec ⁻¹
	HDPE Geonet	Specific Gravity/Density	ASTM D 1505	0.94 gm/cm ³
		<u>Thickness</u>	<u>ASTM D 5199</u>	<u>250 mils</u>
		Peak Tensile Strength	<u>ASTM D 5035 or</u>	<u>45 lb/in</u>
<u>Manufacturer</u>			<u>ASTM D 7179</u>	
		Percent Carbon Black	ASTM D 1603 or	<u>2.0 %</u>
		Transmissivity ²	ASTM D 4218	2 x 10 ⁻³ m ² /sec
N.A			ASTM D 4716	
Manufacturer		Ply Adhesion	ASTM D 7005	1.0 lb/in
Manufacturer/	<u>Drainage</u> <u>Geocomposite</u>	<u>Transmissivity</u> ²	<u>ASTM D 4716</u>	5 x 10 ⁻⁴ m ² /sec
Third Party Lab				(double sided) 1.5 x 10 ⁻³ m ² /sec
				(single sided)

¹ The minimum testing frequency for materials in this table will be one test sample per 100,000 square feet.

² Gradient of O.1, normal load of 10,000 psf, between steel plates for 15 minutes.

### 6.2.1. Geotextile

All geotextile fabric shall be non-woven polypropylene, meeting the following minimum specifications:

Geotextile fabric for use in drainage geocomposite:

Mass per Unit Areas (ASTM D 5261) 8 ounces per square yard

CBR Puncture Strength (ASTM D 6241) 575 pounds
Grab Tensile Strength/Elongation (ASTM D 220 pounds/50%

4632)

Apparent Opening Size (ASTM D 4751) 0.15 mm

Permittivity (ASTM D4491) 1.3 per second (sec⁻¹)

Geotextile fabric for use in leachate collection/leak detection trench:

Mass per Unit Areas (ASTM D 5261) 12 ounces per square yard

CBR Puncture Strength (ASTM D 6241) 925 pounds
Grab Tensile Strength/Elongation (ASTM D 320 pounds/50%

4632)

Apparent Opening Size (ASTM D 4751) 0.15 mm

Permittivity (ASTM D4491) 0.8 per second (sec⁻¹)

# **6.2.2.** HDPE Drainage Net

Minimum specifications for HDPE Drainage Net:

Thickness (ASTM D 5199) 250 mils (average of all measurements)

Density (ASTM D 1505) 0.94 gm/cm³

Peak Tensile strength (ASTM D 5035 or 45 ppi

ASTM D 7179)

Percent Carbon Black (ASTM D 1603 or 2.0% to 3.0%

ASTM D 4218)

Transmissivity (ASTM D4716) 2 x 10⁻³ square meters per second (m²/sec)

at a gradient of 0.1 and a loading of 478.8 kilo-newtons per square meter (kN/m²)

[10,000 pounds per square foot]

21 Maximum

# **6.2.3.** Piping

Minimum specifications for Liquids Collection Piping:

Material HDPE or PVC, single wall Specifications HDPE – ASTM F714

PVC - ASTM D1785, D2241 or D3034

Standard Dimension Ratio (SDR) [Outside

Diameter to Wall Thickness]

Joint Type HDPE - Fusion Welded

PVC – Fusion or Solvent-Cement Welded

Perforation Type (Where required)

Round
Perforation Size (Where required)

1/2" Max.

Perforation Area (Where required) 1-1/2 square inches (in²) per foot

### **6.2.4.** Gravel

Minimum specifications for LCS gravel:

Material Source Washed, rounded river gravel

Maximum particle size (100% Passing – 2"

ASTM C136 or D422)

At least 90% of Material Smaller Than 1-1/2"

(ASTM C136 or D422)

No more than 10% of Material Smaller Than ½"

(ASTM C136 or D422)

Calcium Carbonate Content (ASTM D3042) Less than 15%

Coefficient of Permeability (ASTM D2434) Greater than 0.2 cm/sec

#### 6.3.Installation Procedures

The LCS and GDL material installation procedures shall be conducted by the GMI and observed by QAO. The installation procedures shall conform to the following requirements:

### 6.3.1. Geotextile

# **6.3.1.1.Delivery and Storage**

All rolls of geotextile delivered to the site shall be marked with the name of the manufacturer, the product type, the manufacturing batch code, roll number, date of manufacture, and roll dimensions. The QAE or QAI must inspect the delivered materials for damage and defects. Damage during unloading must be avoided. The rolls shall be kept free of dirt and debris, must be protected from soft or wet ground and rocky or rough ground, and must not be stacked more than five (5) rolls high to avoid crushing the cores of the rolls. A sacrificial cover must be used to protect the rolls if stored on site for more than six (6) months. The rolls shall be stored in such a manner as to avoid shifting, abrasion, or other adverse movements that can damage the materials.

### 6.3.1.2.Deployment

Geotextile shall not be deployed in the presence of excessive wind. On slopes, the geotextile shall be secured and rolled down the slope so that it is kept continuously in tension. Geotextile shall be placed parallel to sideslopes, except in special locations approved by the QAI. It shall be anchored in the synthetic materials anchor trench. All unseamed edges shall be temporarily anchored each day using sand bags, rubber tires or a comparable means that does not damage the material, and does not degrade during the time it is in use. During placement of the geotextile, the GMI shall ensure that it is not clogged with dirt or foreign materials. Geotextile shall be cut only with devices that are recommended by the manufacturer.

# 6.3.1.3. Panel Placement and Alignment

Geotextile panels shall be deployed in accordance with procedures approved by the QAE. As a minimum, the procedures outlined below shall be followed.

- Only those panels which can be seamed in one (1) day should be deployed.
- o Each panel shall be inspected for damage prior to seaming.
- Panels shall be placed in a controlled manner, such as pulling, hoisting, or rolling. The panels shall be installed such that there will be neither excessive tension nor wrinkles that could cause creasing in the final use condition. Wrinkles shall be walked out or removed as much as possible prior to field seaming.
- Adjacent panels shall be overlapped a minimum of three (3) inches (or as sufficient for seaming.) The QAE or QAI shall visually inspect the placement and overlap of the panels to verify that the material is placed with sufficient overlap.
- No vehicular traffic shall be allowed on the geotextile.

# 6.3.1.4. Field Seaming

All field seaming shall be performed by sewing using polymeric thread having chemical and ultraviolet light resistance properties equal to or exceeding those of the geotextile. Thread shall be supplied by the geotextile manufacturer or shall be as recommended by the manufacturer. Provide documentation of the source or recommendation by the manufacturer. Glues and heat bonding are strictly prohibited. In general, horizontal seams or splices should be avoided on side slopes. No two adjacent slope pulls may have a horizontal seam.

# **6.3.1.5.Procedures for Repair**

Holes or tears in the geotextile shall be repaired by placing a patch extending at least six (6) inches beyond the edges of the hole or tear. The patch shall be seamed to the panel. Care shall be taken to remove any soil or other material which may have penetrated the damaged geotextile.

## 6.3.2. HDPE Drainage Net

## **6.3.2.1.Delivery and Storage**

All rolls of HDPE drainage net delivered to the site shall be marked with the name of the manufacturer, the product type, the manufacturing batch code, roll number, date of manufacture, and roll dimensions. The QAE or QAI must inspect the delivered materials for damage and defects. Pushing, sliding or dragging of rolls or pallets can cause damage and must be avoided. The rolls shall be kept free of dirt and debris, must be protected from soft or wet ground and rocky or rough ground, and must not be stacked more than five (5) rolls high to avoid crushing the cores of the rolls. A sacrificial cover must be used to protect the rolls if stored on site for more than six (6) months. The rolls shall be stored in such a manner as to avoid shifting, abrasion, or other adverse movements that can damage the materials.

# 6.3.2.2.Deployment

HDPE Drainage net shall not be deployed in the presence of excessive wind. On slopes, the net shall be secured and rolled down the slope so that it is kept continuously in tension. Drainage net shall be placed parallel to sideslopes, except in special locations approved by the QAI. The drainage net shall be anchored in the synthetic materials anchor trench. All unseamed edges shall be temporarily anchored each day using sand bags, rubber tires or a comparable means that does not damage the material, and does not degrade during the time it is in use. During placement of the net, the GMI shall ensure that the net is not clogged with dirt or foreign materials.

## 6.3.2.3. Panel Placement and Alignment

Drainage net panels shall be deployed in accordance with procedures approved by the QAE. As a minimum, the procedures outlined below shall be followed.

- Only those panels which can be seamed in one (1) day should be deployed.
- Each panel shall be inspected for damage prior to seaming.
- Panels shall be placed in a controlled manner, such as pulling, hoisting, or rolling. The panels shall be installed such that there will be neither excessive tension nor wrinkles that could cause creasing in the final use condition. Wrinkles shall be walked out or removed as much as possible prior to field seaming.
- Adjacent panels shall be overlapped a minimum of three (3) inches. The QAE or QAI shall visually inspect the placement and overlap of the panels to verify that the material is placed with sufficient overlap.
- No vehicular traffic shall be allowed on the drainage net.

# 6.3.2.4. Field Seaming

All field seaming shall be performed using method(s) approved by the manufacturer of the HDPE drainage net. Seaming can be achieved using string, plastic fasteners or ties, or polymer braid. Metallic devices are strictly prohibited. Submit the proposed seam (tie-pattern) with the quality control documents. In general, no horizontal seams are allowed on side slopes.

## **6.3.2.5.Procedures for Repair**

Holes or tears in the drainage net shall be repaired by placing a patch extending at least six (6) inches beyond the edges of the hole or tear. The patch shall be seamed to the panel.

## **6.3.3.** Piping

# **6.3.3.1.Delivery and Storage**

All piping delivered to the site shall be marked with the name of the manufacturer, the product type, and applicable specifications under which the material was manufactured. The QAE or QAI must inspect the delivered materials for damage and defects. Piping shall be kept free of dirt and debris, must be protected from soft or wet ground and rocky

or rough ground, and must not be stacked more than ten (10) sections high. The piping shall be stored in such a manner as to avoid shifting, abrasion, or other adverse movements that can damage the materials.

## 6.3.3.2.Deployment

Piping shall be placed to the lines and grades shown on the project construction documents. Piping shall be temporarily anchored using sand bags, rubber tires or a comparable means that does not damage the piping and ensures proper alignment until covered. During placement of the piping, the GMI shall ensure that dirt or foreign materials do not enter the piping.

## 6.3.3. Field Joints/Seaming

All field joints or seaming shall be performed using fittings and method(s) approved by the manufacturer of the piping. Field joints shall be butt-fusion welded. For PVC piping, joints may be solvent-cement welded with prior written approval by the QAE. If solvent cement joints are to be completed over underlying geosynthetic materials, the GMI shall ensure that a sacrificial impermeable barrier is placed underneath each joint to prevent solvent material from coming in contact with the underlying material. Gasketed joints shall not be used.

## **6.3.3.4.Procedures for Repair**

Damaged piping shall be removed and replaced using procedures consistent with those for installing new piping.

### **6.3.4.** Gravel

### 6.3.4.1.Delivery and Storage

Gravel to be used for LCS construction shall be stockpiled as near as possible to the construction area. Signage near the stockpile shall identify the source, intended use, and gradation specifications (size). Gravel shall not be placed on wet ground.

## 6.3.4.2.Deployment

Gravel may be placed using mobile equipment or hand tools (e.g. wheel barrows, etc.). Where gravel placement must traverse underlying geosynthetic materials, the GMI shall use only low-ground pressure supporting equipment. If such equipment is operating over the geosynthetic materials, it must be placed on a sacrificial surface or rub sheet. Areas of underlying geosynthetic materials that are damaged in this manner shall be repaired as required by this LQCP. Gravel shall be placed to the lines and grades shown on the project construction documents. Gravel materials shall not be placed in direct contact with geomembrance materials. Where this is possible to occur, the GMI shall place a layer of geotextile fabric between the gravel and the geomembrane. During placement of the gravel, the GMI shall ensure that it is not obstructed by dirt or foreign materials.

## **6.4. Quality Assurance Requirements**

The GMS or the QAO shall conduct material conformance tests, as outlined in Section 1.9 and the QAO shall review quality control documents, inspect the placement and finishing of the LCS, and coordinate necessary surveys. In addition, the QAI shall ensure the following QA verification activities are performed:

## **6.4.1.** Inspection Upon Delivery

The QAI shall inspect the geosynthetic, piping and gravel materials delivered to the site, and shall document that the quality control and conformance data has been received and is acceptable for each material lot. The QAI shall also verify that the materials are being stored in a manner to protect them from the elements.

# **6.4.2.** Inspection During Deployment

The QAI shall visually inspect the deployment of the drainage net, geotextile, piping and gravel to ensure proper placement as outlined in the LQCP and in the project construction documents.

## 6.4.3. Sieve Analysis (Gradation) for Gravel

A minimum of one (1) test for each 5,000 cubic yards (cy³) or less of gravel shall be performed in accordance with ASTM C136 or ASTM D422. A minimum of one (1) test shall be performed regardless of the quantity.

## **6.4.4.** Survey Verification

The QAE shall coordinate a survey to locate the piping and verify that proper grades are achieved. Where required to document grades, a minimum of one (1) survey verification shall be made per 5,000 ft² of surface area. Reference locations will be noted on a drawing of the area.

### 7. PROTECTIVE COVER

The following requirements govern the protective cover that will be installed on top of constructed liner materials and leachate collection systems:

### 7.1. Protective Cover Description

Protective cover soil material will be placed with a minimum thickness of 2 feet over the drainage layer component of the leachate collection system, including drainage aggregate where applicable.

# 7.2. Required Material Properties

The protective cover will consist of soils that do not contain any materials detrimental to the underlying geosynthetics. The protective cover shall be free of organics, angular rocks, foreign objects, or other deleterious materials.

### 7.3.Installation Procedures

The protective cover soils shall be placed using low ground pressure equipment. The protective cover shall be placed by spreading in front of the spreading equipment with a minimum of 12 inches of soil between the spreading equipment and the underlying installed geosynthetics. Under no circumstances shall the construction equipment come into direct contact with the installed geosynthetics. Unless otherwise specified by the QAE, all lifts of protective cover soil placed over geosynthetics will conform with the following equipment and lift thickness guidelines.

Equipment Ground Pressure (psi)	Minimum Lift Thickness (in)
< 5.0	12
5.1 - 8.0	18
8.1 - 16.0	24
> 16.0	36

Protective cover placed on sideslopes shall be placed from the bottom and pushed up the slope.

# 7.4. Quality Assurance Requirements

The protective cover soil thickness shall be verified by field surveys using a minimum of one survey point per 5,000 square feet of constructed area. Surveys shall be performed by a licensed Texas land surveyor and the survey results shall be included in the GLER submittal.

During construction the QAE shall:

- 1. Verify that grade control is performed prior to work.
- L. Verify that underlying geosynthetic installations are not damaged during placement operations or by survey grade controls. Mark damaged geosynthetics and verify and document damage repairs.
- 2. Verify that cover soil for sideslopes is pushed from the toe up the slope.
- 3. Monitor haul road thickness over geosynthetic installations and verify that equipment hauling and materials placement meet equipment specifications.

# 8. FINAL COVER CONSTRUCTION

The following requirements govern the final cover system used at the facility:

### **8.1.Final Cover Description**

The final cover system will consist of a six (6) inch thick (minimum) prepared subgrade layer, a geosynthetic clay liner (GCL) layer, a forty mil (0.04 inch) thick LLDPE geomembrane liner, a geocomposite drainage layer, and a twenty five (25) inch thick protective cover soil layer. Soil materials used for the final cover system shall be obtained either from on-site or off-site sources.

# 8.2. Required Material Properties

Soil materials and geosynthetic materials used for final cover construction comply with the following required material properties.

### 8.2.1. Soil Materials

## 8.2.1.1. Subgrade Soils

Soil materials shall meet the requirements of Section 2.2.

## **8.2.1.2.**Protective Cover Vegetative Soil Layer:

The soil material for the protective cover vegetative soil layer shall consist of earthen material capable of sustaining native plant gowth and be composed of particles of which at least thirty percent (30%) but no more than ninety six percent (96%) pass the #200 sieve.

# 8.2.2. Geosynthetic Materials

# 8.2.2.1. Geosynthetic Clay Liner (GCL)

The GCL material shall meet the requirements of Section 4.2.

### 8.2.2.2.Geomembrane Liner

The forty mil (0.04 inch) thick LLDPE geomembrane liner shall meet the requirements of Section 5.2.

# 8.2.2.3. Geocomposite Drainage Layer

The HDPE drainage net and geotextile fabric used in the geocomposite drainage layer shall meet the requirements of Section 6.2.

### 8.3.Installation Procedures

The final cover installation procedures shall be conducted by the Earthwork Contractor and observed by QAO. The installation procedures shall conform to the following requirements:

### **8.3.1.** Subgrade Preparation

The existing intermediate cover material shall be shaped to the appropriate lines and grades as shown in the project contract documents and should coincide with the bottom of the final cover system. Subgrade soil materials shall be installed in accordance with the procedures specified in Section 2.3.

# 8.3.2. GCL Installation

The GCL shall be installed in accordance with the procedures specified in Section 4.8.

### 8.3.3. Geomembrane Liner Installation

The forty mil (0.04 inch) thick LLDPE geomembrane liner shall be installed in accordance with the procedures specified in Section 5.3.

## 8.3.4. Geocomposite Drainage Layer

The geocomposite drainage layer shall be installed in accordance with the procedures specified in Section 6.3.

# 8.3.5. Protective Cover Vegetative Soil Layer

A minimum twenty five (25) inch thick layer of protective cover soil shall be placed above the geocomposite drainage layer on the top and side walls of the area to receive cover. Protective cover does not require compaction control; however it should be stable for construction, operations and maintenance traffic. Care shall be exercised in placement so as not to shift or wrinkle or damage the underlying geosynthetics layers. Protective cover shall be placed using low ground pressure dozers (i.e. track pressure less than 5 psi). A 12-inch thickness of protective cover shall be maintained at all times. A greater thickness will be required to support loaded hauling trucks and trailers and for turning areas. Drivers shall proceed with caution when on the overlying soil and prevent spinning of tires and sharp turns. Protective cover shall be placed in an upslope direction on sidewalls.

The required thickness of the protective cover layer will be verified by survey methods on an established grid system with not less than one verification point per 10,000 square feet of surface area.

# 9. GENERAL DOCUMENTATION REQUIREMENTS

The QAE shall be responsible for ensuring that adequate documentation is prepared to comply with the LQCP. Documentation may consist of daily recordkeeping, manufacturer's test reports, conformance testing and installation reports, nonconformance reports (if necessary), progress reports, and design and specification revisions (if necessary). The appropriate documentation shall be used by the QAE to develop the GCLER, GLER and BER (if required) as well as other reports that may be required by the owner.

# 9.1.Daily Field Reports

The QAI shall prepare a daily field report. This report shall be prepared on the form included in Appendix C or a form containing similar information and shall be submitted to the owner and the QAE. The QAE shall review and sign all daily field reports. These daily field reports shall describe the work performed during the day.

### 9.2.Test Results

All tests shall be documented. The QAE shall develop and implement a tracking process to discretely identify each test result, including failures and subsequent re-tests. All laboratory tests shall have a written report prepared to indicate the results. The QAE or QAI shall review all test results and determine whether the test results meet project requirements. The QAE shall track each failing test result and shall require re-work or re-testing of the failed component to ensure that the completed component meets project requirements. Written and/or tabular summaries of field test results shall be prepared for inclusion in the GCLER/GLER. Copies of laboratory test results shall also be included in the GCLER/GLER.

# 9.3. Surveying Results

The QAE shall ensure that the surveying results are presented on a project drawing prepared to indicate the as-built condition of the constructed components. The QAE shall work with the surveyor to develop and implement a tracking process to discretely identify each surveyed location and the date on which the survey was conducted, including failures and subsequent re-surveys. The QAE shall track each failing survey result and shall require re-work or retesting of the failed component to ensure that the completed component meets project requirements. Calculations supporting the thickness verifications shall be submitted by the surveyor to the QAE for inclusion in the GLER.

# 9.4. Sample Location Plan

The QAE shall be responsible for preparing and maintaining a site map which depicts the components being constructed on which can be documented the progress of the work, including inspections, sampling, testing and surveying. This map may be supplemented with additional maps and drawings sufficient to maintain proper records.

### 9.5. Final Reporting Requirements

The QAE shall be responsible for preparing, signing, and sealing the final GCLER/GLER document. The GCLER/GLER shall also be signed by the site operator and will be submitted to the TCEQ by the QAE. Submittal shall be to the MSW Permits Section of the Waste Permits Division for review and acceptance. If no response is received, either oral or written, within 14 days of receipt at the Waste Permits Division of the TCEQ, the report will be considered accepted. Any notice of deficiency received from the TCEQ will be promptly addressed and incorporated into the GCLER/GLER document. No solid waste will be placed over the constructed liner areas until final acceptance is obtained from the TCEQ.

If a layer of waste has not been placed over the top of protective cover within six months, then the QAE or the design engineer will visually observe that the protective cover has not undergone significant erosion that could compromise the protection of the underlying geosynthetics. A letter report documenting the observation of the cover and the repair measures undertaken to correct any cover damage will be submitted to the TCEQ for review

and acceptance. This procedure shall be repeated at six month intervals until all protective cover has been covered with a layer of waste.

The QAE shall be responsible for preparing, signing and sealing the final BER that will document that enough ballast has been placed in a lined area to offset the potential hydrostatic uplift forces which may exist below the liner. The BER shall also be signed by the site operator and will be submitted to the TCEQ by the QAE. The BER shall also verify that the liner did not undergo uplift during construction. Additional documentation to accompany the BER includes a waste as ballast placement record completed and signed by the site operator, a survey of the top of waste elevations to document that the required waste thickness has been placed, and ballast thickness calculations. Submittal of the BER shall be to the MSW Permits Section of the Waste Permits Division for review and acceptance. The ballast placement and BER will not be considered accepted, and the temporary dewatering system must remain operational, until the TCEQ has given confirmation of its acceptance, or 14 days from the date of arrival of the BER at the Waste Permits Division, TCEQ have lapsed.

### 10. CONSTRUCTION BELOW THE HIGHEST GROUNDWATER LEVEL

## 10.1. Applicability

Future landfill sectors may be constructed below groundwater levels and could potentially experience uplift due to hydrostatic pressure acting on the liner system. Measures for both short term and long term protection of the liner system against uplift forces are described in this section of the LQCP.

A temporary dewatering system consisting of a dewatering drainage geocomposite and dewatering piping installed in gravel filled collection trenches will be installed below the footprint of future sectors prior to construction of the new liner. The geocomposite will also extend up the sidewalls of each newly developed sector to prevent the buildup of hydrostatic forces on the liner system. The sidewall geocomposite will drain to a toe trench and dewatering pipe collection system that will flow to a dewatering sump at the low point of the sector.

Long term protection of the liner system will be accomplished with the placement of sufficient ballast consisting of a combination of drainage gravel, protective cover soils, waste and final cover as applicable. Sample ballast calculations are provided in Appendix E – Example Ballast Calculations.

The highest groundwater elevation contours are shown on Figure III.10D-1of Appendix D. The contours on this drawing are based upon the highest individual reading in each of the monitor wells shown and do not represent a single event, existing conditions or groundwater flow. This contour map will be updated with the design of each new sector or partial sector to incorporate any higher well level data that has been recorded since the previous sector was constructed.

# **10.2.** Dewatering System

To prevent the buildup of hydrostatic forces on the liner system, each new sector will have a temporary dewatering system installed prior to liner construction. The temporary dewatering system design is presented in Appendix D and consists of a drainage geocomposite extending across the floor of the sector that will transmit captured groundwater to a gravel filled collection trench that drains to a groundwater collection sump. The drainage geocomposite will also extend up the sidewalls and will drain to a gravel filled toe trench that coveys collected water to the groundwater collection sump. Water collected in the sump will be pumped to the facility perimeter stormwater drainage system. The drainage geocomposite will be covered with a 1-foot thick foundation soil layer that will serve as a subgrade for the GCL component of the liner system. The foundation soil layer will consist of on-site or off-site soil material that is free of organics, angular rocks, foreign objects or other deleterious materials.

Operation of the temporary dewatering system will continue until sufficient ballast is placed to offset the potential hydrostatic uplift forces acting on the liner. The liner can only be taken out of service upon the written approval of TCEQ once sufficient documentation of ballast placement has been submitted.

Alternate temporary dewatering systems may be submitted to TCEQ for consideration and approval if circumstances warrant the development of such alternate systems. A permit modification application must be submitted detailing the purpose and details of any such changes to this LCQP.

# 10.3. Dewatering System Materials

# **10.3.1. Piping**

The dewatering collection trench piping shall meet the requirements of Section 6.2.3. Collection pipes will be 6-inch diameter HDPE SDR 17 or an approved equal. Installation procedures shall be in accordance with Section 6.3.3.

### 10.3.2. Drainage Gravel

Aggregate for the dewatering system collection trenches shall meet the minimum specifications listed in Section 6.2.4. Calcium carbonate content requirements for the dewatering system drainage gravel will be waived as the groundwater pH is expected to be neutral. Installation of the drainage gravel shall be in accordance with Section 6.3.4.

# 10.3.3. Drainage Geocomposite

The drainage geocomposite shall meet the requirements specified in Appendix D as well the construction documents for the specific sector development project. Installation of the drainage geocomposite shall be in accordance with Section 6.3.

#### 10.4. Operation of the Dewatering System

The dewatering system shall be kept in operation until the ballast evaluation report is submitted to and approved in writing by TCEQ. Pumps used for pumping out water that collects in the dewatering sumps shall be inspected on a weekly basis to ensure proper operation. The pumps will be controlled with pressure transducers to ensure that the groundwater is below the liner elevations. Alternatives to pressure transducers for measuring groundwater levels in the sump include bubbler levels or graduated measuring rods. The QAE will identify the allowable groundwater level in the dewatering sump for each sector. Water levels in the sump shall be recorded weekly and the volume of water pumped shall be recorded on a monthly basis.

#### 10.5. Liner System Ballast

Liner protection against long-term hydrostatic uplift pressures will be provided by the counteracting weight of the materials placed above the geomembrane liner, referred to as ballast. The ballast includes the weight of the leachate collection system, protective cover soil materials, and compacted waste. Additional soil in excess of the minimum protective thickness may also be used as ballast. Example calculations for determining the height of compacted waste or additional protective cover soils above the liner system are provided in Appendix E. Once ballast has been placed to the calculated height above the liner in a newly constructed sector, the temporary dewatering system below the liner no longer needs to remain operational and the groundwater can be allowed to rebound against the bottom of the liner system. A ballast evaluation report (BER) must be prepared and submitted to TCEQ to document that the adequate height of ballast has been achieved in the sector to offset potential hydrostatic uplift forces, and to request that the temporary dewatering system operations be discontinued. Once the BER is accepted by the TCEQ in writing, operation of the temporary dewatering system may be discontinued.

Ballast calculations will be performed to provide an adequate thickness of soil and/or waste to offset the potential hydrostatic uplift forces for each sector constructed below the groundwater table. A calculated factor of safety against uplift of 1.5 will be required for ballasting with waste and a factor of safety of 1.2 will be used for soil ballast. The unit weight for waste used as ballast will be 1200 pounds per cubic yard. The unit weight for soil used as ballast will be determined by laboratory testing for each specific sector construction project.

Landfill personnel working under the supervision of the landfill superintendent will be on site full time during placement of the first 5 feet of waste over the liner system. The site operator will verify and document on a daily basis that this lower 5 feet of waste does not contain brush or large bulky items that could damage the liner system or that cannot be compacted to the required density. Documentation will also be provided on a daily basis that the waste for ballast has been compacted with compaction equipment which weighs in excess of 40,000 pounds. The site operator will complete and sign a waste-as-ballast placement record that will be attached to the BER. A copy of the form, TCEQ-10073, is included in Appendix F. The latest revision of TCEQ-10073 or an equivalent form will be submitted for each sector associated with the BER.

#### 10.6. Verification of Liner Performance

The QAE will verify that the ballast placed is consistent with the established criteria and that uplift of the liner system did not occur during construction. The QAE shall observe the liner subgrade for evidence of seepage during construction. Any areas of seepage will be documented by the QAE as to seepage location, methods and procedures used to control the seepage, and continued monitoring of the seepage area after control.

To document that short-term uplift has not occurred during construction of the liner, the QAE shall verify that the elevations of the GCL are consistent with the design subgrade elevations on shown on the construction drawings. The QAE shall also verify that the protective cover elevations have not increased from those submitted with the GLER. Survey measurements to check against uplift will be taken at a minimum frequency of 1 point per 10,000 square feet. The protective cover uplift survey will be performed once between submittal of the GLER and the beginning of waste placement.

#### 10.7. Documentation

The GCLER, GLER, and BER will include information relevant to construction of the liner below the groundwater table. The calculations for the constructed liner ballast installed over the liner system will be submitted with the BER. The GCLER and GLER shall include a discussion identifying areas constructed below the highest measured groundwater elevations and a discussion of current groundwater conditions. The GCLER and GLER shall also include a discussion addressing any seepage that may have been encountered during construction. The BER will contain survey information verifying that the appropriate depth of ballast has been installed and that the liner did not experience hydrostatic uplift.

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#### **APPENDIX D**

Temporary Dewatering System Design

# CITY OF KINGSVILLE MUNICIPAL SOLID WASTE LANDFILL GROUNDWATER GEOCOMPOSITE

#### **Appendix B DEWATERING DRAINAGE GEOCOMPOSITE FLOW CAPACITY**

<u>I. Objective:</u> Verify that the dewatering drainage geocomposite has the flow capacity for the estimated groundwater flows <u>and results in a reduction of hydrostatic forces by a factor of 1.2.</u>

<u>II. Approach:</u> Compute the maximum depth of groundwater in the geocomposite for the estimated design flow.

#### III. Assumptions:

- **A:** Design groundwater flow rate is 2.42 x 10⁻⁵ cfs/ft which equates to 11.5 gpm for the flow area of 8.47 ac.
- B: Assume 200 mil geocomposite calculations.

#### IV. Calculations:

for surface area 8.47 ac

Q= 
$$11.5 \text{ gpm}$$
  
Q=  $0.02562 \text{ ft}^3/\text{sec}$ 

$$T_{\text{max}} = L \frac{[4(e/k) + \tan^2 B]^{1/2} - \tan B}{2 \cos B}$$

where,

T_{max}= Thickness of groundwater in the collection layer (meters (m))

L= Length of horizontal projection of groundwater layer (m)

e= impingement rate (m/sec)

k= hydraulic conductivity of drainage layer (m/sec)

B= Slope angle of the base of groundwater collection layer (degrees)

L=350 ft L= 106.715 m use surface area (1 ac.) e= 
$$2.12E-08$$
 m/sec compressed thickness of 187 mils T= 0.00475 m Use GSE HyperNet Geonet (200 mil)  $2.0 \times 10^{-3}$  m²/sec transmissivity t= 0.000185 m²/sec Use t = t allow =  $0.002 \times [(1/1.5*1*1.2*1.5*4)]$  t allow = t ult  $[(1/RFcr \times Rfin \times RFcc \times RFbc*RFcb)]$  RFcr=Creep Reduction Factor=1.5 RFin= Intrusion Reduction Factor=1.5 RFic=Ghemical Clogging Reduction Factor=1.2 RFbc=Biological Clogging Reduction Factor=1.5 RFcb=Soil Cloggin

Therefore, the selected 200 mil thick drainage geocomposite is adequate.

The GSE Drainage Design Manual, Second Edition Chapter 2 - Fundamentals Of Geonets And Geocomposites

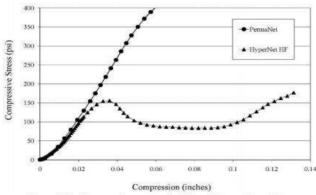


Figure 2.5. Compression strength of HyperNet vs. PermaNet.

# CITY OF KINGSVILLE MUNICIPAL SOLID WASTE LANDFILL GROUNDWATER GEOCOMPOSITE

#### B DEWATERING DRAINAGE GEOCOMPOSITE FLOW CAPACITY (cont.)

The drainage geocomposite of the underdrain has been designed to remove groundwater inflows, so the uplift pressure in the geocomposite will be that resulting from the depth of liquid contained therein.

The resulting upward hydrostatic pressure head acting on the liner (GCL, geomembrane and 2 feet of protective cover soil) is 0.1139 inches or 0.00949 feet. The factor of safety against hydrostatic uplift is calculated as follows:

Hydrostatic Uplift Pressure = 0.59 psf (.00949 feet of water head at 62.4 pcf)

Ballast Pressure = 240 psf (2 feet of protective cover at 120 pcf)

Factor of Safety = 407 > 1.2 OKAY

_____

Since the factor of safey is well above 1.2, the temporary dewatering system will provide adequate protection from uplift during its operation.

#### **APPENDIX E**

**Ballast Thickness Calculations** 

#### **EXAMPLE BALLAST THICKNESS CALCULATIONS**

Material Unit Weights:

Water = 62.4 pcf Protective Cover = 120 pcf Waste = 44.4 pcf

			Uplift Force	Top of	Protective				
	Top of	Historic High	due to	Protective	Cover			Depth of	Top of Waste
Location of	Liner	Groundwater	Groundwater	Cover	Resisting	Uplift FS from	Waste as	Waste Ballast	as Ballast
Ballast	Elevation	Elevation	Head	Elevation	Force	Protective	Ballast	Required	Elevation
Evaluation	(ft-msl)	<u>(ft-msl)</u>	<u>(psf)</u>	<u>(ft-msl)</u>	<u>(psf)</u>	Cover Only	Req'd?	(feet)	<u>(ft-msl)</u>
Sump 7B	22.5	40.55	1126.3	24.5	240.0	0.2	Y	32.6	57.1
Sump 7A	22.5	40	1092.0	24.5	240.0	0.2	Y	31.5	56.0
Sump 6B	22.5	39.35	1051.4	24.5	240.0	0.2	Y	30.1	54.6
Sump 6A	22.5	38.9	1023.4	24.5	240.0	0.2	Y	29.2	53.7
Sump 5B	22.5	38.7	1010.9	24.5	240.0	0.2	Y	28.7	53.2
Sump 5A	22.5	38.5	998.4	24.5	240.0	0.2	Y	28.3	52.8
Sump 4C	22.5	37.4	929.8	24.5	240.0	0.3	Y	26.0	50.5

See Figure III.10D-2 in Part III, Attachment 10, Appendix D for elevations of liner and historic high groundwater contours.

The last two columns above show the minimum depth of waste as ballast and minimum elevation of the top of waste placed as ballast that is required to provide sufficient resisting force to offset the uplift force due to groundwater with a Factor of Safety of 1.5 at each location selected. The evaluation point selected in each of the sectors is the worst case in each sector with the greatest groundwater head above liner.

#### FINAL FILLED CONDITION SUFFICIENT BALLAST CALCULATIONS

Material Unit Weights:

Water =  $62.4 \,\mathrm{pcf}$ 

Protective Cover = 120 pcf

Waste =  $44.4 \,\mathrm{pcf}$ 

Final Cover = 120 pcf

			Uplift Force	Top of	<u>Protective</u>					
	Top of	Historic High	due to	<u>Protective</u>	Cover	Top of	Waste	Top of Final	Final Cover	<u>Factor</u>
Location of	<u>Liner</u>	Groundwater	Groundwater	Cover	Resisting	Waste	Resisting	Cover	Resisting	<u>Of</u>
<u>Ballast</u>	Elevation	<b>Elevation</b>	<u>Head</u>	<u>Elevation</u>	<u>Force</u>	Elevation	<u>Force</u>	Elevation	<u>Force</u>	Safety
<b>Evaluation</b>	(ft-msl)	<u>(ft-msl)</u>	<u>(psf)</u>	(ft-msl)	<u>(psf)</u>	(feet)	<u>(psf)</u>	(feet)	<u>(ft-msl)</u>	
Sump 7B	<u>22.5</u>	<u>40.55</u>	<u>1126.3</u>	<u>24.5</u>	<u>240.0</u>	<u>87.01</u>	<u>2775.4</u>	90.09	<u>369.6</u>	<u>3.0</u>
Sump 7A	<u>22.5</u>	<u>40</u>	<u>1092.0</u>	<u>24.5</u>	<u>240.0</u>	<u>87.01</u>	<u>2775.4</u>	90.09	<u>369.6</u>	<u>3.1</u>
Sump 6B	<u>22.5</u>	<u>39.35</u>	<u>1051.4</u>	<u>24.5</u>	<u>240.0</u>	<u>87.01</u>	<u>2775.4</u>	90.09	<u>369.6</u>	<u>3.2</u>
Sump 6A	<u>22.5</u>	<u>38.9</u>	<u>1023.4</u>	<u>24.5</u>	<u>240.0</u>	<u>87.01</u>	<u>2775.4</u>	90.09	<u>369.6</u>	<u>3.3</u>
Sump 5B	<u>22.5</u>	<u>38.7</u>	<u>1010.9</u>	<u>24.5</u>	<u>240.0</u>	<u>87.01</u>	<u>2775.4</u>	90.09	<u>369.6</u>	<u>3.4</u>
Sump 5A	<u>22.5</u>	<u>38.5</u>	<u>998.4</u>	<u>24.5</u>	<u>240.0</u>	<u>87.01</u>	<u>2775.4</u>	90.09	<u>369.6</u>	<u>3.4</u>
Sump 4C	<u>22.5</u>	<u>37.4</u>	<u>929.8</u>	<u>24.5</u>	<u>240.0</u>	<u>86.91</u>	<u>2771.0</u>	<u>89.99</u>	<u>369.6</u>	<u>3.6</u>

The calculations above demonstrate that there is sufficient waste and cover material at each of the evaluated locations to offset groundwater uplift forces by greater than a factor of safety of 1.5. Each of the locations evaluated represent the worst case scenario within the future sectors to be constructed below the groundwater table.

# CITY OF KINGSVILLE LANDFILL PART III ATTACHMENT 11

GROUNDWATER SAMPLING AND ANALYSIS PLAN

# THE CITY OF KINGSVILLE LANDFILL TCEQ PERMIT MSW 235-C

# PERMIT AMENDMENT APPLICATION PART III, ATTACHMENT 11 GROUNDWATER SAMPLING AND ANALYSIS PLAN



### CITY OF KINGSVILLE, TEXAS

September 2018
Revision 1 – November 2018
Revision 2 – February 2019
Revision 3 – April 2019

Prepared by



HANSON PROJECT NO. 16L0438-0003

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1.2

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Item 2 – Monitor Well Field Data Sheet

Item 3 – Chain-of-Custody Form

Item 4 – TCEQ 0312 Ground Water Sampling Report

Item 5 – Laboratory Review Checklist

Item 6 – Laboratory Quality Assurance/Quality Control Manual

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#### 1.0 INTRODUCTION

The State of Texas promulgated regulations governing all aspects of municipal solid waste (MSW) management in Title 30 of the Texas Administrative Code (TAC), Chapter 330. Subchapter J, Section 330.405 (b) requires that the owners or operators of Municipal Solid Waste Landfills (MSWLFs) prepare and submit a Groundwater Sampling and Analysis Plan (GWSAP) to the Texas Commission on Environmental Quality (TCEQ). The purpose of this document is to satisfy the requirements of the above-referenced regulations as they pertain to the City of Kingsville Landfill (hereafter referred to as the Kingsville Landfill) and provide groundwater sampling procedures, frequencies, analytical parameters, monitoring data evaluation, and reporting requirements.

In accordance with TCEQ regulations, this GWSAP contains the procedures and techniques to be used to conduct Background Monitoring Statistical Evaluations, Detection Monitoring, Assessment Monitoring, and Corrective Action implementation should a significant groundwater impact be determined.

#### 1.1 Facility Description

The Kingsville Landfill is located 1.7 miles southeast of the City of Kingsville at the intersection of County Road (CR) 2130 and Farm to Market (FM) 2619 in Kleberg County, Texas. The primary land use within a one-mile radius of the site is agricultural consisting of cropland and pasture coexisting with some oil and gas production. Adjacent to the landfill on the east of the property are a series of borrow pits that have been used for the purpose of daily cover and other site soil needs. Low-density residential development is scattered throughout the one-mile radius area of the facility, with most development located to the southeast and northeast. Immediately to the east and west of the permitted facility boundary, the land use is agricultural with some oil and gas production. To the north, south, and southeast, residences are widely scattered throughout brush and agricultural areas.

#### 1.2 Groundwater Monitoring System

Based upon an understanding of the local ground water flow regime and site stratigraphy, the groundwater monitoring system will monitor the uppermost aquifer identified in the site Geology and Groundwater Characterization Reports. Analysis of the ground water level data over the life of the facility indicate that the ground water flow tends to leave the site in all directions except the northwest. Construction at the landfill should have minimal impact on ground water flow. The most likely pollutant pathway for pollutant migration in the event that the primary barrier liner system is penetrated would follow the groundwater flow away from the site. Further discussion and detail can be seen in the provided Groundwater Characterization Report (Part III, Attachment 4, Appendix 1, Section 2.0 beginning on page 762).

The completed groundwater monitoring system will be comprised of a total of twenty-two (22) monitoring wells. Monitor Wells 6RA, 15, 22R, 23, and 30 shall be considered upgradient wells until further development of waste sectors occur. The remaining 17 monitor wells shall be considered downgradient wells. All monitoring wells will be installed and monitored throughout the active life and post-closure care period of this site. The design will provide for monitoring well spacing of not more than 600 feet at the closest practicable distance to the point of compliance

(when physical obstacles preclude installation of the groundwater monitoring wells at the point of compliance), as defined in 30 TAC §330.3, that will ensure detection of groundwater contamination of the uppermost aquifer. All parts of the groundwater monitoring system shall be operated and maintained so that they perform at least to design specifications. The design of the monitoring system is based on site specific technical information gathered during multiple site investigations and further discussed in the site Geology Report included as Part III Attachment 4 of this permit, Part III Attachment 4 Appendix 1, and the Groundwater Characterization Report included as Part III Attachment 4, Appendix 1 beginning on page 752. The City of Kingsville Landfill will promptly notify the executive director, and any local pollution agency with jurisdiction that has requested to be notified, in writing of changes in facility construction or operation or changes in adjacent property that affect or are likely to affect the direction and rate of groundwater flow and the potential for detecting groundwater contamination from a solid waste management unit and that may require the installation of additional monitoring wells or sampling points and that such additional wells or sampling points require a modification of the site development plan.

A topographic and Groundwater Contour map identifying the existing and proposed monitor well locations, installed depths, property boundary, a delineation of the waste management area, and the point of compliance line has been included in Appendix A-Item 1A and B Site Layout Maps. All monitoring wells will be constructed in accordance with 30 TAC §330.421. Monitor well installation and construction details will be provided on form TCEQ-10308, or current appropriate TCEQ reporting form, upon completion. The Groundwater Monitoring System Design Certification has been included as Appendix A-Item 2.

#### 2.0 HEALTH AND SAFETY

Personnel performing water level measurements, well purging, or sampling will, at a minimum, wear latex or other equivalent non-powdered gloves. The gloves will be changed when they become damaged and when activities begin at a different well location. All personnel that are associated with the purging and sample collections from monitor wells will wear other appropriate Personal Protective Equipment (PPE) such as eye protection, safety vests, chemical resistant clothing and/or aprons, and air purifying respirators, as necessary.

#### 3.0 GROUNDWATER SAMPLING FREQUENCY

#### 3.1 Background Monitoring

At least eight (8) statistically independent background groundwater samples will be obtained on a quarterly basis prior to commencing with Detection Monitoring for each groundwater monitor well at the facility (see Appendix A, Table 1, for parameters). Background monitoring events should allow approximately 90 days between each monitoring event to allow the collection of groundwater data over the different seasons of the year.

#### 3.2 **Detection Monitoring**

After establishment of background groundwater quality, detection monitoring will be performed on a semi-annual basis at approximately 6-month intervals during the remaining operational life and post-closure care period for this facility. Detection monitoring will begin on the first semiannual monitoring event following the completion of the background monitoring establishment period.

#### 4.0 GROUNDWATER ANALYTICAL PARAMETERS

The constituents to be analyzed for both background monitoring and detection monitoring are listed in Appendix A-Table 1. The respective Practical Quantitation Limits (PQLs), analytical methods, and Chemical Abstracts Service number (CAS) are also located in Appendix A-Table 1 and Table 2.

At the conclusion of the background monitoring period, all the detection monitoring constituents will be thoroughly reviewed. As a result of this review, the City may request that the Executive Director eliminate subsequent monitoring for those constituents that were consistently below the method detection limits (MDL) throughout this period and are not expected to originate from the MSWLF unit.

#### 5.0 GROUNDWATER PURGING AND SAMPLING

The following subsections will summarize tasks involved in the purging and sampling of the groundwater monitoring wells at the facility.

#### 5.1 Well Inspection

Prior to performing any purging or sampling, each monitoring well will be inspected to assess its integrity. The visual inspection will include the lock, protective casing or collar, concrete pad, and casing for signs of damage by vandalism, animals, heavy equipment, or other causes. All necessary repairs or maintenance needed will be documented on the Monitor Well Field Data Sheet for each respective well. If it is determined that the integrity of the well has been compromised, the necessary information will be documented and the TCEQ will be notified. No additional actions will be taken without prior approval of the TCEQ.

#### 5.2 Well Headspace Screening

Upon the opening of each monitoring well, an appropriately calibrated gas meter capable of measuring methane concentrations in percent volume and combustible gases in a percentage of the Lower Explosive Limit (LEL) will be utilized to screen the well headspace for hazardous concentrations of gasses that the sampling personnel could be exposed to during the well gauging and sampling procedures. The gas meter will contain a methane specific sensor and be able to measure the percent volume of methane in air. The concentration of methane, or percentage of the LEL, will dictate what precautions will be necessary during sampling activities. If methane is detected in excess of 5.0% by volume (100% LEL), the well will be left open and allowed to vent. No work will be performed at the well until methane concentrations fall below 5.0% by volume. Results of the well headspace screening for methane will be recorded and retained in the facility operating record.

#### **5.3** Equipment Decontamination

All non-dedicated equipment used for water level measurement, purging, and/or the collection of groundwater samples will be decontaminated prior to use at each well location. An appropriate decontamination procedure consists of washing the non-dedicated equipment in a solution of Alconox, or equivalent laboratory-grade detergent, and distilled water followed by a distilled or deionized water rinse. Containers for the collection of rinsates will be utilized, as appropriate,

#### **CITY OF KINGSVILLE LANDFILL**

#### PART III, ATTACHMENT 11

#### **APPENDIX A**

TABLE 3
MONITOR WELL DESIGNATIONS

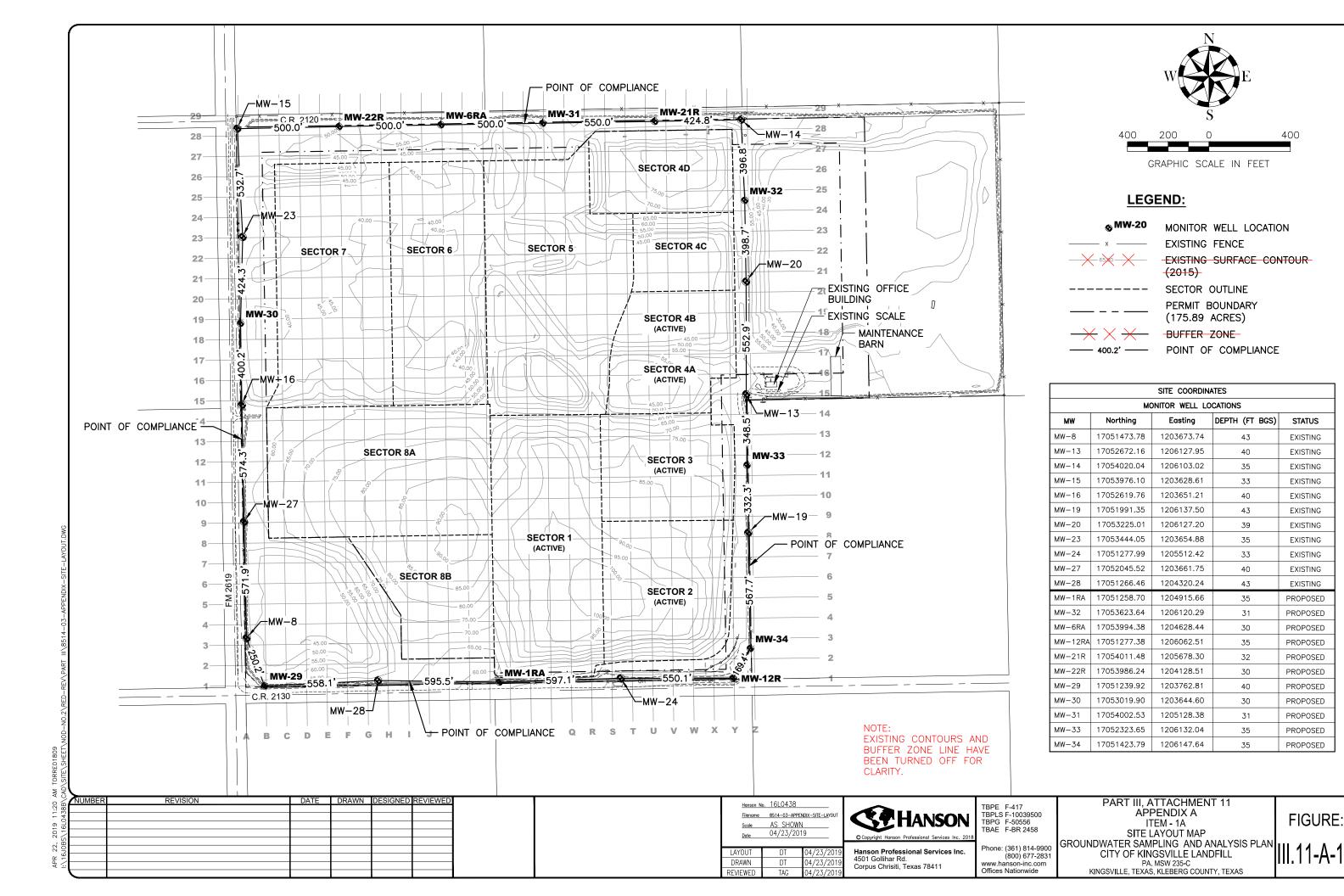
Monitor Well Designation								
Monitor Well	Sector 1	Sector 2	Sector 3	Sector 4	Sector 5	Sector 6	Sector 7	Sector 8
MW-1RA	С	С	С	С	С	С	С	С
MW-6RA	U	U	U	U	U	С	C	С
MW-8	C	C	C	C	C	C	C	C
MW-12RA	С	C	С	С	С	С	С	С
MW-13	С	C	С	С	С	С	С	C
MW-14	С	C	С	С	С	C	C	С
MW-15	U	U	U	U	U	U	U	U
MW-16	С	С	С	С	С	С	С	С
MW-19	C	C	С	C	С	С	C	С
MW-20	С	С	С	С	С	С	С	С
MW-21R	С	C	С	С	С	С	C	С
MW-22R	U	U	U	U	U	U	C	C
MW-23	U	U	U	U	U	U	U	U
MW-24	С	С	С	С	С	С	С	С
MW-27	С	С	С	С	С	С	С	С
MW-28	С	С	С	С	С	С	С	С
MW-29	С	С	С	С	С	С	С	С
MW-30	U	U	U	U	U	U	U	U
MW-31	С	С	С	С	С	С	С	С
MW-32	С	С	С	С	С	С	С	С
MW-33	С	С	С	С	С	С	С	С
MW-34	С	С	С	С	С	С	С	С

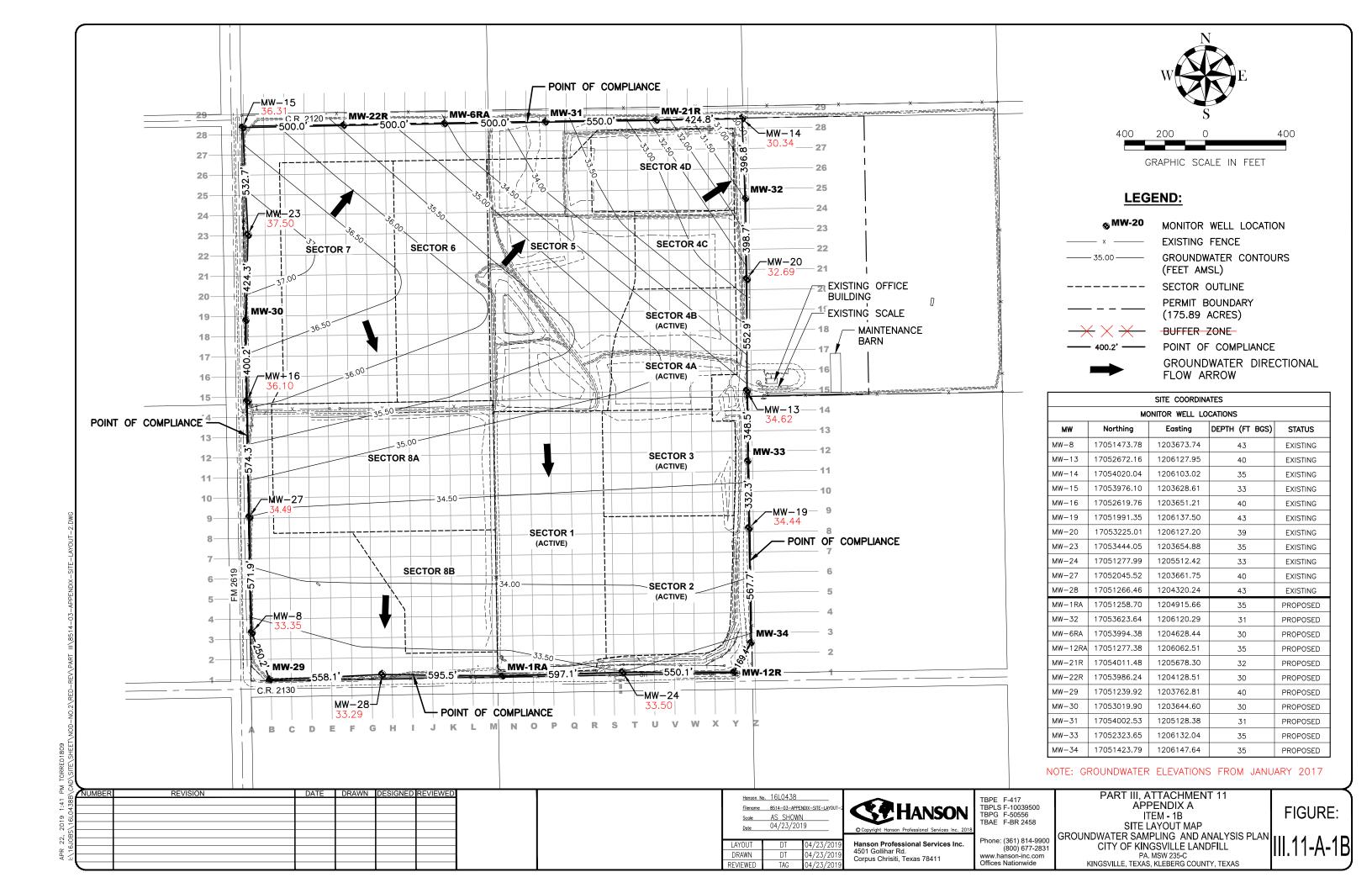
U = Upgradient Well

C = Compliance Well

# CITY OF KINGSVILLE LANDFILL PART III, ATTACHMENT 11 APPENDIX A

ITEM 1A-SITE LAYOUT MAP (TOPO)
ITEM 1B-SITE LAYOUT MAP (GW CONTOUR)





# CITY OF KINGSVILLE LANDFILL PART III ATTACHMENT 12

FINAL CLOSURE PLAN



## **Texas Commission on Environmental Quality**

## Closure Plan for Municipal Solid Waste Type I Landfill Units and Final Facility Closure

This form is for use by applicants or site operators of Municipal Solid Waste (MSW) Type I landfills to detail the plan for closure of a landfill unit, closure of associated storage or processing units, and final closure of the facility to meet the requirements in 30 TAC Chapter 330, §330.63(h) and 30 TAC Chapter 330 Subchapter K for a MSW Type I facility.

If you need assistance in completing this form, please contact the MSW Permits Section in the Waste Permits Division at (512) 239-2335.

#### I. General Information

Facility Name: The City Of Kingsville Landfill

MSW Permit No.: 235C

Site Operator/Permittee Name: City of Kingsville

# II. Landfill and Other Waste Management Units and Operations Requiring Closure at the Facility

#### A. Facility Units

Table 1. Description of Landfill Units.

Name or Descriptor of Unit	Operating Status of Unit	Type of Liner System Under Unit	Above Grade Class 1 Disposal Cells in this Unit	Below Grade Class 1 Disposal Cells in this Unit	Other Class 1 Disposal Cells in this Unit (describe)	Size of Unit's Waste Footprint (acres)	Maximum Inventory of Waste Ever in Unit (cubic yards)	Other Necessary Information that Pertains to the Unit
Type I	Active	Alternate Liner				121.3	17,994,286	
Totals							17,994,286	

#### **Closure Plan for Type I Landfill Unit and Facility**

Facility Name: The City of Kingsville Landfill Revision No.: 0-3

Permit No: 235C Date: September 12, 2018 April 25, 2019

#### C. Drawings Showing Details of the Waste Management Units at Closure

Table 4. Location of the Drawings showing Details of the Waste Management Units at Closure (outlines, dimensions, maximum elevations of waste and final cover of landfill units, and waste storage or processing units or operations at closure of the facility).

Drawing Location in the SDP	Drawing Figure Number	Drawing Title	Waste Management Units Details Shown
Part III, Attachment 1	III.1-3	Landfill Excavation Plan	Outlines, waste footprints, and dimensions of the landfill units
Part III, Attachment 1	III.1-4	Landfill Completion Plan	Maximum elevations of waste and final cover of the landfill units
Part III, Attachment 1	III.1-14	Support Area Layout	Locations and limits of storage and processing units in the support area

#### III. Description of the Final Cover System Design

#### A. Types and Descriptions of the Final Cover Systems

Table 5. Types and Descriptions of the Final Cover Systems Permitted or Proposed for Closure of the Landfill Units.

Landfill Unit Name or Descriptor	Type of Final Cover System	Final Cover System Components Description	Other Information (Enter other information as applicable)
Type I Landfill	Alternative Composite Final Cover	A six (6) inch thick (minimum) prepared soil subgrade layer; A geosynthetic clay liner (GCL) layer; A forty mil (0.04 inch) thick LLDPE geomembrane layer; A geocomposite drainage layer consisting of a synthetic drainage net and geotextile fabric; A twenty five (25) inch thick protective cover soil layer, the top seven (7) inches of which must be capable of supporting vegetation.	

#### Closure Plan for Type I Landfill Unit and Facility

Facility Name: The City of Kingsville Landfill Revision No.: 0-3

Permit No: <u>235C</u> Date: <u>September 12, 2018 April 25, 2019</u>

#### VII. Professional Engineer's Statement, Seal, and Signature

Name: Jon M. Reinhard, P.E. Title: Project Engineer

Date: September 12, 2018 April 25, 2019

Company Name: Hanson Professional Services Inc. Firm Registration Number: F-417

Professional Engineer's Seal

Signature

# THE CITY OF KINGSVILLE LANDFILL TCEQ PERMIT MSW 235C

# PERMIT AMENDMENT APPLICATION Volume 6 of 6



## CITY OF KINGSVILLE, KLEBERG COUNTY, TEXAS

September 2018
Revision 1 – November 2018
Revision 2 – February 2019
Revision 3 – April 2019

HANSON

Engineering | Planning | Allied Services

TBPE F-417

HANSON PROJECT NO. 16L0438-0003

# THE CITY OF KINGSVILLE LANDFILL TCEQ PERMIT MSW 235C

# PERMIT AMENDMENT APPLICATION PART IV



## CITY OF KINGSVILLE, KLEBERG COUNTY, TEXAS

September 2018
Revision 1 – November 2018
Revision 2 - February 2019
Revision 3 - April 2019



HANSON PROJECT NO. 16L0438-0003

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FORM 3 - SPECIAL WASTE INSPECTION FORM

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ATTACHMENT 3 - SPECIAL WASTE ACCEPTANCE PLAN

ATTACHMENT 4 - PONDED WATER PREVENTION PLAN

ATTACHMENT 5 - LIQUID WASTE SOLIDIFICATION OPERATING PLAN

#### LIST OF ACRONYMS

ADC – Alternate Daily Cover

CESQG - Conditionally Exempt Small Quantity Generator

CFC - Chlorinated Fluorocarbon

CFR – Code of Federal Regulations

DIY - Do It Yourself

EPA – Environmental Protection Agency

GLER - Geosynthetics Liner Evaluation Report

GWSAP – Groundwater Sampling and Analysis Plan

LCS – Leachate Collection System

LCWMP – Leachate and Contaminated Water Management Plan

LFG - Landfill Gas

LGMP – Landfill Gas Management Plan

LQCP - Liner Quality Control Plan

M/S – Landfill Manager/Supervisor

MSW – Municipal Solid Waste

MSWLF - Municipal Solid Waste Landfill

MSWMR – Municipal Solid Waste Management Regulations

PCB – Polychlorinated Biphenyl

RRC – Railroad Commission of Texas

SDP – Site Development Plan

SLER – Soil Liner Evaluation Report

SOP – Site Operating Plan

SOR – Site Operating Record

SPCC – Spill Prevention, Control, and Countermeasures Plan

SWAP – Special Waste Acceptance Plan

SWPPP – Stormwater Pollution Prevention Plan

TAC – Texas Administrative Code

TCEQ – Texas Commission on Environmental Quality

TPDES – Texas Pollutant Discharge Elimination System

TXDOT – Texas Department of Transportation

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should be maintained in the site operating records and should include evidence of successful completion of the training, type of training received, and the name of the instructor. The minimum level of training for the facility manager should be a Class A license as defined in §30.213. In addition, key on-site personnel should attend a course for screening for unauthorized waste.

#### 4.2.2 Wastes Prohibited From Disposal

The City of Kingsville Landfill will not accept the following types of waste for disposal:

- Municipal Hazardous Waste other than from a Conditionally Exempt Small Quantity Generator (CESQG) as defined in 30 TAC §330.171(c)(6);
- Polychlorinated Biphenyls (PCBs) as discussed in section 4.2.1;
- Class 1, Class 2, and Class 3 industrial waste;
- Do-it-yourself (DIY) used motor vehicle oil will not be intentionally or knowingly accepted for disposal per §330.15(e)(2);
- Whole used or scrap tires shall not be accepted for disposal or disposed of in any MSW landfill, unless processed prior to disposal in a manner acceptable to the executive director per §330.15(e)(4);
- Lead acid storage batteries will not be intentionally or knowingly accepted for disposal per §330.15(e)(1);
- Used oil filters from internal combustion engines will not be intentionally or knowingly accepted for disposal per §330.171(d);
- Items containing chlorinated fluorocarbon (CFC) unless all the CFC contained within them is properly managed as defined in §330.15(e)(5);
- The following special wastes without prior approval from TCEQ and accompanied with the relevant analytical test results, MSDS documents, or process knowledge documents:
  - Septic tank pumpings which have been stabilized and have passed the paint filter test;
  - Wastes from commercial or industrial wastewater treatment plants; air pollution control facilities; and tanks, drums, or containers used for shipping or storing any material that has been listed as a hazardous constituent in 40 CFR, Part 261, Appendix VIII but has not been listed as a commercial chemical product in 40 CFR Part 261.33(e) or (f);
  - Drugs, contaminated foods, or contaminated beverages, other than those contained in normal household waste;
  - o Incinerator ash:
  - Light ballasts and/or small capacitors containing PCB compounds with a PCB content less than 50 parts per million;
  - o And waste generated outside the boundaries of Texas that contains:
  - o Any industrial waste,

- 1. The active working face(s): Municipal solid waste will be unloaded at the active working face(s). Unloading of municipal solid waste at the active working face will be confined to as small an area as practical and will not exceed 30,000 square feet, or about 300 feet by 100 feet. The size of the working face will be directly impacted by the amount of waste being received and may vary accordingly. There may be one, two or three working faces open at any given time. Typically, there will be one general purpose waste unloading area. The M/S may designate up to three waste unloading areas; one for commercial customers, one for light commercial/residential customers, and one for other wastes requiring special attention or while moving a working face (i.e., establishing a working face in a new location, while covering, or during periods of emergency clean up operations (i.e., hurricane, hailstorm, flood, etc.).
- 2. White Goods and Metal Recyclable Storage Area: The white goods and metal recyclable unloading and storage area will not be larger than 20,000 square feet (100 feet by 200 feet). Large items/white goods may include ovens, dishwashers, freezers, air conditioners, and other items. These items will not be stored in excess of 180 days.
- 3. <u>Tire storage and processing area:</u> Tires will be managed in a manner that minimizes possible ponding of water in order to eliminate potential conditions that would promote disease vectors. The quantity of tires stored on-site will not exceed 500 tires on the ground (maximum storage area of 25 feet by 25 feet), or 2,000 tires in enclosed containers (maximum storage area of one standard 40 to 52 foot trailer). The tires will be processed/reduced in size to the extent practical for disposal in the landfill or sent to an authorized tire recycler. Whole used or scrap tires will not be disposed of in the landfill. Tires will not be stored in excess of 180 days.
- 4. <u>Liquid waste solidification area:</u> Liquid waste will be unloaded into one (1) of four (4) approximately eight (8) feet by 20 feet liquid tight mixing containers and will be located within a lined landfill sector. The maximum size of the liquid waste solidification area will be 30-75 feet by 50-115 feet. Bulking agents such as on-site soil, sawdust, kiln dust, coal combustion residuals, auto-fluff or other inert material with absorptive capacity will be mixed with the liquids until the resulting mixture passes the paint filter test and any other requirements outlined for the specific material. Once the liquids have been solidified, the solidified waste material will be transported and disposed of in the working face. Liquid waste will be unloaded directly into the mixing containers and solidification will begin upon receipt. See Part IV, Attachment 5 for the Liquid Waste Solidification Operating Plan.
- 5. Brush storage and processing area: Vegetative material not mixed with other wastes will be diverted to a location outside of the active disposal area and drainage ways so that they do not interfere with on-site drainage or wash off-site. The maximum size of the unloading area for brush and yard waste is 200 feet by 400 feet. Brush will be processed for mulch. Brush will not be stored in excess of 180 days.

#### 4.11.2 Site Grid System Markers §330.143(b)(5)

Site grid system markers (White) will be installed at the facility. The grid system will encompass at least the area expected to be filled within the next 3 year period. Grid markers will be maintained during the active life of the site: post-closure maintenance of the grid system is recommended but not required. The grid system will consist of lettered markers along one (1) side and numbered markers along the other perpendicular side. Markers will be spaced no greater than 100 feet apart measured along perpendicular lines. Where markers cannot be seen from opposite boundaries, intermediate markers will be installed, where feasible.

#### 4.11.3 SLER or GLER Area Markers §330.143(b)(6)

SLER or GLER area markers (Red) will be placed so that all areas for which a SLER or GLER has been submitted and approved by TCEQ are readily determinable. Such markers are to provide site workers immediate knowledge of the extent of approved disposal areas. These markers will be located so that they are not destroyed during operations until operations extend into the next SLER or GLER. The location of these markers will be tied into the site grid system and will be reported on each SLER/GLER submitted. SLER and GLER markers will not be placed inside the constructed/evaluated areas.

#### 4.11.4 100 Year Flood Limit Protection Markers §330.143(b)(7)

Flood protection markers (Blue) must be installed in any area within a solid waste disposal facility that is subject to flooding prior to the construction of flood protection levee. The area subject to flooding will be clearly marked by means of permanent posts spaced not more than 300 feet apart or closer if necessary to retain visual continuity. City of Kingsville Landfill is NOT located within a 100 year floodplain.

#### 4.11.5 Site Boundary Markers §330.143(b)(2)

Site boundary markers (Black) will be placed at each corner of the site and along each boundary line at intervals no greater than 300 feet. Fencing may be placed within these markers as required.

#### 4.11.6 Buffer Zone Markers §330.143(b)(3)

Markers (Yellow) identifying the buffer zone will be placed along each buffer zone boundary at all corners and between corners at intervals no greater than 300 feet. Placement of the landfill grid markers may be made along a buffer zone boundary.

#### 4.11.7 Permanent Benchmark §330.143(b)(8)

A permanent monument has been established at the site. The monument is established at the site in an area that is readily accessible and will not be used for disposal. The monument elevation was surveyed from a known United States Coast and Geodetic Survey benchmark. The location (NAD 27: N 27° 26' 41.95", W 97° 48' 55.89"/NAD 83: N 27; 26'; 43.08", W 97; 48'; 56.88") and elevation (52.61 ft above mean sea level) of the reference benchmark monument are provided in Part II, Attachment 1, Figure II.1-2,

# CITY OF KINGSVILLE LANDFILL PART IV ATTACHMENT 5

LIQUID WASTE SOLIDIFICATION OPERATING PLAN

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### **FIGURES**

FIGURE IV.5-1 LIQUID WASTE SOLIDIFICATION AREA LAYOUT PLAN

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#### 1.0 Background and Purpose

For those wastes sent to the Liquid Waste Solidification Area (LWSA), the LWSA site operating plan (SOP) is as follows. The LWSA SOP is to document the design and operation procedures of a liquid waste solidification/bulking operation, which will consist of four (4) approximately eight (8) feet by 20 feet liquid tight mixing containers/basins located within a lined landfill sector, constructed in accordance with 30 TAC §330.331(b), of the City of Kingsville Landfill permit boundary. The LWSA will be installed within an area that is operationally feasible where final cover has not been constructed; and will periodically be relocated because of general sequence of filling operations. The LWSA will include basins that may vary in size with a maximum number of four liquid tight mixing containers/basins — only one LWSA may be operational at one time. Processing or bulking of liquid material is typically needed to allow direct disposal to the landfill (i.e., liquid waste material requires bulking to pass the paint filter test). The liquid material collected at the facility will be bulked and disposed of in the landfill-

#### 2.0 Design

The facility will utilize a liquid tight mixing containers/basin(s), placed and secured in landfill material and soil. Wastes excavated during liquid tight mixing container/basin installation will be properly disposed at the active working face. The liquid tight mixing container/basin will be installed so that a minimum of 1 foot of the liquid tight mixing container/basin extends above the surrounding soil where the surrounding soils are graded away from the liquid tight mixing container/basin to prevent stormwater run-on into the liquid tight mixing container(s)/basin(s). A runoff/run-on control berm will be installed around perimeter of the liquid tight mixing container(s)/basin(s) and solidifying/stabilizing material storage area. This berm constructed of compacted earthen material will be a minimum of 2 foot in height unless the location of the LWSA is adjacent to a waste slope with potential for storm water run-on. In addition, the bottom of the liquid tight mixing container(s)/basin(s) will be at least 10 ft above the top of protective cover soil of the underlying constructed lining system. Figure IV.5-1, Liquid Waste Solidification Area Layout Plan shows typical layout and liquid tight mixing containers/basins and runoff/run-on control berm details.

#### 2.03.0 Liquid Waste Processing Operations

The liquids collected at the facility will be bulked (i.e., solidified) and disposed of in the landfill. The installation of a liquid processing operation at the Facility will provide an essential service for food, beverage, and other commercial and industrial facilities in the surrounding region.

Liquid waste will be unloaded into one (1) of four (4) approximately eight (8) feet by 20 feet liquid tight mixing containers/basins and will be located within a lined landfill sector. The maximum size of the liquid waste solidification area will be 30-75 feet by 50-115 feet. Bulking agents such as onsite soil, sawdust, kiln dust, coal combustion residuals, auto-fluff or other inert material with absorptive capacity will be mixed with the liquids until the resulting mixture passes the paint filter test and any other requirements outlined for the specific material. Once the liquids have been solidified, the solidified waste material will be transported and disposed of in the working face. Liquid waste will be unloaded directly into the mixing containers/basins and solidification will begin upon receipt

Dust and odors will be controlled by covering the containers/basins or by adding sawdust or wood chips to the waste.

Any rainfall or water entering the LWSA will be managed as contaminated water and will be solidified before disposal in the landfill.

Control of liquids processed at the operation will be controlled by the procedures in Part IV – Attachment 3– Special Waste Acceptance Plan. A more complete discussion of the quality control process is presented in the following sections.

#### 3.04.0 Description of Waste

Untreated liquid wastes which typically cannot pass the paint filter test include nonhazardous industrial wastes and sludges, food and beverage byproducts and other nonhazardous liquids. These liquids will generally be transported to the facility by private haulers in vacuum trucks, tank trucks, and sealed containers in accordance with §330.171(b)(3). The facility is approved to accept liquid waste by approval of this permit for processing in the LWSA. The liquids will originate from food and beverage processing plants, and other commercial and industrial facilities.

#### 4.05.0 Processing Method

The bulking/solidification process involves the addition of a solid material that will absorb the liquid and form a sludge that can pass the paint filter test to be disposed of in the landfill.

Liquid waste will be unloaded directly into the mixing containers/basins and solidification will begin upon receipt. Liquid waste will be unloaded into one (1) of four (4) approximately eight (8) feet by 20 feet liquid tight mixing containers/basins located within a lined landfill sector.

Bulking agents will be mixed with the liquids until the resulting mixture passes the paint filter test and any other requirements outlined for the specific material. The bulking agent used in the liquid waste solidification process will be soil, sawdust, kiln dust, coal combustion residuals, auto-fluff or other inert material with absorptive capacity as approved by the Texas Commission on Environmental Quality (TCEQ).

Once the liquids have been solidified, the solidified waste material will be transported and disposed of in the working face.

The bulking process has the advantages of being a simple process that does not require discharge to a wastewater treatment plant.

#### 5.06.0 Monitoring

Incoming liquid waste will be documented on a Part IV, Attachment 1, Form 3 – Special Waste Inspection Form, or other required manifest. Incoming waste will also be pre-characterized by the generator in accordance with the facility's approved waste acceptance procedures listed in the Part IV – Attachment 3. The pre-characterization will include analytical analysis and/or process information as necessary to make the determination that the waste is nonhazardous. No waste material will be accepted at the site that is not precharacterized or does not have the proper manifest(s).

The landfill may request and use additional information to assist in evaluating an industrial or non-industrial liquid waste for management at the Facility. Such information includes, but is not limited to, analytical data, product and/or raw component Material Safety Data Sheets (MSDS), additional waste composition data, and pertinent letters or memoranda

Upon arrival, each load shall be verified and the shipment compared to the waste approval records for conformity. Any discrepancy which cannot be rectified will result in the rejection of the load.

#### 6.07.0 Storage and Processing

Accepted loads of liquids will be directed to the LWSA for discharge into the mixing containers/basins and solidification will begin upon receipt. Bulked wastes will pass a paint filter test (EPA SW-846/9095) before disposal at the landfill working face.

Operation of the facility will include the following:

- Control of dust by wetting the roads and facility area and covering the bulking agents when not in use.
- Control of odors by covering the containers/basins, or using sawdust or wood chips for temporary odor masking.
- Protect the health and environment of employees, citizens, and surrounding communities by operating the facility in accordance with TCEQ, EPA, OSHA, and other applicable regulations.

Facility personnel will be trained in the bulking/solidification procedure, acceptable testing method, recognition of waste streams and their compatibility, daily operations, recordkeeping and reporting, implementation of emergency procedures, fire protection, and regulations pertaining to liquid waste disposal as set forth by the TCEQ.

### 7.08.0 Testing and Recordkeeping

The testing and recordkeeping requirements are listed below.

- The Paint Filter Liquid Test (EPA Method SW-846/9095) is required immediately prior to disposal of the waste in the landfill. Representative grab samples shall be obtained at a rate of one per batch of treated material.
- Records concerning the type, quantity, source, and test results of liquid wastes processed shall be maintained on a daily basis, and become part of the site operating record.

### 8.09.0 Training of Operational Personnel

Personnel involved in the bulking/ shall receive adequate training in the bulking procedure, acceptable testing method, recognition of waste streams and their compatibility, daily operations, recordkeeping and reporting, implementation of emergency procedures, and regulations pertaining to liquid waste disposal.

#### 9.010.0 Closure

All liquid wastes will be treated and disposed of in the landfill or an off-site permitted disposal facility. A notice will be sent to the TCEQ and placed in the Site Operating Record noting the specific steps taken to decommission the facility.

#### **10.011.0** Fire Protection

Landfill personnel, including equipment operators, will watch for signs of fire at the liquid waste solidification area. Landfill personnel will watch for fire, smoke, steam, or signs of heat. If signs of fire are detected at the liquid waste solidification area, all vehicles and equipment will be immediately moved away from the fire. The unloading of materials will either be relocated to a safe location away from the fire and a collection area established there or halted all together until the fire is extinguished.

If detected soon enough, a small fire may be fought with a hand-held fire extinguisher. The fire area may be watered down or smothered with 6 inches of soil, as appropriate, to ensure that the fire is out.

If the fire cannot be quickly extinguished with the fire extinguisher, the bulldozer, earth moving equipment, and water truck will immediately mobilize to the site of the fire. All available landfill personnel will assist with fire protection measures unless otherwise directed by the M/S.

Fire fighting methods for processed liquid wastes or bulking agents include smothering with soil, separating burning material from other waste, spraying with water from an on-site water truck, or pumping with water from an on-site pond. The burning material should be isolated or pushed away immediately before the fire can spread, or fire breaks should be cut around the fire before it can spread. If moving the material is not possible, or if it is unsafe, efforts should be made to cover the burning area with earth immediately to smother the fire.