PART I FORM UPDATES

(includes Applicant's Certification Statement)

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

Facility Name: Fairbanks Landfill
County: Harris
TCEQ Region-12

MSW Authorization #:1565B
Initial Submittal Date:8/30/2013
Revision Date:3/3/2014

Texas Commission on Environmental Quality

Part I Form

New Permit/Registration and Amendment Applications for an MSW Facility

1. Reason for Submittal

☐ Initial Submittal ☒ Notice of Deficiency (NOD) Response

2. Authorization Type

☒ Permit ☐ Registration

3. Application Type

☐ New ☒ Major Amendment

☐ Major Amendment (Limited Scope)

4. Application Fees

☐ Pay by Check ☒ Online Payment

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

5. Application URL

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

☐ Yes ☒ No

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

6. Application Publishing

Party Responsible for Publishing Notice:

☐ Applicant ☐ Agent in Service ☒ Consultant

Ocean Dumping Permits under the Marine Protection Research and Sanctuaries Act	☐	☐	☒
Dredge or Fill Permits under the FCAA	☐	☐	☒
Licenses under the Texas Radiation Control Act	☐	☐	☒
Subsurface Area Drip Dispersal System Permits under Texas Water Code, Chapter 32	☐	☐	☒

Other Environmental Permits

Harris County Flood Control District (HCFCD) Drainage Impact Analysis Review for Fairbanks Landfill Expansion - Approval received 12/19/2012 (HCFCD letter of "no objection").

Petroleum Storage Tank Registration No. 56952 - Received (inactive).

12. General Facility Information

Facility Name: Fairbanks Landfill

MSW Authorization No. (if available): 1565B

Regulated Entity Reference No. (if issued)*: RN100218544

Physical or Street Address (if available): 8205 Fairbanks N Houston Rd

City: Houston County: Harris State: TX Zip Code: 77064

(Area Code) Telephone Number: (713) 824-6867

Latitude: N 29 Deg 53' 59.78" Longitude: W 95 Deg 31' 36.40"

Benchmark Elevation (above mean sea level): 105.74ft.

Provide a description of the location of the facility with respect to known or easily identifiable landmarks: Located approx. 14 miles northwest of downtown Houston, inside the northwest corner of Beltway 8 (Sam Houston Tollway), and approx. 2 miles east of Jersey Village.

Detail access routes from the nearest United States or state highway to the facility: The site is located on the west side of Fairbanks N Houston Rd, 2.7 miles north of the intersection of US 290 (Northwest Freeway) and Fairbanks N Houston Rd

*If this number has not been issued for the facility, complete a TCEQ Core Data Form (TCEQ-10400) and submit it with this application. List the Facility as the Regulated Entity.

13. Facility Type(s)

☐ Type I	☒ Type IV	☐ Type V
☐ Type I AE	☐ Type IV AE	☐ Type VI

14. Activities Conducted at the Facility

☐ Storage	☐ Processing	☒ Disposal

15. Facility Waste Management Unit(s)

☒ Landfill Unit(s)	☐ Incinerator(s)
☐ Class 1 Landfill Unit(s)	☐ Autoclave(s)
☐ Process Tank(s)	☐ Refrigeration Unit(s)
☐ Storage Tank(s)	☐ Mobile Processing Unit(s)
☐ Tipping Floor	☐ Type VI Demonstration Unit
☐ Storage Area	☐ Compost Pile(s) and/or Vessel(s)
☐ Container(s)	☒ Other (Specify) Wood Recycling Area
☐ Roll-off Boxes	☒ Other (Specify) Large/Heavy/Bulky Item Area
☐ Surface Impoundment	☒ Other (Specify) C&D Waste Recycling Area

16. Description of the Revisions to the Facility

Skip this box, if "New" is selected under "Application Type".

Provide a brief description of all revisions to the permit conditions and supporting documents referenced by the permit. Also, provide an explanation of why the amendment is requested.
This application is for a major amendment to the permit for a lateral and vertical expansion at the existing Fairbanks Landfill, a Type IV landfill facility. The application is composed of Parts I through IV in accordance with 30 TAC 330.57. The amendment is requested to increase the volume and extend the site life, to thereby provide for the long-term solid waste disposal needs for the individuals, businesses, and communities in Harris County and surrounding areas.

17. Facility Contact Information

Site Operator (Permittee/Registrant) Name: USA Waste of Texas Landfills, Inc.

Customer Reference No. (if issued)*: CN602560930

Mailing Address: 9821 Katy Freeway, Suite 700 Attn: Chuck Rivette

City: Houston County: Harris State: TX Zip Code: 77024

(Area Code) Telephone Number: (713) 647-5542

Email Address: crivette@wm.com

TX Secretary of State (SOS) Filing Number: 8836806

*If the Site Operator (Permittee/Registrant) does not have this number, complete a TCEQ Core Data Form (TCEQ-10400) and submit it with this application. List the Site Operator (Permittee/Registrant) as the Customer.

Operator Name[1]: Same as Site Operator (Permittee)

Customer Reference No. (if issued)*:

Mailing Address:

City: County: State: Zip Code:

(Area Code) Telephone Number:

Email Address:

TX SOS Filing Number:

[1]If the Operator is the same as Site Operator/Permittee type "Same as "Site Operator (Permittee/Registrant)".
*If the Operator does not have this number, complete a TCEQ Core Data Form (TCEQ-10400) and submit it with this application. List the Operator as the customer.

Consultant Name (if applicable): Geosyntec Consultants

Texas Board of Professional Engineers Firm Registration Number: 1182

Mailing Address: 8217 Shoal Creek Blvd, Suite 200 Attn: Scott M. Graves, P.E.

City: Austin County: Travis State: TX Zip Code: 78757

(Area Code) Telephone Number: (512) 451-4003

E-Mail Address: sgraves@geosyntec.com

Agent in Service Name (required only for out-of-state): CT Corporation System

Mailing Address: 350 North St. Paul Street, Ste 2900

City: Dallas County: Dallas State: TX Zip Code: 75201-4234

(Area Code) Telephone Number: 214-979-1172

E-Mail Address: -

18. Facility Supervisor's License

Select the Type of License that the Solid Waste Facility Supervisor, as defined in 30 TAC Chapter 30, Occupational Licenses and Registrations, will obtain prior to commencing facility operations.

☒ Class A ☐ Class B

19. Ownership Status of the Facility

☒ Corporation	☐ Limited Partnership	☐ Federal Government
☐ Individual	☐ City Government	☐ Other Government
☐ Sole Proprietorship	☐ County Government	☐ Military
☐ General Partnership	☐ State Government	☐ Other (Specify):

Signature Page

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

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

Signature: _____ Date: 3-3-2014

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

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

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

_____
Printed or Typed Name of Operator or Principal Executive Officer

_____
Signature

SUBSCRIBED AND SWORN to before me by the said Steve Jacobs
On this 3rd day of March, 2014
My commission expires on the 27th day of July, 2016
Jill Beardsley
Notary Public in and for State of Texas
Travis County, Texas
(Note: Application Must Bear Signature & Seal of Notary Public)

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

REPLACEMENT PAGES

The items that follow are to completely replace the previous versions of those pages. For convenience, divider tabs are provided to indicate which portion of the application the revisions pertain to.

Prepared for:

USA Waste of Texas Landfills, Inc.

PERMIT AMENDMENT APPLICATION

PART I – SITE AND APPLICANT INFORMATION

SUPPLEMENTAL TECHNICAL REPORT

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



SEALED FOR THIS PART I SUPPLEMENTAL TECHNICAL REPORT, AND FOR PERMITTING PURPOSES ONLY.

WITHIN EACH APPENDIX, ITEMS THAT REQUIRE A SIGNATURE AND SEAL BY A LICENSED PROFESSIONAL (E.G., ENGINEER, SURVEYOR, OR GEOSCIENTIST) ARE SIGNED, SEALED, AND DATED, AS APPROPRIATE, BY THE RESPONSIBLE PROFESSIONAL.

Prepared by:

Geosyntec consultants

Texas Board of Professional Engineers Firm Registration No. F-1182
3600 Bee Caves Road, Suite 101
Austin, Texas 78746
(512) 451-4003

Submitted August 2013
Revised March 2014

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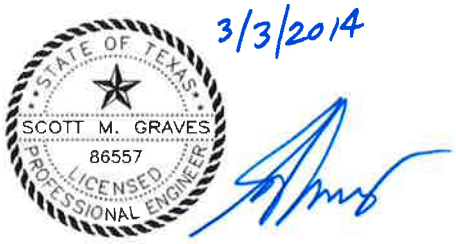


FOR PERMIT PURPOSES ONLY

APPENDICES

WITHIN EACH APPENDIX, ITEMS THAT REQUIRE A SIGNATURE AND SEAL BY A LICENSED PROFESSIONAL (E.G., ENGINEER, SURVEYOR, OR GEOSCIENTIST) ARE SIGNED, SEALED, AND DATED, AS APPROPRIATE, BY THE RESPONSIBLE PROFESSIONAL.

Appendix IA General Location Maps
Appendix IB Adjacent Land Ownership Map and List
Appendix IC Permit Boundary, Property Ownership, and Easement Information
Appendix ID Property Owner Affidavit and Legal Authority
Appendix IE Evidence of Competency
Appendix IF Appointment Letters

4. PROPERTY AND OWNER INFORMATION

This section provides property and owner-related information, to address the requirements of 30 TAC §330.59(d) through (h).

4.1 Legal Description of Facility

A legal description of the Fairbanks Landfill facility permit boundary, prepared, signed, and sealed by a Texas Registered Professional Land Surveyor with Martin Surveying Associates, Inc., is presented in Appendix IC. This legal description of the facility in Appendix IC includes the following:

- a boundary metes and bounds legal description of the facility, which references the legal description of the affected property parcels from the Harris County real property records, and also indicates the Texas survey abstract numbers; and

- a survey drawing of the facility metes and bounds description, titled "Permit Boundary, Fairbanks Landfill".

Both the written legal description and the survey drawing include reference to the current ownership record of the affected property parcels (also discussed further in the section below). Copies of deeds are also provided in Appendix IC as backup documentation. The survey drawing shows the portion of the facility that was originally platted and provides the identifying reference to the Harris County Deed Records (HCDR) of the platted area and identification of the platted lot numbers.

4.2 Property Ownership

The proposed permit boundary will encompass several parcels of land, as shown on the survey drawing of the permit boundary in Appendix IC. USA Waste of Texas Landfills, Inc. owns, or will be the future owner, of all land within the permit boundary, as explained subsequently in this section. There are no individuals who have over a 20% ownership in USA Waste of Texas Landfills, Inc.

The permit boundary survey drawing in Appendix IC identifies the owner of each parcel within the permit boundary, and indicates the corresponding ownership deed record number from the real property records of Harris County (i.e., Harris County Clerk's File (HCCF) deed records or the Harris County Map Records (HCMR)), which are identifying reference numbering systems used by Harris County. This information is summarized below in Table I-2, which also identifies the ownership status for Permit No. MSW-1565B.

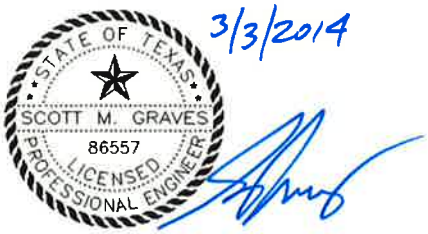
Prepared for:
USA Waste of Texas Landfills, Inc.

PERMIT AMENDMENT APPLICATION

PART II – EXISTING CONDITIONS SUMMARY AND CHARACTER OF THE FACILITY AND SURROUNDING LAND

SUPPLEMENTAL TECHNICAL REPORT

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



SEALED FOR THIS PART II SUPPLEMENTAL TECHNICAL REPORT, AND FOR PERMITTING PURPOSES ONLY.

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Prepared by:

Geosyntec consultants
Texas Board of Professional Engineers Firm Registration No. F-1182
3600 Bee Caves Road, Suite 101
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Submitted August 2013
Revised March 2014

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3/3/2014

STATE OF TEXAS
SCOTT M. GRAVES
86557
LICENSED
PROFESSIONAL ENGINEER

SEALED FOR THIS PART II SUPPLEMENTAL TECHNICAL REPORT, AND FOR PERMITTING PURPOSES ONLY.

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3/3/2014

STATE OF TEXAS
SCOTT M. GRAVES
86557
LICENSED
PROFESSIONAL ENGINEER

SEALED FOR THIS PART II SUPPLEMENTAL TECHNICAL REPORT, AND FOR PERMITTING PURPOSES ONLY.

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SEALED FOR THIS PART II SUPPLEMENTAL TECHNICAL REPORT, AND FOR PERMITTING PURPOSES ONLY.

APPENDICES

WITHIN EACH APPENDIX, ITEMS THAT REQUIRE A SIGNATURE AND SEAL BY A LICENSED PROFESSIONAL (E.G., ENGINEER OR GEOSCIENTIST) ARE SIGNED, SEALED, AND DATED, AS APPROPRIATE, BY THE RESPONSIBLE PROFESSIONAL.

Appendix IIA Maps and Drawings
Appendix IIB Land Use Study
Appendix IIC Transportation Study (Roads and Traffic)
Appendix IID Airports and Aviation Information
Appendix IIE General Geology and Soils
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Appendix IIJ Texas Historical Commission (THC), Antiquities Code Documentation
Appendix IIK Houston-Galveston Area Council (H-GAC) of Governments Documentation
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Ancillary site facilities located outside the permitted waste disposal areas are the entrance facilities (entrance/exit road, scales and scale house/office area), perimeter access roads, surface water drainage features, groundwater monitoring wells, and landfill gas monitoring and control systems. In addition to waste disposal, the following recycling activities will occur on-site: (i) a staging area to collect large/heavy/bulky items (e.g., appliances) for recycling or salvaging; (ii) a wood recycling area; and (iii) a construction and demolition (C&D) waste recycling area. These areas are described in the Part III narrative report, and their operations are discussed in Part IV (the SOP).

1.4 Organization of Part II Supplemental Technical Report

The remainder of this report is organized as follows:

- information on the waste sources, generation area, and waste characteristics is presented in Section 2;
- the facility location is discussed in Section 3;
- the facility layout is discussed in Section 4;
- a land use evaluation and discussion on the facility's potential impact on the surrounding area is addressed Section 5;
- information on transportation (roads, traffic, airports) is presented in Section 6;
- information on geologic conditions and soils is addressed in Section 7;
- information on groundwater and surface water conditions at and near the site are addressed in Section 8;
- abandoned oil and gas wells and existing water wells situated within the facility are discussed in Section 9;
- floodplains data and wetlands are discussed in Section 10;
- information on endangered or threatened species is discussed in Section 11;
- compliance with the Texas Antiquities Code and related Texas Historical Commission documentation is addressed in Section 12;

2. WASTE ACCEPTANCE PLAN

This section provides information on waste acceptance to address 30 TAC §330.61(b); including a description of the waste characteristics, anticipated facility service area, and a five-year projection of the estimated maximum annual waste acceptance rate.

2.1 Waste Characteristics

The facility is a Type IV landfill. In accordance with 30 TAC §330.5(a)(2) the facility may accept brush, construction waste, demolition waste, and/or rubbish. The facility may not accept putrescible wastes, conditionally exempt small-quantity generator waste, or household wastes. More detailed lists of the allowable and prohibited wastes are provided below.

Allowable Wastes: The facility may accept the following wastes:

- brush;
- construction waste;
- demolition waste;
- rubbish;
- inert material (both natural and man-made);
- Class 2 industrial solid waste that is free of putrescible waste;
- Class 3 industrial solid waste;
- special wastes as allowed by 30 TAC §330.171(a), including non-regulated asbestos-containing materials (non-RACM) and empty containers that meet the requirements of 30 TAC §330.171(c)(5) and which have been used for pesticides, herbicides, fungicides, or rodenticides;
- soils contaminated by petroleum products with concentrations of less than 1,500 milligrams per kilogram total petroleum hydrocarbons;
- trash;
- yard waste that is free of putrescible and household waste; and
- scrap tires that have been slit and quartered or shredded and do not come from a tire disposer/recycler who is reimbursed from the State Waste Tire Recycling Fund (note that these scrap tires, if accepted, will not be received for storage or processing – only disposal).

Prohibited Wastes: The facility may not accept the following wastes:

- putrescible wastes;
- conditionally exempt small-quantity generator waste;
- household wastes;
- regulated hazardous waste;

- Class 1 nonhazardous industrial waste;
- special wastes (with the exception of those allowable special wastes noted in the above list of wastes that may be accepted);
- regulated asbestos-containing materials (RACM);
- radioactive waste;
- prohibited polychlorinated biphenyls (PCB) waste;
- liquid waste;
- water and wastewater treatment sludges;
- grease/grit trap waste;
- lead acid storage batteries;
- used motor vehicle oil;
- used oil filters from internal combustion engines;
- whole tires;
- wastes incompatible with landfilling activities.

2.2 Facility Service Area

2.2.1 Waste Sources and Generation Areas

This section describes the general sources of waste and the anticipated landfill service area (i.e., those generation areas contributing wastes to the facility). As mentioned, as a Type IV landfill, the facility will be accepting brush, construction waste, demolition waste, and/or rubbish. As the Type IV landfill waste-stream designation suggests, in general these types of wastes are from sources such as: for-hire construction projects (e.g., new commercial building and home construction, renovations/remodeling, repairs, and demolition of related infrastructure and pavements) and from site-work (e.g., landscaping, clearing, dredging, maintenance). The Fairbanks Landfill will serve individuals, businesses, and communities in Harris County and surrounding Texas counties. In general, it is anticipated that the primary landfill service area will be the portions of Harris County north and west of downtown Houston, southern Montgomery County, and eastern Waller County.

2.2.2 Population Served

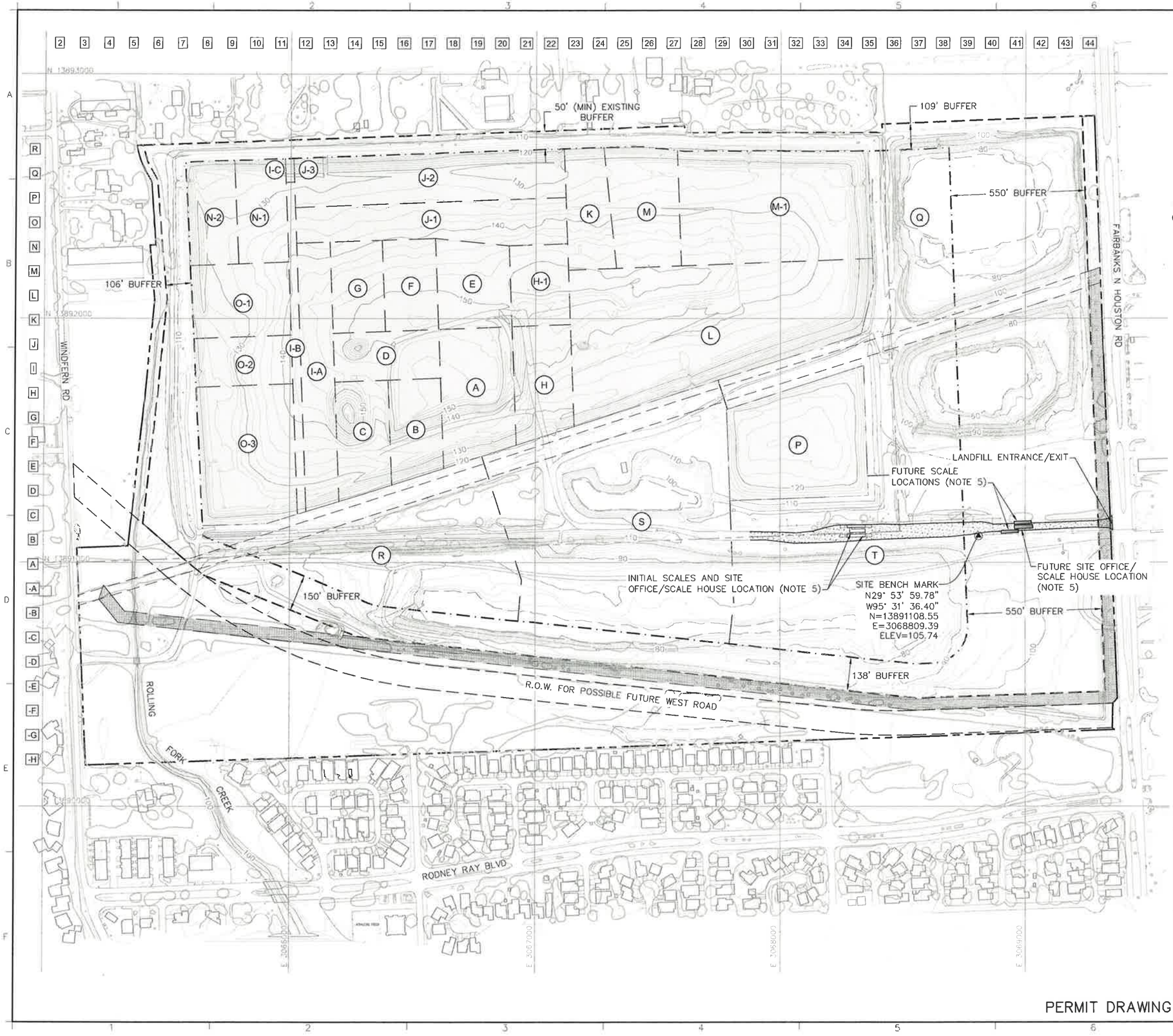
As noted earlier in this section, in general the primary landfill service area is expected to be the portions of Harris County north and west of downtown Houston, southern Montgomery County, and eastern Waller County. The estimated population served by the facility is as follows:

- Year 1: 1,119,000 persons; and

APPENDIX IIA

GENERAL MAPS AND DRAWINGS

LIST OF DRAWINGS		
Drawing No.	Title	Drawing Date (latest revision)
IIA-1	Highway Map	August 2013
IIA-2	General Topographic Map	August 2013
IIA-3	Aerial Photograph	August 2013
IIA-4	General Land Use Map	August 2013
IIA-5	Airport Map	August 2013
IIA-6	Structures and Inhabitable Buildings Map	August 2013
IIA-7	Water Wells Map	August 2013
IIA-8	Oil and Gas Wells Map	August 2013
IIA-9	Drainage, Pipeline, and Utility Easements Map	August 2013
IIA-10	Facility Layout Plan	March 2014
IIA-11	Groundwater and Landfill Gas Monitoring Plan	August 2013
IIA-12	Sector Layout Plan	August 2013
IIA-13	Phase Development Plan 1	August 2013
IIA-14	Phase Development Plan 2	August 2013
IIA-15	Phase Development Plan 3	August 2013
IIA-16	Phase Development Plan 4	August 2013
IIA-17	Landfill Completion Plan	March 2014
IIA-18	Landfill Entrance Area Plan	August 2013



LEGEND

- EXISTING GROUND ELEVATION (FT, MSL) (NOTE 1)
- EXISTING ROAD (NOTE 4)
- EXISTING FENCE
- EXISTING VEGETATION
- EXISTING WATER LINE
- N 13893000 E 3069000 — STATE PLANE COORDINATES (NOTE 2)
- 44 — SITE GRID
- PROPERTY BOUNDARY
- EXISTING (PERMIT MSW-1565A) PERMIT BOUNDARY
- EXISTING (PERMIT MSW-1565A) LANDFILL FOOTPRINT
- EXISTING ASPHALT-PAVED SITE ACCESS ROAD (NOTE 4)
- PERMIT BOUNDARY
- PROPOSED LANDFILL FOOTPRINT
- SECTOR BOUNDARY
- Q — SECTOR DESIGNATION
- ENTERPRISE CRUDE PIPELINE EASEMENT (TO BE RELOCATED)
- FUTURE (RELOCATED) ENTERPRISE CRUDE PIPELINE EASEMENT

N

0 200' 400'
SCALE IN FEET

NOTES:

1. WITHIN THE ENTIRE EXTENT OF THE MAPPING SHOWN ON THIS DRAWING, THE BASE MAP TOPOGRAPHY AND EXISTING FEATURES WAS COMPILED USING PHOTOGRAMMETRIC METHODS BASED ON AERIAL PHOTOGRAPHY PERFORMED ON 26 MARCH 2012 AND PREPARED BY DALLAS AERIAL SURVEYS (DAS), INC.
2. ELEVATIONS ARE IN FEET ABOVE MEAN SEA LEVEL (FT, MSL), AS DEFINED BY THE USGS NATIONAL GEODETIC VERTICAL DATUM (NAVD) OF 1988. STATE PLANE COORDINATE GRID CORRESPONDS TO TEXAS STATE PLANE COORDINATE SYSTEM, TEXAS SOUTH CENTRAL ZONE (4204), NORTH AMERICAN DATUM OF 1983 (NAD-83).
3. FACILITY ACCESS CONTROL FEATURES: THE ENTIRE PERIMETER OF THE FACILITY SHALL BE FENCED. THE MAIN LANDFILL ENTRANCE/EXIT HAS A GATE THAT IS LOCKED AT TIMES WHEN THE FACILITY IS NOT OPEN. REFER TO PART III, SECTION 2.2 OF THE NARRATIVE REPORT FOR FURTHER DETAILS.
4. MAIN ENTRANCE ROAD IS ASPHALT-PAVED WHERE SHOWN. FROM WHERE THE ASPHALT ENDS, THE ROADS USED TO ACCESS FILL AREAS ARE ALL-WEATHER (E.G. GRAVEL).
5. SCALES AND SITE OFFICE/SCALE HOUSE WILL BE RELOCATED FROM INITIAL LOCATION TO FUTURE LOCATION WHEN LANDFILL DEVELOPMENT AFFECTS THE INITIAL LOCATION (AT THE LATEST). REFER TO PART II, DRAWING IIA-18 FOR MORE INFORMATION.
6. BESIDES THE BUFFERS SHOWN ON THIS DRAWING, THERE ARE NO SPECIFIC PROVISIONS FOR THE MAINTENANCE OF NATURAL WINDBREAKS OR PLANS FOR SCREENING THE FACILITY FROM PUBLIC VIEW. NOTE THAT NEW PROPOSED AREAS DUE TO THE EXPANSION TO THE SOUTH AND EAST WILL MAINTAIN LARGER BUFFERS THAN THE REQUIRED 50-FT MINIMUM, AND THIS GREATER SET-BACK DISTANCE WILL HELP SCREEN THE FACILITY FROM PUBLIC VIEW.

STATE OF TEXAS
SCOTT M. GRAVES
86557
LICENSED
PROFESSIONAL ENGINEER
3/3/2014

FOR PERMIT PURPOSES ONLY

REV	DATE	DESCRIPTION	DRN	APP
1	MAR. 2014	REVISED, RESPONSE TO NOD 1	JJV/KH	SMG
-	AUG. 2013	INITIAL SUBMITTAL TO TCEQ	JJV	SMG

USA WASTE OF TEXAS LANDFILLS, INC.

LANDFILL SITE ADDRESS:
8205 FAIRBANKS N HOUSTON RD
HOUSTON, TEXAS 77064
PHONE: 713.824.6867

Geosyntec consultants

GEOSYNTEC CONSULTANTS, INC.
TEXAS ENG. FIRM REGISTRATION NO. 1182
8217 SHOAL CREEK BLVD, SUITE 200
AUSTIN, TEXAS 78757
PHONE: 512.451.4003

TITLE: FACILITY LAYOUT PLAN

PROJECT: FAIRBANKS LANDFILL
PERMIT AMENDMENT APPLICATION – PERMIT NO. MSW-1565B

PROJECT NO.: TXL0263	DESIGN BY: JJV	REVIEWED BY: BK	PART NO.: II	DRAWING: IIA-10
FILE: 0263F18	DRAWN BY: JJV	APPROVED BY: SMG		

PERMIT DRAWING

DRAWING: Austin P:\CADD\Projects\F\Fairbanks Landfill\Permit\Expansion (TXL0263)\Drawings\Dwgs-Rev0\0263F18.dwg PLOTTED: Feb. 28, 2014 - 11:00am





LEGEND

- 100 — EXISTING GROUND ELEVATION (FT, MSL) (NOTES 1,2)
- EXISTING ROAD
- EXISTING FENCE
- EXISTING WATER LINE
- STATE PLANE COORDINATES (NOTE 2)
- 44 — SITE GRID
- PROPERTY BOUNDARY
- PROPOSED PERMIT BOUNDARY
- OVERALL LIMIT OF FINAL COVER
- FINAL COVER DRAINAGE TERRACE
- FINAL COVER DOWNCHUTE
- 200 — PROPOSED GROUND ELEVATION (FT, MSL) (NOTE 3)

NOTES:

1. THE EXISTING TOPOGRAPHIC BASE MAP SHOWN ON THIS DRAWING WAS COMPILED USING PHOTOGRAMMETRIC METHODS BASED ON AERIAL PHOTOGRAPHY PERFORMED ON 26 MARCH 2012 AND PREPARED BY DALLAS AERIAL SURVEYS (DAS), INC.
2. ELEVATIONS ARE IN FEET ABOVE MEAN SEA LEVEL (FT, MSL), AS DEFINED THE USGS NATIONAL GEODETIC VERTICAL DATUM (NAVD) OF 1988. STATE PLANE COORDINATE GRID CORRESPONDS TO THE TEXAS STATE PLANE COORDINATE SYSTEM, TEXAS SOUTH CENTRAL ZONE (4204), NORTH AMERICAN DATUM OF 1983 (NAD 83).
3. TOP OF FINAL COVER SYSTEM REFERS TO THE PROPOSED FINISHED GRADE (TOP OF THE TOPSOIL COMPONENT OF THE FINAL COVER SYSTEM). LIMIT OF FINAL COVER SYSTEM REFERS TO THE TOE OF SLOPE OF THE TOPSOIL LAYER.
4. OUTSIDE OF THE LIMIT OF FINAL COVER, THE PROPOSED CONTOURS REFER TO FINISHED GRADE.
5. REFER TO PART III, ATTACHMENT 2, DRAWING 2-1 FOR ADDITIONAL SURFACE WATER MANAGEMENT FEATURES ON THE FINAL COVER SYSTEM (NOT SHOWN ON THIS DRAWING FOR CLARITY).
6. ⚠1 TOP OF FINAL COVER ELEVATIONS ARE FOR THE 2-FT THICK FINAL COVER SYSTEM SHOWN ON DETAIL 2 ON DRAWING 3-11. AS INDICATED ON NOTE 4 OF DRAWING 3-11, A TOPSOIL LAYER THAT IS AN ADDITIONAL 6-INCHES THICKER (I.E., 1-FT THICK INSTEAD OF 0.5-FT THICK) MAY BE REQUIRED, DEPENDING ON THE ACTUAL SOIL CLASSIFICATION OF THE COMPACTED SOIL INFILTRATION LAYER AT THE TIME OF FINAL COVER CONSTRUCTION OF A GIVEN AREA, RESULTING IN A 2.5-FT THICK FINAL COVER. IF THIS OCCURS ALONG THE PEAK RIDGELINE OF THE LANDFILL, THE MAXIMUM FINAL COVER ELEVATION WOULD BE ELEVATION 250.5 FT, MSL INSTEAD OF THE 250.0 FT, MSL SHOWN.

STATE OF TEXAS
SCOTT M. GRAVES
86557
LICENSED
PROFESSIONAL ENGINEER
3/3/2014

FOR PERMIT PURPOSES ONLY

REV	DATE	DESCRIPTION	DRN	APP
⚠1	MAR. 2014	REVISED, RESPONSE TO NOD 1	JJV/KH	SMG
–	AUG. 2013	INITIAL SUBMITTAL TO TCEQ	JJV	SMG

USA WASTE OF TEXAS LANDFILLS, INC.

LANDFILL SITE ADDRESS:
8205 FAIRBANKS N HOUSTON RD
HOUSTON, TEXAS 77064
PHONE: 713.824.6867

Geosyntec consultants

GEOSYNTEC CONSULTANTS, INC.
TEXAS ENG. FIRM REGISTRATION NO. 1182
8217 SHOAL CREEK BLVD, SUITE 200
AUSTIN, TEXAS 78757
PHONE: 512.451.4003

TITLE:
LANDFILL COMPLETION PLAN

PROJECT:
FAIRBANKS LANDFILL
PERMIT AMENDMENT APPLICATION – PERMIT NO. MSW-1565B

PROJECT NO.: TXL0263	DESIGN BY: SMG	REVIEWED BY: SMG	PART NO.: III	DRAWING: IIA-17
FILE: 0263F25	DRAWN BY: JJV	APPROVED BY: SMG		

PERMIT DRAWING

DRAWING: Austin P:\CADD\Projects\F\Fairbanks Landfill\Permit\Expansion (TXL0263)\Drawings\Dwgs-Rev0\0263F25.dwg PLOTTED: Feb 28, 2014 - 11:05am

Ranjiv Gupta

From: noreply@faa.gov
Sent: Thursday, February 27, 2014 3:09 PM
To: crivette@wm.com; Ranjiv Gupta
Subject: Status of FAA Filing

Your filing is assigned Aeronautical Study Number(s) (ASN): 2014-ASW-1565-OE, 2014-ASW-1566-OE, 2014-ASW-1567-OE, 2014-ASW-1568-OE, 2014-ASW-1569-OE, 2014-ASW-1570-OE, 2014-ASW-1571-OE.

To review your electronic record, go to our website oeaaa.faa.gov and select the Search Archives link to locate your case using the assigned Aeronautical Study Number (ASN). Copies of your letter are available on the website for your convenience.

The FAA verified your filing and an aeronautical study has been initiated. Please allow a minimum 45 days for the FAA to complete the study. Please refer to the assigned ASN on all future inquiries regarding this filing.

For Wind Turbine proposals only, please ensure Wind Turbine Data as described on the project summary page in your registered e-filing account has been uploaded to your filing.

To ensure e-mail notifications are delivered to your inbox please add noreply@faa.gov to your address book. Notifications sent from this address are system generated FAA e-mails and replies to this address will NOT be read or forwarded for review. Each system generated e-mail will contain specific FAA contact information in the text of the message.

Project Submission Success
Project Name: CHUCK-000265645-14

Project CHUCK-000265645-14 has been submitted successfully to the FAA.

Your filing is assigned Aeronautical Study Number (ASN):

2014-ASW-1565-OE
2014-ASW-1566-OE
2014-ASW-1567-OE
2014-ASW-1568-OE
2014-ASW-1569-OE
2014-ASW-1570-OE
2014-ASW-1571-OE

Please refer to the assigned ASN on all future inquiries regarding this filing.

Please return to the system at a later date for status updates.

It is the responsibility of each e-filer to exercise due diligence to determine if coordination of the proposed construction or alteration is necessary with their state aviation department. Please use the link below to contact your state aviation department to determine their requirements:
State Aviation Contacts

To ensure e-mail notifications are delivered to your inbox please add noreply@faa.gov to your address book. Notifications sent from this address are system generated FAA e-mails and replies to this address will NOT be read or forwarded for review. Each system generated e-mail will contain specific FAA contact information in the text of the message.

Notice of Proposed Construction or Alteration - Off Airport

Project Name: CHUCK-000265645-14 **Sponsor:** Chuck A. Rivette, P.E.

Project Summary : CHUCK-000265645-14

Add Another Case to this Project Change the sponsor for this Project

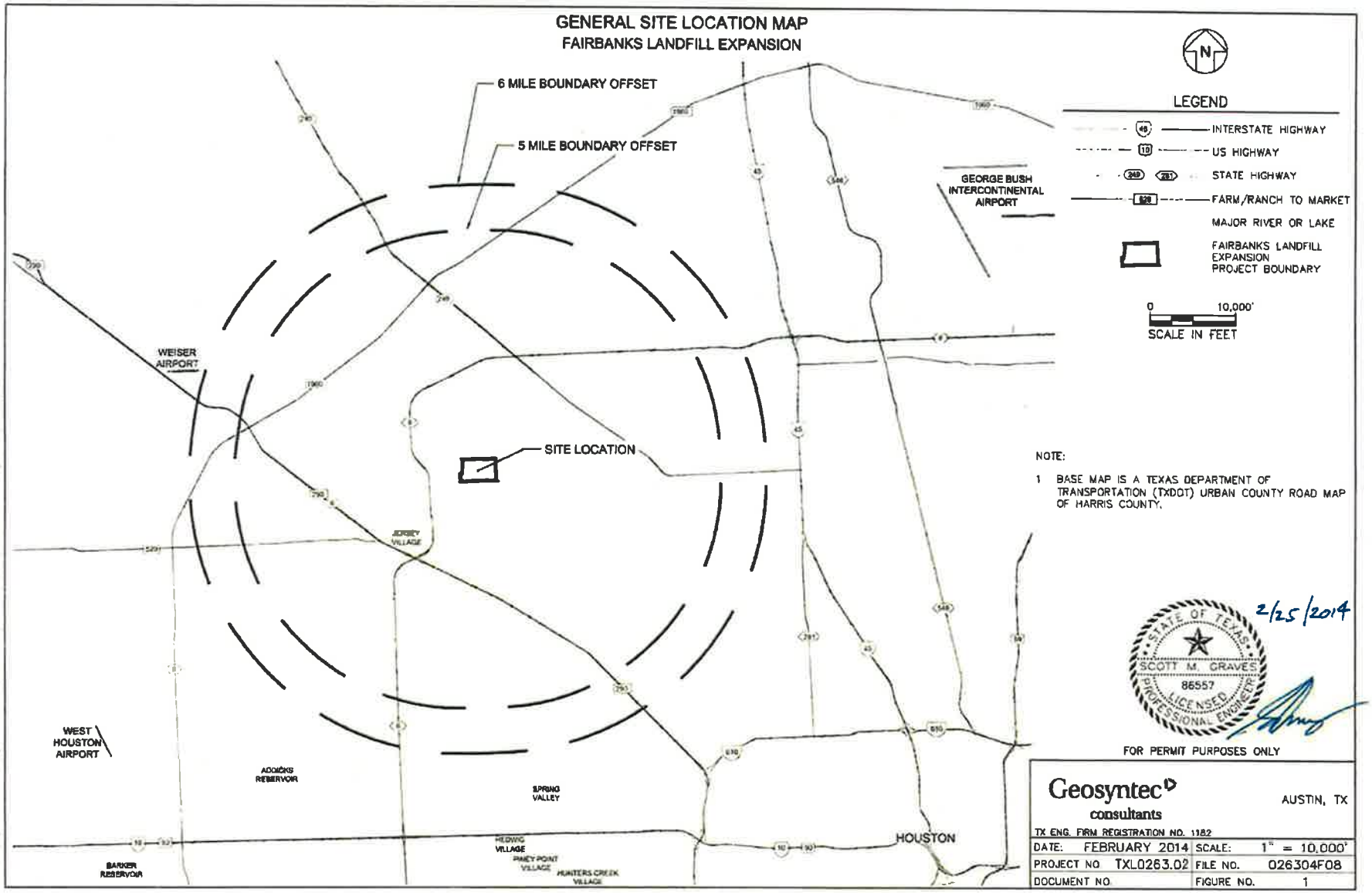
Structure	City, State	Lat/Long	Map	Actions
Fairbanks Landfill Draft	Houston, TX	29° 54' 6.30" N 95° 31' 55.10" W	Show Map (Re-Verify)	Clone Delete Upload a PDF
Fairbanks Landfill Draft	Houston, TX	29° 54' 6.55" N 95° 32' 6.38" W	Show Map (Re-Verify)	Clone Delete Upload a PDF
Fairbanks Landfill Draft	Houston, TX	29° 54' 6.08" N 95° 31' 43.22" W	Show Map (Re-Verify)	Clone Delete Upload a PDF
Fairbanks Landfill Draft	Houston, TX	29° 54' 4.07" N 95° 32' 6.57" W	Show Map (Re-Verify)	Clone Delete Upload a PDF
Fairbanks Landfill Draft	Houston, TX	29° 53' 59.64" N 95° 31' 42.35" W	Show Map (Re-Verify)	Clone Delete Upload a PDF
Fairbanks Landfill Draft	Houston, TX	29° 54' 10.91" N 95° 31' 42.72" W	Show Map (Re-Verify)	Clone Delete Upload a PDF
Fairbanks Landfill Draft	Houston, TX	29° 54' 11.07" N 95° 32' 7.28" W	Show Map (Re-Verify)	Clone Delete Upload a PDF

Upload a PDF to the Project

Please upload all supporting case documentation including the latest certified survey, if available.

You may submit your Project to the FAA.

GENERAL SITE LOCATION MAP
FAIRBANKS LANDFILL EXPANSION



NOTE:

1 BASE MAP IS A TEXAS DEPARTMENT OF TRANSPORTATION (TXDOT) URBAN COUNTY ROAD MAP OF HARRIS COUNTY.

STATE OF TEXAS
SCOTT M. GRAVES
86557
LICENSED
PROFESSIONAL ENGINEER

2/25/2014

FOR PERMIT PURPOSES ONLY

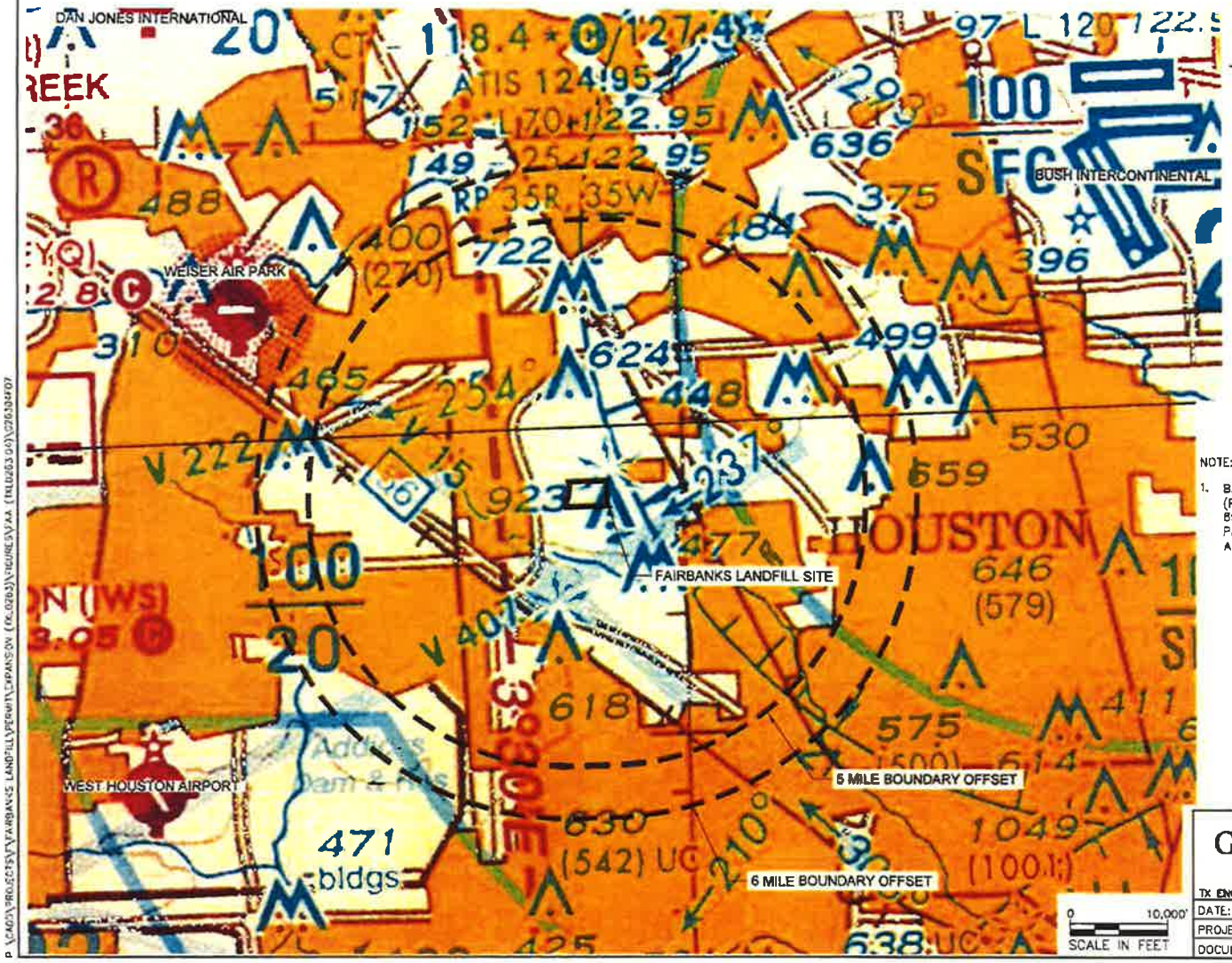
Geosyntec consultants — AUSTIN, TX

TX ENG. FIRM REGISTRATION NO. 1182

DATE:	FEBRUARY 2014	SCALE:	1" = 10,000'
PROJECT NO.	TXL0263.02	FILE NO.	026304F08
DOCUMENT NO.		FIGURE NO.	1

AERONAUTICAL MAP

FAIRBANKS LANDFILL EXPANSION



LEGEND

AIRPORTS

NOTE:

1. BASE MAP IS THE FEDERAL AVIATION ADMINISTRATION (FAA) SECTIONAL AERONAUTICAL CHART FOR HOUSTON 89TH EDITION DATED 08 MARCH 2012, RELEVANT PROJECT INFORMATION (SITE LOCATION, OFFSET LINES, AND NEARBY AIRPORTS) HAVE BEEN ADDED.

STATE OF TEXAS
SCOTT M. GRAVES
86557
LICENSED
PROFESSIONAL ENGINEER
2/25/2014

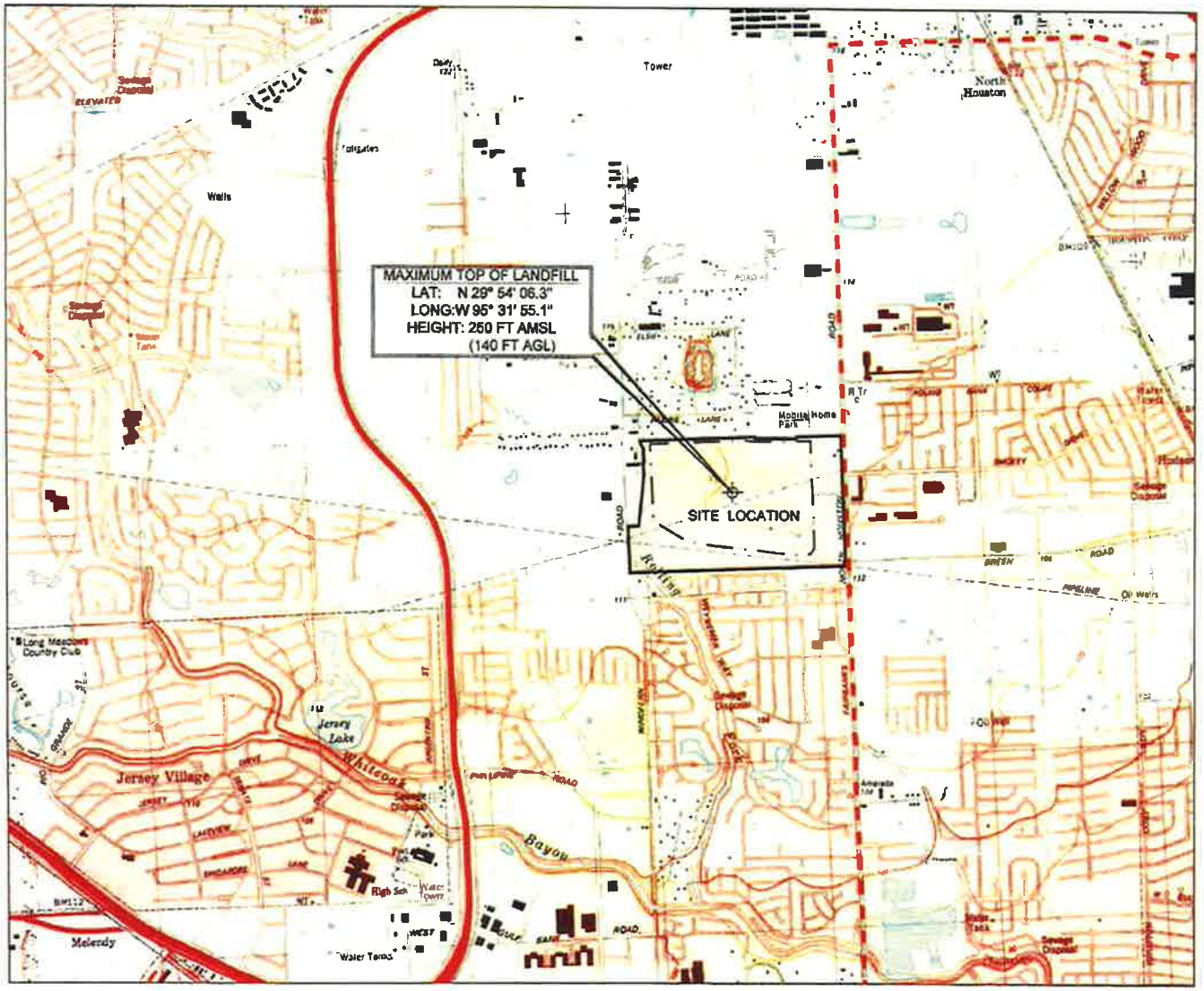
FOR PERMIT PURPOSES ONLY

Geosyntec consultants — AUSTIN, TX

TX ENG. FIRM REGISTRATION NO. 1182

DATE:	FEBRUARY 2014	SCALE:	1" = 10,000'
PROJECT NO.	TXL0263.02	FILE NO.	026304F07
DOCUMENT NO.		FIGURE NO.	2

SITE MAP
FAIRBANKS LANDFILL EXPANSION





LEGEND

- FAIRBANKS LANDFILL EXPANSION PROJECT BOUNDARY
- PROPOSED LIMIT OF EXPANDED LANDFILL (PRELIMINARY, SEE NOTE 2)
- AMSL = ABOVE MEAN SEA LEVEL
- AGL = ABOVE GROUND LEVEL

0 2,000'
SCALE IN FEET

NOTES:

1. MAP SOURCE: UNITED STATES DEPARTMENT OF THE INTERIOR, GEOLOGICAL SURVEY (USGS), 7 1/2 MINUTE SERIES QUADRANGLE TOPOGRAPHIC MAP OF SATSUMA, TEXAS DATED 1995.



2/25/2014

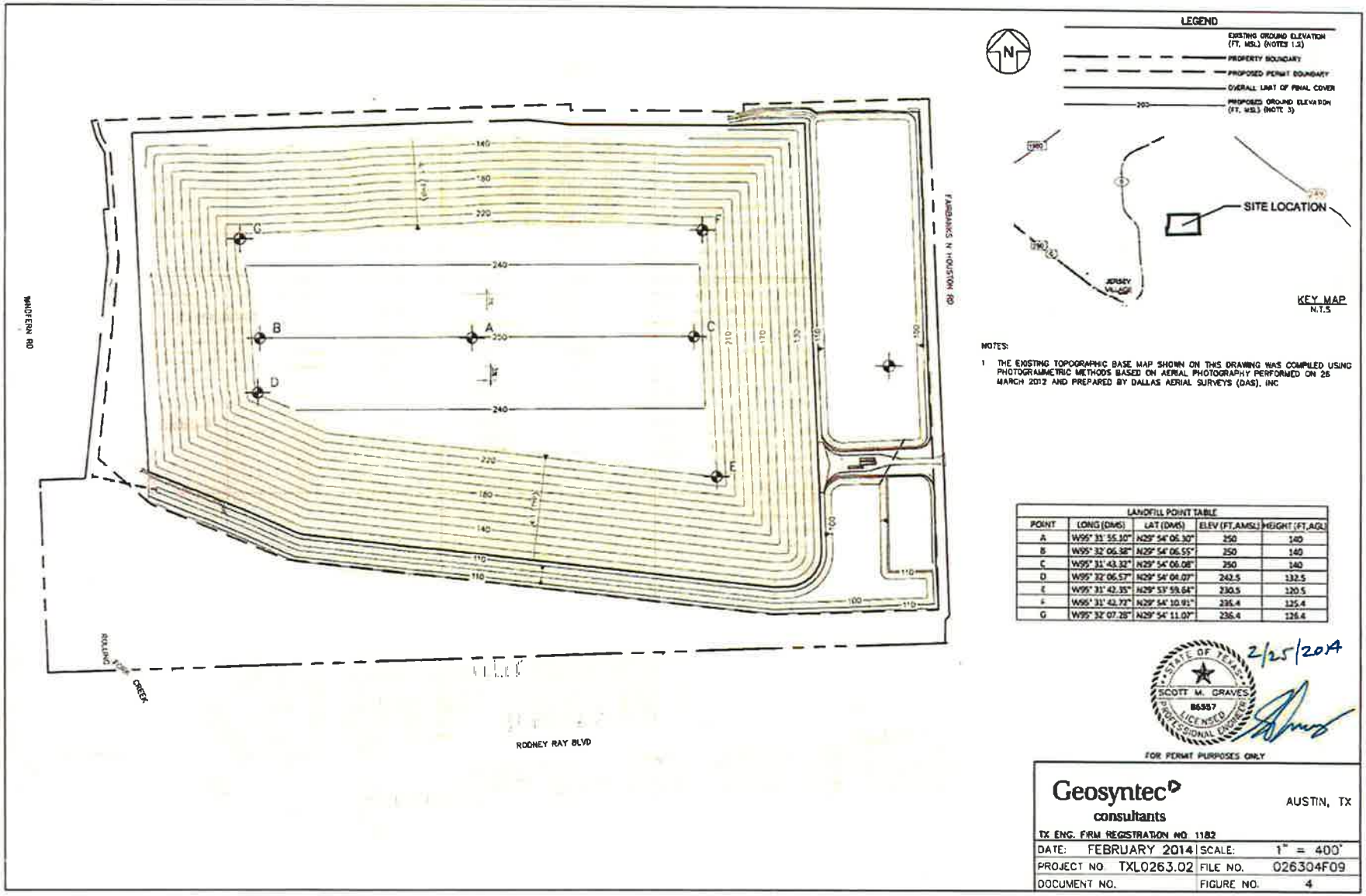
FOR PERMIT PURPOSES ONLY

Geosyntec consultants — AUSTIN, TX

TX ENG. FIRM REGISTRATION NO. 1182

DATE: FEBRUARY 2014	SCALE:	1" = 2000'
PROJECT NO. TXL0263.04	FILE NO.	026304F06
DOCUMENT NO.	FIGURE NO.	3

P:\CADD\PROJECTS\FV\FAIRBANKS LANDFILL\PERMIT\EXPANSION (TXL0263)\FIGURES\AA (TXL0263.04)\026304F06



LANDFILL POINT TABLE

POINT	LONG (DMS)	LAT (DMS)	ELEV (FT,AMSL)	HEIGHT (FT,AGL)
A	W95° 31' 55.30"	N29° 54' 06.30"	250	140
B	W95° 32' 06.38"	N29° 54' 06.55"	250	140
C	W95° 31' 43.32"	N29° 54' 06.08"	250	140
D	W95° 32' 06.57"	N29° 54' 04.07"	242.5	132.5
E	W95° 31' 42.35"	N29° 53' 59.64"	230.5	120.5
F	W95° 31' 42.72"	N29° 54' 10.91"	235.4	125.4
G	W95° 32' 07.28"	N29° 54' 11.07"	236.4	126.4

STATE OF TEXAS
SCOTT M. GRAVES
86557
LICENSED
PROFESSIONAL ENGINEER

2/25/2014

FOR PERMIT PURPOSES ONLY

Geosyntec consultants — AUSTIN, TX

TX ENG. FIRM REGISTRATION NO. 1182

DATE:	FEBRUARY 2014	SCALE:	1" = 400'
PROJECT NO.	TXL0263.02	FILE NO.	026304F09
DOCUMENT NO.		FIGURE NO.	4

Federal Aviation Administration

Notice of Proposed Construction or Alteration - Off Airport

Project Name: CHUCK-000265645-14 **Sponsor:** Chuck A. Rivette, P.E.

Details for Case : Fairbanks Landfill

Show Project Summary

Case Status

Status: Draft

Documents: None

Project Documents:
02/27/2014 FINAL Signed_Seal... Delete for Project

Construction / Alteration Information

* **Notice Of:** Alteration
* **Duration:** Permanent
if Temporary : Months: Days:
Work Schedule - Start: 05/01/2014 (mm/dd/yyyy)
Work Schedule - End: 03/03/2041 (mm/dd/yyyy)

For temporary cranes-Does the permanent structure require separate notice to the FAA?
To find out, use the Notice Criteria Tool. If separate notice is required, please ensure it is filed.
If it is not filed, please state the reason in the Description of Proposal.

State Filing: Not filed with State

Structure Summary

* **Structure Type:** Landfill
* **Structure Name:** Fairbanks Landfill
NOTAM Number:
FCC Number:
Prior ASN: - - - OE
Micro-Siting: Yes

For Wind Turbine/Met Tower-Only check this box if you are re-filing a location previously studied due to micro-siting.
The FAA will validate your latitude/longitude coordinates against the prior ASN to ensure the structure has not moved more than 500 feet.

Structure Details

* **Latitude:** 29 ° 54 ' 6.3 " N
* **Longitude:** 95 ° 31 ' 55.1 " W
* **Horizontal Datum:** NAD83
* **Site Elevation (SE):** 110 (nearest foot)
* **Structure Height (AGL):** 140 (nearest foot)
* **Current Height (AGL):** 44 (nearest foot)
For notice of alteration or existing provide the current AGL height of the existing structure.
Include details in the Description of Proposal
* **Nacelle Height (AGL):** (nearest foot)
For Wind Turbines 500ft AGL or greater
* **Requested Marking/Lighting:** None
Other :
Audio Visual Warning System(AVWS): Yes
Only check this box if you are proposing the installation and use of an Audio Visual Warning System
* **Current Marking/Lighting:** None
Other :
* **Nearest City:** Houston
* **Nearest State:** Texas
* **Description of Location:** Landfill site is located on northwest side of Houston, Texas (Figure
On the Project Summary page upload any certified survey.
* **Description of Proposal:** This notice is for landfill Point "A" (Figure 4).Proposal is

Common Frequency Bands

Low Freq	High Freq	Freq Unit	ERP	ERP Un
698	806	MHz	1000	W
806	824	MHz	500	W
824	849	MHz	500	W
851	866	MHz	500	W
869	894	MHz	500	W
896	901	MHz	500	W
901	902	MHz	7	W
930	931	MHz	3500	W
931	932	MHz	3500	W
932	932.5	MHz	17	dBW
935	940	MHz	1000	W
940	941	MHz	3500	W
1850	1910	MHz	1640	W
1930	1990	MHz	1640	W
2305	2310	MHz	2000	W
2345	2360	MHz	2000	W

Specific Frequencies

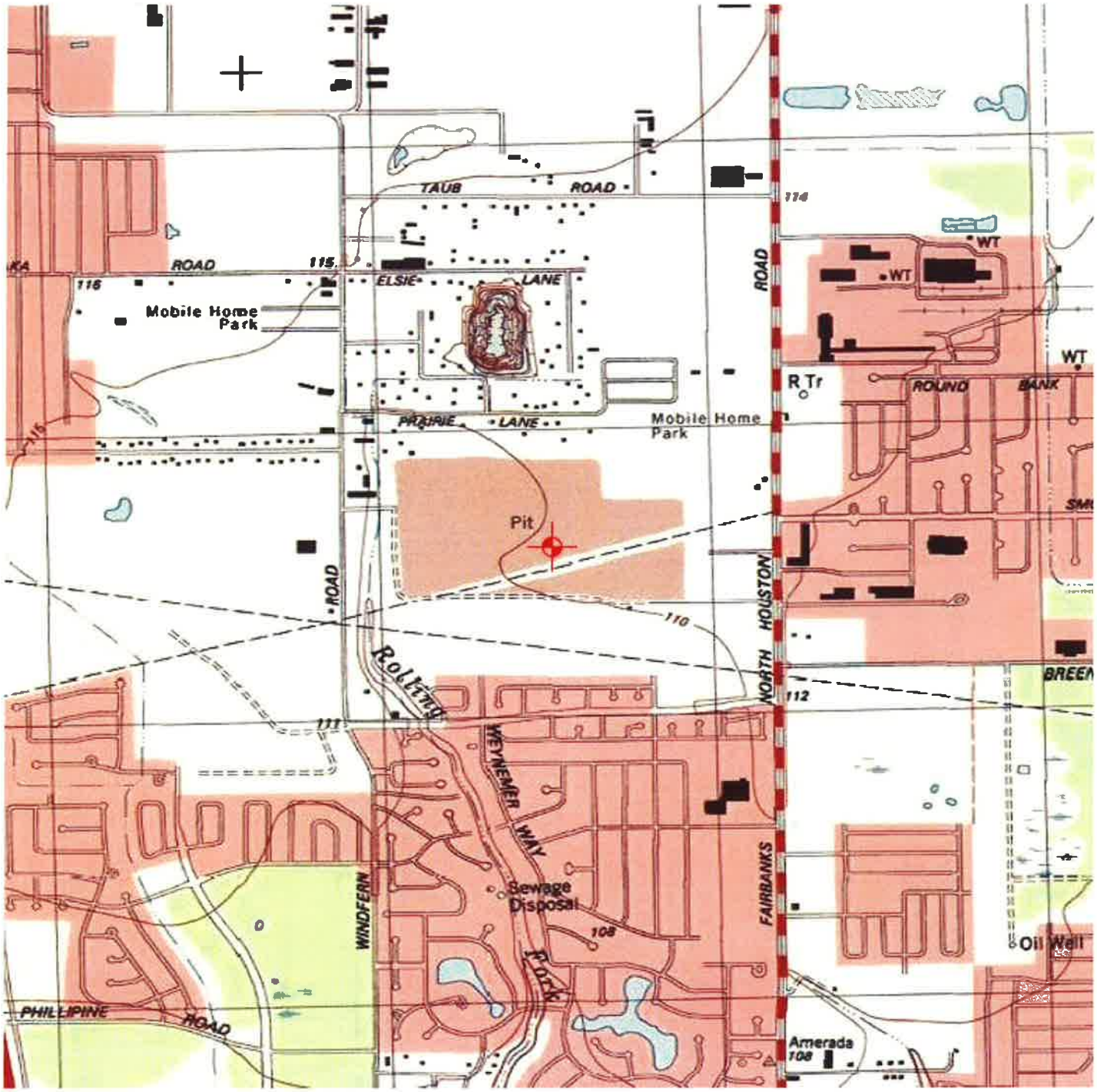
Add Specific Frequency

Additional Location(s)

Add New Location(s)

I hereby certify that all of the above statements made by me are true, complete, and correct to the best of my knowledge. In addition, I agree to mark and/or light the structure in accordance with established marking and lighting standards as necessary.

Close Print


TAUB ROAD
114
ROAD
115
116
ELSIE LANE
Mobile Home Park
WT
WT
WT
R Tr
ROUND BANK
PRAIRIE LANE
Mobile Home Park
Pit
ROAD
110
NORTH HOUSTON
Rolling
112
111
WEYNEMER WAY
Sewage Disposal
108
WINDFERN
FAIRBANKS
Fork
Oil Well
PHILLIPINE ROAD
Amerada
108

Federal Aviation Administration

Notice of Proposed Construction or Alteration - Off Airport

Project Name: CHUCK-000265645-14 **Sponsor:** Chuck A. Rivette, P.E.

Details for Case : Fairbanks Landfill

Show Project Summary

Case Status

Status: Draft

Documents: None

Project Documents:
02/27/2014 FINAL Signed_Seal... Delete for Project

Construction / Alteration Information

* **Notice Of:** Alteration
* **Duration:** Permanent
if Temporary : Months: Days:
Work Schedule - Start: 05/01/2014 (mm/dd/yyyy)
Work Schedule - End: 03/03/2041 (mm/dd/yyyy)

For temporary cranes-Does the permanent structure require separate notice to the FAA?
To find out, use the Notice Criteria Tool. If separate notice is required, please ensure it is filed.
If it is not filed, please state the reason in the Description of Proposal.

State Filing: Not filed with State

Structure Summary

* **Structure Type:** Landfill
* **Structure Name:** Fairbanks Landfill
NOTAM Number:
FCC Number:
Prior ASN: - - - OE
Micro-Siting: Yes

For Wind Turbine/Met Tower-Only check this box if you are re-filing a location previously studied due to micro-siting.
The FAA will validate your latitude/longitude coordinates against the prior ASN to ensure the structure has not moved more than 500 feet.

Structure Details

* **Latitude:** 29 ° 54 ' 6.55 " N
* **Longitude:** 95 ° 32 ' 6.38 " W
* **Horizontal Datum:** NAD83
* **Site Elevation (SE):** 110 (nearest foot)
* **Structure Height (AGL):** 140 (nearest foot)
* **Current Height (AGL):** 44 (nearest foot)
For notice of alteration or existing provide the current AGL height of the existing structure.
Include details in the Description of Proposal
* **Nacelle Height (AGL):** (nearest foot)
For Wind Turbines 500ft AGL or greater
* **Requested Marking/Lighting:** None
Other :
Audio Visual Warning System(AVWS): Yes
Only check this box if you are proposing the installation and use of an Audio Visual Warning System
* **Current Marking/Lighting:** None
Other :
* **Nearest City:** Houston
* **Nearest State:** Texas
* **Description of Location:** Landfill site is located on northwest side of Houston, Texas (Figure
On the Project Summary page upload any certified survey.
* **Description of Proposal:** This notice is for landfill Point "B" (Figure 4).Proposal is

Common Frequency Bands

Low Freq	High Freq	Freq Unit	ERP	ERP Un
698	806	MHz	1000	W
806	824	MHz	500	W
824	849	MHz	500	W
851	866	MHz	500	W
869	894	MHz	500	W
896	901	MHz	500	W
901	902	MHz	7	W
930	931	MHz	3500	W
931	932	MHz	3500	W
932	932.5	MHz	17	dBW
935	940	MHz	1000	W
940	941	MHz	3500	W
1850	1910	MHz	1640	W
1930	1990	MHz	1640	W
2305	2310	MHz	2000	W
2345	2360	MHz	2000	W

Specific Frequencies

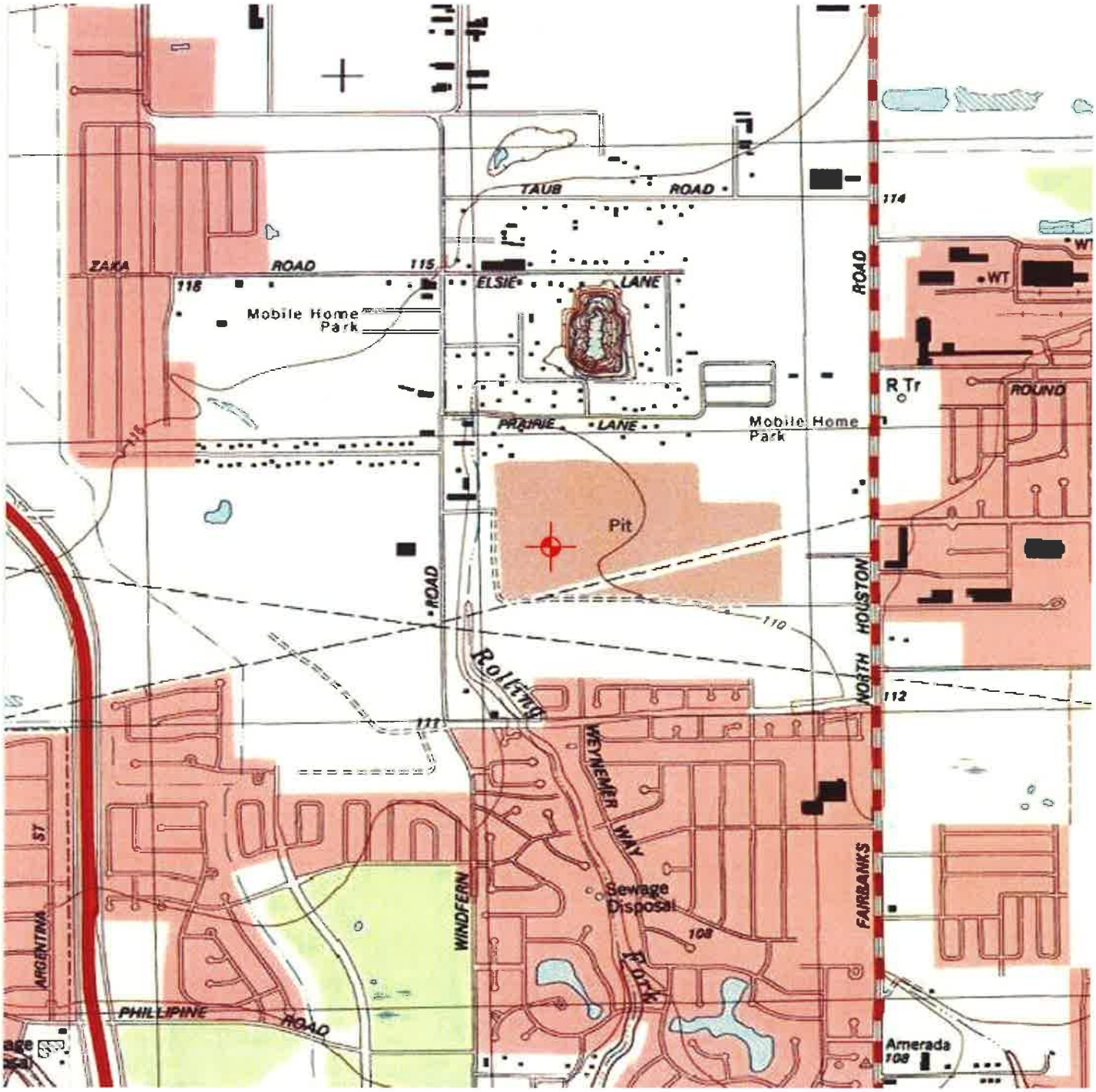
Add Specific Frequency

Additional Location(s)

Add New Location(s)

I hereby certify that all of the above statements made by me are true, complete, and correct to the best of my knowledge. In addition, I agree to mark and/or light the structure in accordance with established marking and lighting standards as necessary.

Close Print



TAUB ROAD
114
ZAKA ROAD
115
118
ELSIE LANE
Mobile Home Park
ROAD
WT
R Tr
ROUND
PRAIRIE LANE
Mobile Home Park
Pit
ROAD
110
NORTH HOUSTON
Rolling
112
111
WEYNEMER WAY
ST
ARGENTINA
WINDFERN
Sewage Disposal
108
FAIRBANKS
Fork
PHILLIPINE ROAD
Amerada
108

Notice of Proposed Construction or Alteration - Off Airport

Project Name: CHUCK-000265645-14 **Sponsor:** Chuck A. Rivette, P.E.

Details for Case : Fairbanks Landfill

Show Project Summary

Case Status

Status: Draft

Documents: None

Project Documents:
02/27/2014 FINAL Signed_Seal... Delete for Project

Construction / Alteration Information

* **Notice Of:** Alteration
* **Duration:** Permanent
if Temporary : Months: Days:
Work Schedule - Start: 05/01/2014 (mm/dd/yyyy)
Work Schedule - End: 03/03/2041 (mm/dd/yyyy)

**For temporary cranes-Does the permanent structure require separate notice to the FAA?*
To find out, use the Notice Criteria Tool. If separate notice is required, please ensure it is filed.
If it is not filed, please state the reason in the Description of Proposal.

State Filing: Not filed with State

Structure Summary

* **Structure Type:** Landfill
* **Structure Name:** Fairbanks Landfill
NOTAM Number:
FCC Number:
Prior ASN: - - - OE
Micro-Siting: Yes

**For Wind Turbine/Met Tower-Only check this box if you are re-filing a location previously studied due to micro-siting.*
The FAA will validate your latitude/longitude coordinates against the prior ASN to ensure the structure has not moved more than 500 feet.

Structure Details

* **Latitude:** 29 ° 54 ' 6.08 " N
* **Longitude:** 95 ° 31 ' 43.22 " W
* **Horizontal Datum:** NAD83
* **Site Elevation (SE):** 110 (nearest foot)
* **Structure Height (AGL):** 140 (nearest foot)
* **Current Height (AGL):** 44 (nearest foot)
** For notice of alteration or existing provide the current AGL height of the existing structure.*
Include details in the Description of Proposal
* **Nacelle Height (AGL):** (nearest foot)
** For Wind Turbines 500ft AGL or greater*
* **Requested Marking/Lighting:** None
Other :
Audio Visual Warning System(AVWS): Yes
** Only check this box if you are proposing the installation and use of an Audio Visual Warning System*
* **Current Marking/Lighting:** None
Other :
* **Nearest City:** Houston
* **Nearest State:** Texas
* **Description of Location:**
On the Project Summary page upload any certified survey.
Landfill site is located on northwest side of Houston, Texas (Figure
* **Description of Proposal:**
This notice is for landfill Point "C" (Figure 4).Proposal is

Common Frequency Bands

Low Freq	High Freq	Freq Unit	ERP	ERP Un
698	806	MHz	1000	W
806	824	MHz	500	W
824	849	MHz	500	W
851	866	MHz	500	W
869	894	MHz	500	W
896	901	MHz	500	W
901	902	MHz	7	W
930	931	MHz	3500	W
931	932	MHz	3500	W
932	932.5	MHz	17	dBW
935	940	MHz	1000	W
940	941	MHz	3500	W
1850	1910	MHz	1640	W
1930	1990	MHz	1640	W
2305	2310	MHz	2000	W
2345	2360	MHz	2000	W

Specific Frequencies

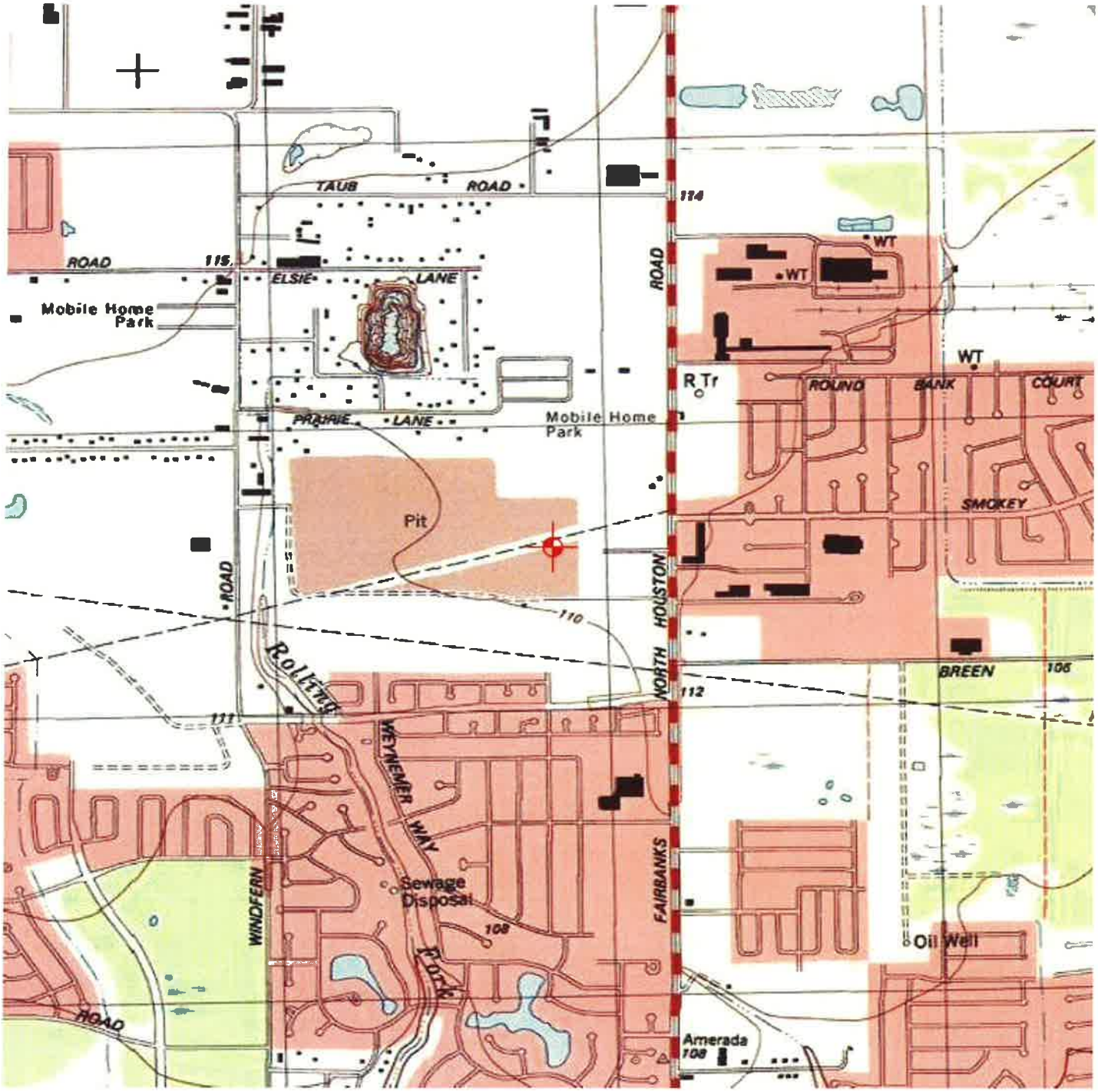
Add Specific Frequency

Additional Location(s)

Add New Location(s)

I hereby certify that all of the above statements made by me are true, complete, and correct to the best of my knowledge. In addition, I agree to mark and/or light the structure in accordance with established marking and lighting standards as necessary.

Close Print


TAUB ROAD
ROAD
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ELSIE LANE
Mobile Home Park
PRAIRIE LANE
Mobile Home Park
Pit
ROAD
Rolling
WEYNEMER WAY
WINDFERN
Sewage Disposal
FORK
ROAD
FAIRBANKS
NORTH HOUSTON
ROAD
114
WT
WT
WT
R Tr
ROUND BANK COURT
SMOKEY
110
112
BREEN
106
111
108
Oil Well
Amerada
108

Federal Aviation Administration

Notice of Proposed Construction or Alteration - Off Airport

Project Name: CHUCK-000265645-14 **Sponsor:** Chuck A. Rivette, P.E.

Details for Case : Fairbanks Landfill

Show Project Summary

Case Status

Status: Draft

Documents: None

Project Documents:
02/27/2014 FINAL Signed_Seal... Delete for Project

Construction / Alteration Information

* **Notice Of:** Alteration
* **Duration:** Permanent
if Temporary : Months: Days:
Work Schedule - Start: 05/01/2014 (mm/dd/yyyy)
Work Schedule - End: 03/03/2041 (mm/dd/yyyy)

**For temporary cranes-Does the permanent structure require separate notice to the FAA?*
To find out, use the Notice Criteria Tool. If separate notice is required, please ensure it is filed.
If it is not filed, please state the reason in the Description of Proposal.

State Filing: Not filed with State

Structure Summary

* **Structure Type:** Landfill
* **Structure Name:** Fairbanks Landfill
NOTAM Number:
FCC Number:
Prior ASN: - - - OE
Micro-Siting: Yes

**For Wind Turbine/Met Tower-Only check this box if you are re-filing a location previously studied due to micro-siting.*
The FAA will validate your latitude/longitude coordinates against the prior ASN to ensure the structure has not moved more than 500 feet.

Structure Details

* **Latitude:** 29 ° 54 ' 4.07 " N
* **Longitude:** 95 ° 32 ' 6.57 " W
* **Horizontal Datum:** NAD83
* **Site Elevation (SE):** 110 (nearest foot)
* **Structure Height (AGL):** 132 (nearest foot)
* **Current Height (AGL):** 44 (nearest foot)
** For notice of alteration or existing provide the current AGL height of the existing structure.*
Include details in the Description of Proposal
* **Nacelle Height (AGL):**
** For Wind Turbines 500ft AGL or greater*
* **Requested Marking/Lighting:** None
Other :
Audio Visual Warning System (AVWS): Yes
** Only check this box if you are proposing the installation and use of an Audio Visual Warning System*
* **Current Marking/Lighting:** None
Other :
* **Nearest City:** Houston
* **Nearest State:** Texas
* **Description of Location:**
On the Project Summary page upload any certified survey.
Landfill site is located on northwest side of Houston, Texas (Figure
* **Description of Proposal:**
This notice is for landfill Point "D" (Figure 4).Proposal is

Common Frequency Bands

Low Freq	High Freq	Freq Unit	ERP	ERP Un
698	806	MHz	1000	W
806	824	MHz	500	W
824	849	MHz	500	W
851	866	MHz	500	W
869	894	MHz	500	W
896	901	MHz	500	W
901	902	MHz	7	W
930	931	MHz	3500	W
931	932	MHz	3500	W
932	932.5	MHz	17	dBW
935	940	MHz	1000	W
940	941	MHz	3500	W
1850	1910	MHz	1640	W
1930	1990	MHz	1640	W
2305	2310	MHz	2000	W
2345	2360	MHz	2000	W

Specific Frequencies

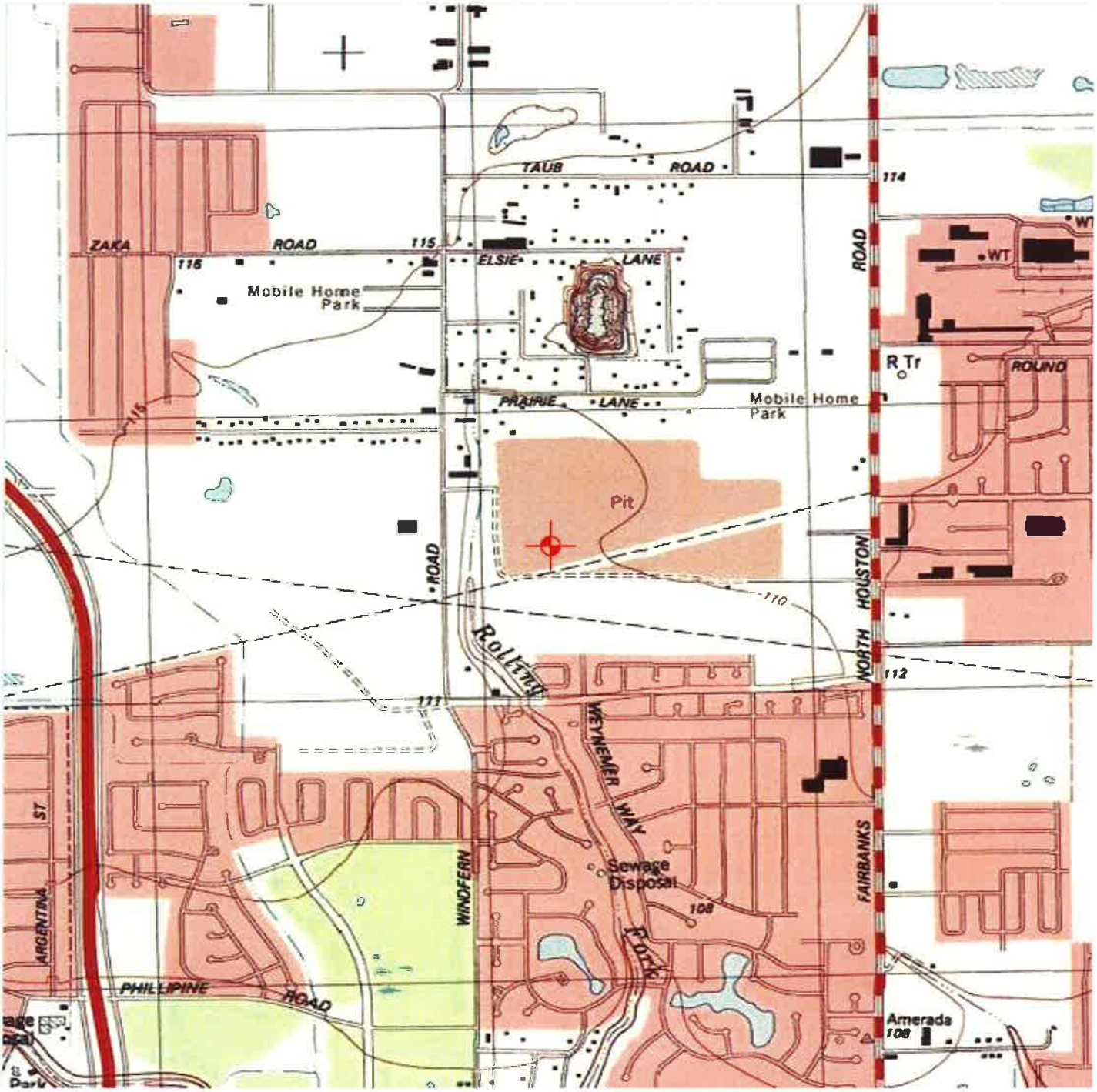
Add Specific Frequency

Additional Location(s)

Add New Location(s)

I hereby certify that all of the above statements made by me are true, complete, and correct to the best of my knowledge. In addition, I agree to mark and/or light the structure in accordance with established marking and lighting standards as necessary.

Close Print


TAUB ROAD
114
ZAKA ROAD
115
116
ELSIE LANE
Mobile Home Park
ROAD
WT
R Tr
ROUND
PRAIRIE LANE
Mobile Home Park
Pit
ROAD
110
NORTH HOUSTON
112
Rolling
111
WEYNEMER WAY
ST
ARGENTINA
WINDFERN
Sewage Disposal
108
Fork
FAIRBANKS
PHILLIPINE ROAD
Amerada
108

Federal Aviation Administration

Notice of Proposed Construction or Alteration - Off Airport

Project Name: CHUCK-000265645-14 **Sponsor:** Chuck A. Rivette, P.E.

Details for Case : Fairbanks Landfill

Show Project Summary

Case Status

Status: Draft

Documents: None

Project Documents:
02/27/2014 FINAL Signed_Seal.., Delete for Project

Construction / Alteration Information

* **Notice Of:** Alteration
* **Duration:** Permanent
if Temporary : Months: Days:
Work Schedule - Start: 05/01/2014 (mm/dd/yyyy)
Work Schedule - End: 03/03/2041 (mm/dd/yyyy)

**For temporary cranes-Does the permanent structure require separate notice to the FAA?*
To find out, use the Notice Criteria Tool. If separate notice is required, please ensure it is filed.
If it is not filed, please state the reason in the Description of Proposal.

State Filing: Not filed with State

Structure Summary

* **Structure Type:** Landfill
* **Structure Name:** Fairbanks Landfill
NOTAM Number:
FCC Number:
Prior ASN: - - - OE
Micro-Siting: Yes

**For Wind Turbine/Met Tower-Only check this box if you are re-filing a location previously studied due to micro-siting.*
The FAA will validate your latitude/longitude coordinates against the prior ASN to ensure the structure has not moved more than 500 feet.

Structure Details

* **Latitude:** 29 ° 53 ' 59.64 " N
* **Longitude:** 95 ° 31 ' 42.35 " W
* **Horizontal Datum:** NAD83
* **Site Elevation (SE):** 110 (nearest foot)
* **Structure Height (AGL):** 120 (nearest foot)
* **Current Height (AGL):** 44 (nearest foot)
** For notice of alteration or existing provide the current AGL height of the existing structure.*
Include details in the Description of Proposal
* **Nacelle Height (AGL):** (nearest foot)
** For Wind Turbines 500ft AGL or greater*
* **Requested Marking/Lighting:** None
Other :
Audio Visual Warning System(AVWS): Yes
** Only check this box if you are proposing the installation and use of an Audio Visual Warning System*
* **Current Marking/Lighting:** None
Other :
* **Nearest City:** Houston
* **Nearest State:** Texas
* **Description of Location:**
On the Project Summary page upload any certified survey.
Landfill site is located on northwest side of Houston, Texas (Figure
* **Description of Proposal:**
This notice is for landfill Point "E" (Figure 4).Proposal is

Common Frequency Bands

Low Freq	High Freq	Freq Unit	ERP	ERP Un
698	806	MHz	1000	W
806	824	MHz	500	W
824	849	MHz	500	W
851	866	MHz	500	W
869	894	MHz	500	W
896	901	MHz	500	W
901	902	MHz	7	W
930	931	MHz	3500	W
931	932	MHz	3500	W
932	932.5	MHz	17	dBW
935	940	MHz	1000	W
940	941	MHz	3500	W
1850	1910	MHz	1640	W
1930	1990	MHz	1640	W
2305	2310	MHz	2000	W
2345	2360	MHz	2000	W

Specific Frequencies

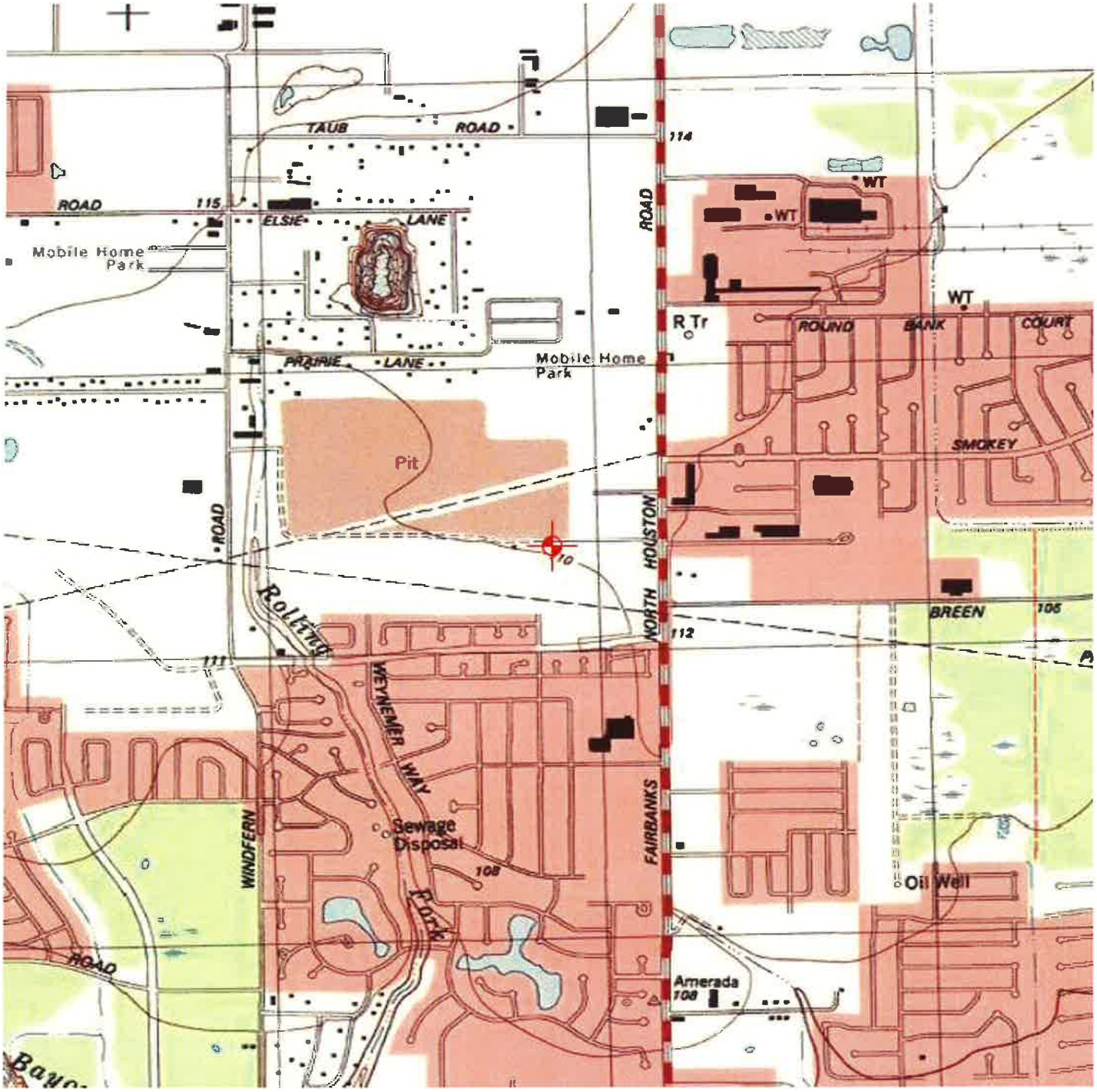
Add Specific Frequency

Additional Location(s)

Add New Location(s)

I hereby certify that all of the above statements made by me are true, complete, and correct to the best of my knowledge. In addition, I agree to mark and/or light the structure in accordance with established marking and lighting standards as necessary.

Close Print


TAUB ROAD
ROAD
115
ELSIE LANE
Mobile Home Park
PRAIRIE LANE
Mobile Home Park
Pit
ROAD
Rolling
WEYNEMER WAY
WINDFERN
Sewage Disposal
108
Fork
ROAD
Amerada
108
FAIRBANKS
NORTH HOUSTON ROAD
114
WT
WT
WT
R Tr
ROUND BANK COURT
SMOKEY
BREEN
105
112
111
10
Oil Well

Notice of Proposed Construction or Alteration - Off Airport

Project Name: CHUCK-000265645-14 **Sponsor:** Chuck A. Rivette, P.E.

Details for Case : Fairbanks Landfill

Show Project Summary

Case Status

Status: Draft

Documents: None

Project Documents:
02/27/2014 FINAL Signed_Seal... Delete for Project

Construction / Alteration Information

* **Notice Of:** Alteration
* **Duration:** Permanent
if Temporary : Months: Days:
Work Schedule - Start: 05/01/2014 (mm/dd/yyyy)
Work Schedule - End: 03/03/2041 (mm/dd/yyyy)

**For temporary cranes-Does the permanent structure require separate notice to the FAA?*
To find out, use the Notice Criteria Tool. If separate notice is required, please ensure it is filed.
If it is not filed, please state the reason in the Description of Proposal.

State Filing: Not filed with State

Structure Details

* **Latitude:** 29 ° 54 ' 10.91 " N
* **Longitude:** 95 ° 31 ' 42.72 " W
* **Horizontal Datum:** NAD83
* **Site Elevation (SE):** 110 (nearest foot)
* **Structure Height (AGL):** 125 (nearest foot)
* **Current Height (AGL):** 44 (nearest foot)
** For notice of alteration or existing provide the current AGL height of the existing structure.*
Include details in the Description of Proposal
* **Nacelle Height (AGL):**
** For Wind Turbines 500ft AGL or greater*
* **Requested Marking/Lighting:** None
Other :
Audio Visual Warning System (AVWS): Yes
** Only check this box if you are proposing the installation and use of an Audio Visual Warning System*
* **Current Marking/Lighting:** None
Other :
* **Nearest City:** Houston
* **Nearest State:** Texas
* **Description of Location:**
On the Project Summary page upload any certified survey.
Landfill site is located on northwest side of Houston, Texas (Figure
* **Description of Proposal:**
This notice is for landfill Point "F" (Figure 4).Proposal is

Additional Location(s)

Add New Location(s)

Structure Summary

* **Structure Type:** Landfill
* **Structure Name:** Fairbanks Landfill
NOTAM Number:
FCC Number:
Prior ASN: - - - OE
Micro-Siting: Yes

**For Wind Turbine/Met Tower-Only check this box if you are re-filing a location previously studied due to micro-siting.*
The FAA will validate your latitude/longitude coordinates against the prior ASN to ensure the structure has not moved more than 500 feet.

Common Frequency Bands

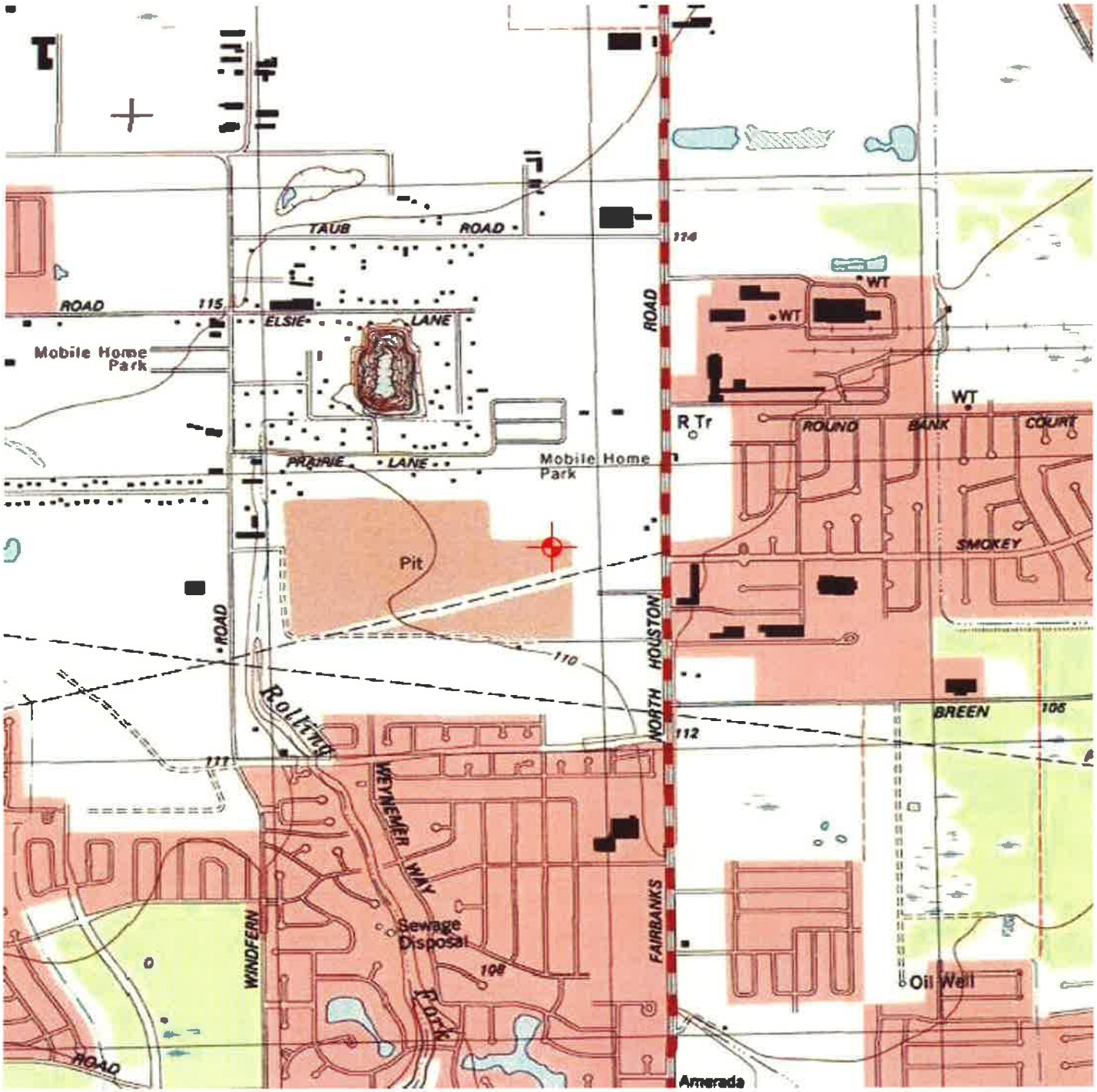
Low Freq	High Freq	Freq Unit	ERP	ERP Un
698	806	MHz	1000	W
806	824	MHz	500	W
824	849	MHz	500	W
851	866	MHz	500	W
869	894	MHz	500	W
896	901	MHz	500	W
901	902	MHz	7	W
930	931	MHz	3500	W
931	932	MHz	3500	W
932	932.5	MHz	17	dBW
935	940	MHz	1000	W
940	941	MHz	3500	W
1850	1910	MHz	1640	W
1930	1990	MHz	1640	W
2305	2310	MHz	2000	W
2345	2360	MHz	2000	W

Specific Frequencies

Add Specific Frequency

I hereby certify that all of the above statements made by me are true, complete, and correct to the best of my knowledge. In addition, I agree to mark and/or light the structure in accordance with established marking and lighting standards as necessary.

Close Print


TAUB ROAD
114
ROAD
115
ELSIE LANE
Mobile Home Park
WT
WT
WT
R Tr
ROUND BANK COURT
PRAIRIE LANE
Mobile Home Park
SMOKEY
Pit
ROAD
110
NORTH HOUSTON
BREEN
106
112
111
Rolling
WEYNEMER WAY
Sewage Disposal
108
WINDFERN
FAIRBANKS
Oil Well
Fork
ROAD
Amerada

Federal Aviation Administration

Notice of Proposed Construction or Alteration - Off Airport

Project Name: CHUCK-000265645-14 **Sponsor:** Chuck A. Rivette, P.E.

Details for Case : Fairbanks Landfill

Show Project Summary

Case Status

Status: Draft

Documents: None

Project Documents:
02/27/2014 FINAL Signed_Seal... Delete for Project

Construction / Alteration Information

* **Notice Of:** Alteration
* **Duration:** Permanent
if Temporary : Months: Days:
Work Schedule - Start: 05/01/2014 (mm/dd/yyyy)
Work Schedule - End: 03/03/2041 (mm/dd/yyyy)

**For temporary cranes-Does the permanent structure require separate notice to the FAA?*
To find out, use the Notice Criteria Tool. If separate notice is required, please ensure it is filed.
If it is not filed, please state the reason in the Description of Proposal.

State Filing: Not filed with State

Structure Summary

* **Structure Type:** Landfill
* **Structure Name:** Fairbanks Landfill
NOTAM Number:
FCC Number:
Prior ASN: - - - OE
Micro-Siting: Yes

**For Wind Turbine/Met Tower-Only check this box if you are re-filing a location previously studied due to micro-siting.*
The FAA will validate your latitude/longitude coordinates against the prior ASN to ensure the structure has not moved more than 500 feet.

Structure Details

* **Latitude:** 29 ° 54 ' 11.07 " N
* **Longitude:** 95 ° 32 ' 7.28 " W
* **Horizontal Datum:** NAD83
* **Site Elevation (SE):** 110 (nearest foot)
* **Structure Height (AGL):** 126 (nearest foot)
* **Current Height (AGL):** 44 (nearest foot)
** For notice of alteration or existing provide the current AGL height of the existing structure.*
Include details in the Description of Proposal
* **Nacelle Height (AGL):** (nearest foot)
** For Wind Turbines 500ft AGL or greater*
* **Requested Marking/Lighting:** None
Other :
Audio Visual Warning System(AVWS): Yes
** Only check this box if you are proposing the installation and use of an Audio Visual Warning System*
* **Current Marking/Lighting:** None
Other :
* **Nearest City:** Houston
* **Nearest State:** Texas
* **Description of Location:**
On the Project Summary page upload any certified survey.
Landfill site is located on northwest side of Houston, Texas (Figure
* **Description of Proposal:**
This notice is for landfill Point "G" (Figure 4).Proposal is

Common Frequency Bands

Low Freq	High Freq	Freq Unit	ERP	ERP Un
698	806	MHz	1000	W
806	824	MHz	500	W
824	849	MHz	500	W
851	866	MHz	500	W
869	894	MHz	500	W
896	901	MHz	500	W
901	902	MHz	7	W
930	931	MHz	3500	W
931	932	MHz	3500	W
932	932.5	MHz	17	dBW
935	940	MHz	1000	W
940	941	MHz	3500	W
1850	1910	MHz	1640	W
1930	1990	MHz	1640	W
2305	2310	MHz	2000	W
2345	2360	MHz	2000	W

Specific Frequencies

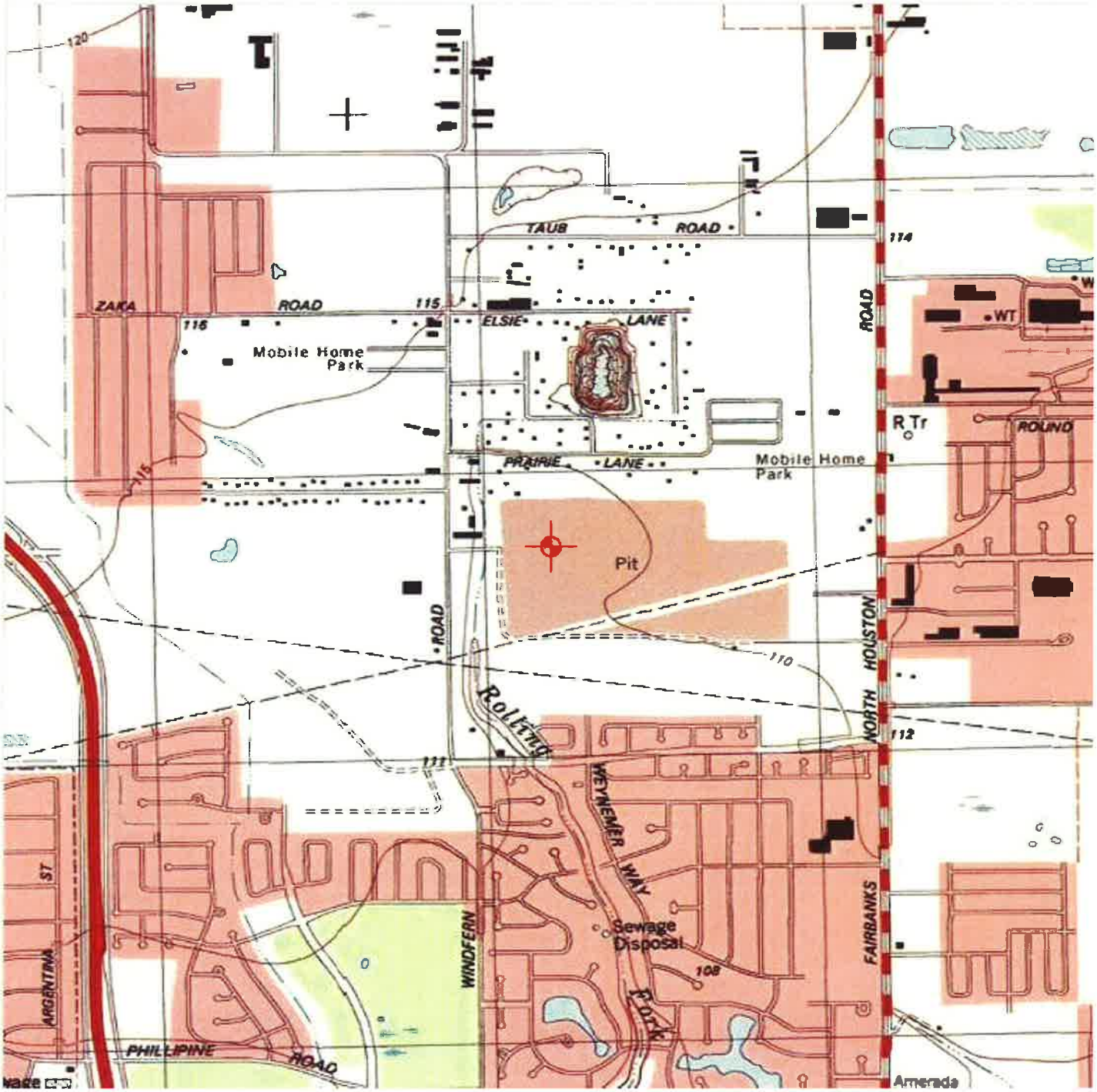
Add Specific Frequency

Additional Location(s)

Add New Location(s)

I hereby certify that all of the above statements made by me are true, complete, and correct to the best of my knowledge. In addition, I agree to mark and/or light the structure in accordance with established marking and lighting standards as necessary.

Close Print



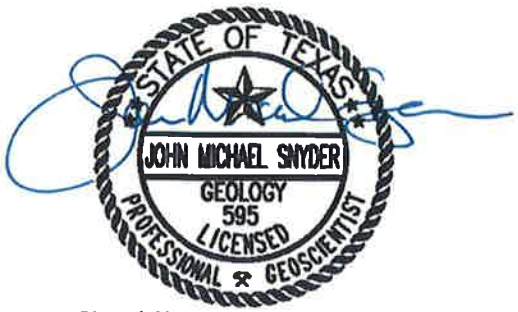
120
TAUB
ROAD
114
ZAKA
ROAD
115
116
ELSIE
LANE
Mobile Home Park
ROAD
WT
R Tr
ROUND
PRAIRIE
LANE
Mobile Home Park
115
Pit
ROAD
110
NORTH HOUSTON
Rolling
112
111
WEYNEMER
WAY
ST
ARGENTINA
WINDFERN
Sewage Disposal
108
FAIRBANKS
Fork
PHILLIPINE
ROAD
Amerada

FAIRBANKS LANDFILL

APPENDIX IIE

GENERAL GEOLOGY AND SOILS STATEMENT

Includes Pages IIE-1 through IIE-5



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

3-3-2014

composition. Layer I soils were encountered from the surface to a maximum depth of approximately 40 feet. Average thickness of this Layer is approximately 14 feet across the site. Correlation of individual sand and clay units within this Layer was not attempted since they are discontinuous, grading from sandy to clayey lithologies, and because their correlation is not necessary for the hydrogeologic interpretation and design of the groundwater monitoring system.

Layer II Sand

Layer II is a fine-grained sand and silty sand unit with some clayey sand. Layer II sand was encountered in all of the borings completed at the site. As illustrated on the cross sections in Attachment 4, Appendix 4C (Figures 4C-2 through 4C-8), this Layer is continuous and correlatable across the site. A few discontinuous interbeds of clay and sandy clay occur within the Layer II sand. Over most of the site, Layer II has been removed by previous sand mining and waste fill excavation. Once the expansion area is excavated into the Layer III clay, only isolated remnants of the Layer II sand will remain. However, Layer II sand has been removed and does not exist at the east and south perimeter of the site. The thickness of Layer II ranges from approximately 20 to 40 feet. Average thickness is about 35 feet.

The Layer II sand unit is an unconfined, water-bearing zone and has been interpreted as the uppermost groundwater zone at the site. Groundwater levels within this zone have been affected by open excavations at the site and on adjacent properties throughout the site life.

Layer III Clay

Layer III consists of a very stiff to hard, reddish brown and gray clay (mostly CH), silty clay, and sandy clay. This thick clay unit has an average thickness of about 27 feet and is continuous across the site. The Layer III clay functions as the lower confining unit to the overlying Layer II groundwater zone and the upper confining unit to the underlying Layer IV groundwater zone due to the low permeability and continuity of this Layer. The existing landfill is and the proposed landfill bottom will be excavated in the Layer III clay.

Layer IV Sand

A deeper sand unit was encountered below the Layer III clay. This deep sand unit, designated Layer IV, consists primarily of sand, silty sand, and gravelly sand. The average thickness encountered was 50 feet. The average depth to the top of this Layer is approximately 65 feet. Layer IV is the uppermost aquifer beneath the site. A few discontinuous interbeds of clay and sandy clay occur within this layer of sand and have been labeled Layer IVA on the cross sections (Attachment 4, Appendix 4C, Figures 4C-2 through 4C-8).

Layer V Clay

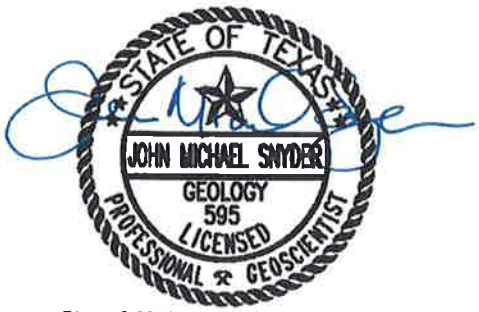
Layer V is a deep, continuous clay Layer, below the Layer IV groundwater zone. Layer V consists of a hard, gray and light brown clay similar to the Layer III clay. The Layer V clay was not completely penetrated during exploration. The maximum thickness explored was 30 feet. The average depth to the top of this Layer is 105 feet. Laboratory

FAIRBANKS LANDFILL

APPENDIX IIF

GROUNDWATER

Includes Pages IIF-1 through IIF-3



Biggs & Mathews Environmental, Inc.
Firm Registration No. 50222
3-3-2014

IIF GROUNDWATER

TAC §330.61(k)

IIF.1 Groundwater

Consistent with §330.61(k)(1), a discussion of groundwater conditions at or near the facility has been prepared. A groundwater investigation report is included in Part III, Attachment 4, Section 6. The groundwater monitoring system proposed for the site is discussed in Part III, Attachment 5, Section 2.

Groundwater conditions at the site were determined using data from a combination of piezometers and monitoring wells that are a part of the approved site Subtitle D groundwater monitoring system. Details and logs of the borings, monitoring wells and piezometers are provided in Part III, Attachment 4, Appendix 4B.

IIF.2 Regional Aquifers

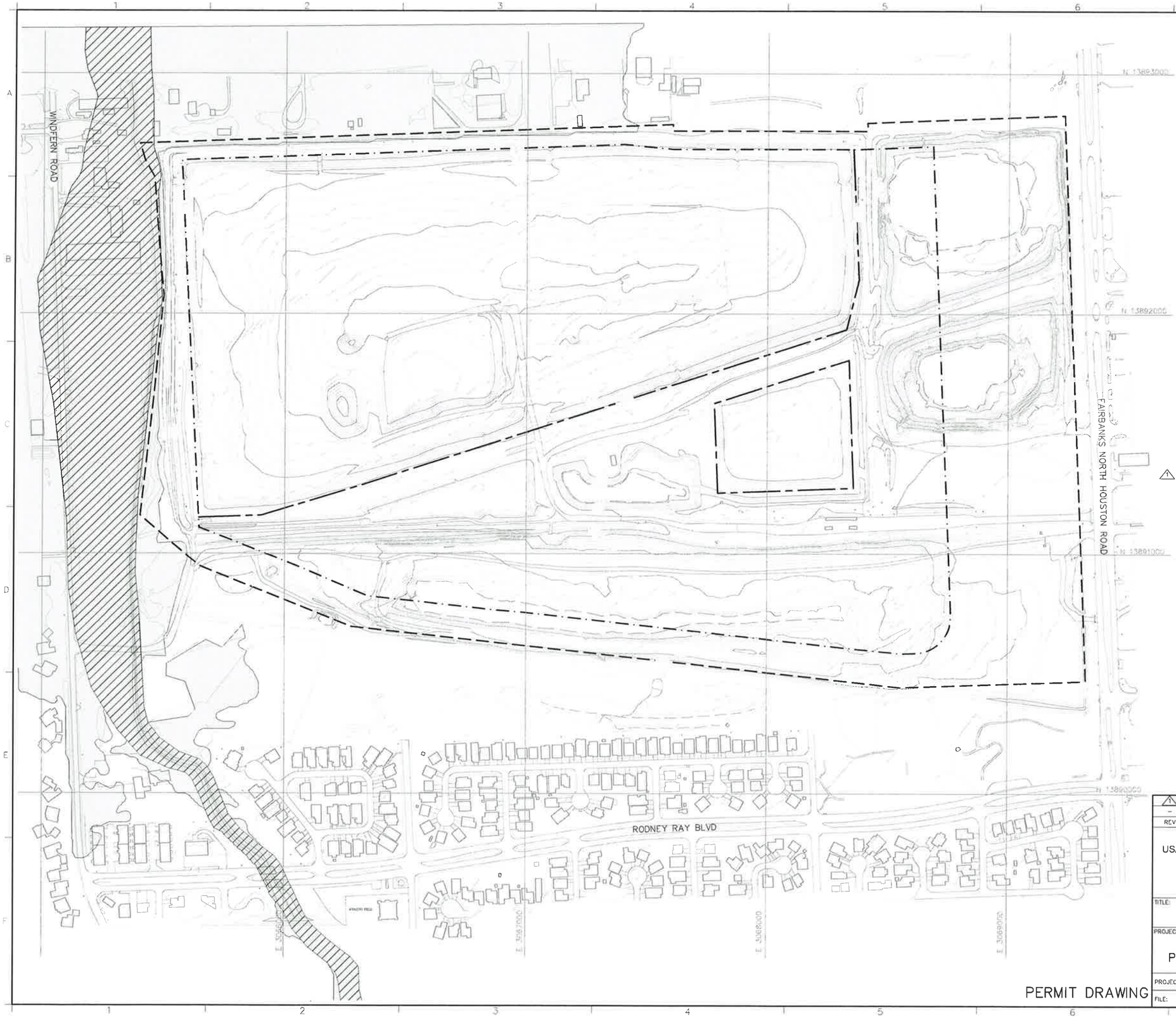
Defined regional aquifers discussed in the following sections are the Chicot and Evangeline (Baker, 1979). The site is excavated within deposits of the Chicot Aquifer. Stratigraphically below the Chicot is the Evangeline Aquifer. The Burkeville confining system of the upper Miocene Fleming Formation serves as the lower confining unit to the Evangeline Aquifer.

IIF.2.1 Gulf Coast Aquifer

The Gulf Coast Aquifer (Kasmarek and Strom, 2002) is classified by the state of Texas as a major aquifer. In Texas, the Gulf Coast Aquifer extends from the Rio Grande Valley and northeastward to the Louisiana border, encompassing more than 50,000 square miles and all or parts of 54 counties (Ashworth and Hopkins, 1995). The Chicot and Evangeline comprise the Gulf Coast Aquifer (Kasmarek and Strom, 2002). These aquifers are regionally connected in a "leaky artesian aquifer" condition. The Chicot is the uppermost aquifer. The Evangeline occurs below the Chicot. The Burkeville Confining System, including the Fleming Formation, serves as the aquiclude to the Evangeline. Clay interbeds occurring within the Chicot and Evangeline serve as aquicludes to overlying sandy zones preventing local downward migration of groundwater. Deeper, confined zones within each aquifer results in a "leaky artesian aquifer" situation. This upward pressure gradient condition also prevents downward migration of groundwater. Hydraulic properties of the Chicot and Evangeline are summarized in Table IIF-1.

IIF.2.2 Chicot Aquifer

The Chicot Aquifer includes more permeable sediments in the Pleistocene-age Willis Sand, Lissie Formation, and Beaumont Clay and any overlying Holocene alluvium (Baker, 1979). According to Baker (1979), delineation of Pleistocene units is very difficult because of the similarities in lithology and the lack of correlatable fossil records within those units.



LEGEND

- 100 — EXISTING GROUND ELEVATION (FT, MSL) (NOTE 1)
- EXISTING ROAD
- EXISTING BUILDING
- N 13860000 E 3268000 — STATE PLANE COORDINATES (NOTE 2)
- EXISTING (PERMIT MSW-1565A) LANDFILL FOOTPRINT
- PERMIT BOUNDARY
- PROPOSED LANDFILL FOOTPRINT (NOTE 4)
- 100 YEAR FLOODPLAIN (NOTE 3)
- 100 YEAR FLOODWAY (NOTE 3)

-N-

0 200' 400'
SCALE IN FEET

NOTES:

1. THE EXISTING TOPOGRAPHIC BASE MAP SHOWN ON THIS DRAWING WAS COMPILED USING PHOTOGRAMMETRIC METHODS BASED ON AERIAL PHOTOGRAPHY PERFORMED ON 26 MARCH 2012 AND PREPARED BY DALLAS AERIAL SURVEYS (DAS), INC.
2. ELEVATIONS ARE IN FEET ABOVE MEAN SEA LEVEL (FT, MSL) AS DEFINED BY THE USGS NATIONAL GEODETIC VERTICAL DATUM (NAVD) OF 1988. STATE PLANE COORDINATE GRID CORRESPONDS TO TEXAS STATE PLANE COORDINATE SYSTEM, TEXAS SOUTH CENTRAL ZONE (4204), NORTH AMERICAN DATUM 83 (NAD-83) 1983.
3. THE FLOODPLAIN INFORMATION SHOWN ON THIS DRAWING IS FROM THE FEDERAL EMERGENCY MANAGEMENT AGENCY (FEMA) FLOOD INSURANCE RATE MAP (FIRM) NUMBER 48201C0445L, PANEL 0445L, INCORPORATING PREVIOUS FEMA-APPROVED MAP REVISIONS, AS FURTHER DESCRIBED IN THE PART II TECHNICAL REPORT NARRATIVE, SECTIONS 10.1.2 AND 10.1.3.
4. RECYCLING AREAS ARE PROPOSED FOR THIS FACILITY AS IDENTIFIED ON PART III, ATTACHMENT 1, DRAWING 1-2. AS INDICATED ON THAT DRAWING, THE RECYCLING AREAS WILL ALWAYS BE LOCATED WITHIN THE LIMITS OF THE PROPOSED LANDFILL FOOTPRINT. ACCORDINGLY, THE FACILITIES ARE NOT WITHIN THE 100-YEAR FLOODPLAIN.

STATE OF TEXAS
SCOTT M. GRAVES
86557
LICENSED
PROFESSIONAL ENGINEER
3/3/2014

FOR PERMIT PURPOSES ONLY

REV	DATE	DESCRIPTION	DRN	APP
1	MAR. 2014	REVISED, RESPONSE TO NOD 1	JJV/KH	SMG
-	AUG. 2013	INITIAL SUBMITTAL TO TCEQ	JJV	SMG

USA WASTE OF TEXAS LANDFILLS, INC.

LANDFILL SITE ADDRESS:
8205 FAIRBANKS N HOUSTON RD
HOUSTON, TEXAS 77064
PHONE: 713.824.6867

Geosyntec consultants
GEOSYNTEC CONSULTANTS, INC.
TEXAS ENG. FIRM REGISTRATION NO. 1182
8217 SHOAL CREEK BLVD, SUITE 200
AUSTIN, TEXAS 78757
PHONE: 512.451.4003

TITLE: DETAILED FLOODPLAIN MAP

PROJECT: FAIRBANKS LANDFILL
PERMIT AMENDMENT APPLICATION – PERMIT NO. MSW-1565B

PROJECT NO.:	TXL0263	DESIGN BY:	JJV	REVIEWED BY:	BK	PART NO.:	DRAWING:
FILE:	0263F30	DRAWN BY:	JJV	APPROVED BY:	SMG	II	IIG-1

PERMIT DRAWING

DRAWING: Austin P:\CADD\Projects\F\Fairbanks Landfill\Permit\Expansion (TXL0263)\Drawings\Dwgs-Rev0\0263F30.dwg PLOTTED: Feb 28, 2014 - 11:05am

DEPARTMENT OF THE ARMY
GALVESTON DISTRICT, CORPS OF ENGINEERS
P. O. BOX 1229
GALVESTON, TEXAS 77553-1229

February 11, 2014

Compliance Section

SUBJECT: **SWG-2012-00741**; Waste Management, Approved Jurisdictional Determination, 189-Acre Tract, Harris County, Texas

Shanon Mathis
Berg-Oliver Associates, Inc.
14701 St. Mary's Lane, Suite 400
Houston, Texas 77079

Dear Mr. Mathis:

This letter is in response to your request, dated August 20, 2012 and on behalf of Waste Management, for a jurisdictional determination on a 231-acre tract. The tract is located west of the Fairbanks North Houston Road and West Road intersection, in Harris County, Texas. The tract was reduced to 189 acres on January 17, 2014.

Based on our January 16, 2014 site visit and subsequent desk review, we determined that the 189-acre tract (see enclosed map) does not contain any waters of the United States. Therefore, the discharge of dredged or fill material onto the 189-acre tract is not subject to Section 404 of the Clean Water Act or Section 10 of the Rivers and Harbors Act and does not require a Department of the Army permit.

This determination has been conducted to identify the limits of the United States Army Corps of Engineers (USACE) CWA jurisdiction for the site identified in this request. However, this determination may not be valid for the wetland conservation provisions of the Food Security Act of 1985 as amended. If you or your tenant are USDA program participants or anticipate participation in USDA programs, you should request a certified wetland determination from the local office of the Natural Resources Conservation Service prior to starting work.

This letter contains an approved jurisdictional determination for your subject site. If you wish to appeal the approved jurisdictional determination, please see the enclosed sheets regarding the administrative appeal process for jurisdictional determinations: Notification of Appeals Process (NAP) fact sheet and Request for Appeal (RFA) form. If you object to this determination, you may request an administrative appeal under USACE regulations at 33 CFR Part 331. If you request to appeal this determination, you must submit a completed RFA form to the Southwest Division Office at the following address:

Mr. Elliott Carman
Appeal Review Officer, CESWD-PD-O
U.S. Army Corps of Engineer Division,
Southwestern
1100 Commerce Street, Room 831
Dallas, Texas 75242-1731
Telephone: 469-487-7061; FAX: 469-487-7199

In order for an RFA to be accepted by the Corps, the Corps must determine that it is complete; that it meets the criteria for appeal under 33 CFR Part 331.5, and that it has been received by the Division Office within **60 days** of the date of the NAP. It is not necessary to submit an RFA form to the Division office if you do not object to the determination in this letter.

This approved jurisdictional determination is valid for 5 years from the date of this letter unless new information warrants a revision prior to the expiration date. If you have any questions concerning this jurisdictional determination please reference file number **SWG-2012-00741** and contact me at the letterhead address or by telephone at 409-766-3933 or email at john.davidson@usace.army.mil. To assist us in improving our service to you, please complete the survey found at http://corpsmapu.usace.army.mil/cm_apex/f?p=136:4:0 and/or if you would prefer a hard copy of the survey form, please let us know, and one will be mailed to you.

Sincerely,

John Davidson
Team Lead
Compliance Section

Enclosures

NOTIFICATION OF ADMINISTRATIVE APPEAL OPTIONS AND PROCESS AND REQUEST FOR APPEAL

Applicant:	File Number:	Date:
WASTE MANAGEMENT	**SWG 2012-00741**	**02/11/2014**

Attached is:		See Section below
	INITIAL PROFFERED PERMIT (Standard Permit or Letter of Permission)	A
	PROFFERED PERMIT (Standard Permit or Letter of Permission)	B
	PERMIT DENIAL	C
X	APPROVED JURISDICTIONAL DETERMINATION	D
	PRELIMINARY JURISDICTIONAL DETERMINATION	E

SECTION I - The following identifies your rights and options regarding an administrative appeal of the above decision. Additional information may be found at http://www.usace.army.mil/inet/functions/cw/cecwo/reg/ Or Corps regulations at 33 CFR Part 331.

A: INITIAL PROFFERED PERMIT: You may accept or object to the permit.

- ACCEPT: If you received a Standard Permit, you may sign the permit document and return it to the district engineer for final authorization. If you received a Letter of Permission (LOP), you may accept the LOP and your work is authorized. Your signature on the Standard Permit or acceptance of the LOP means that you accept the permit in its entirety, and waive all rights to appeal the permit, including its terms and conditions, and approved jurisdictional determinations associated with the permit.
- OBJECT: If you object to the permit (Standard or LOP) because of certain terms and conditions therein, you may request that the permit be modified accordingly. You must complete Section II of this form and return the form to the district engineer. Your objections must be received by the district engineer within 60 days of the date of this notice, or you will forfeit your right to appeal the permit in the future. Upon receipt of your letter, the district engineer will evaluate your objections and may: (a) modify the permit to address all of your concerns, (b) modify the permit to address some of your objections, or (c) not modify the permit having determined that the permit should be issued as previously written. After evaluating your objections, the district engineer will send you a proffered permit for your reconsideration, as indicated in Section B below.

B: PROFFERED PERMIT: You may accept or appeal the permit

- ACCEPT: If you received a Standard Permit, you may sign the permit document and return it to the district engineer for final authorization. If you received a Letter of Permission (LOP), you may accept the LOP and your work is authorized. Your signature on the Standard Permit or acceptance of the LOP means that you accept the permit in its entirety, and waive all rights to appeal the permit, including its terms and conditions, and approved jurisdictional determinations associated with the permit.
- APPEAL: If you choose to decline the proffered permit (Standard or LOP) because of certain terms and conditions therein, you may appeal the declined permit under the Corps of Engineers Administrative Appeal Process by completing Section II of this form and sending the form to the division engineer. This form must be received by the division engineer within 60 days of the date of this notice.

C: PERMIT DENIAL: You may appeal the denial of a permit under the Corps of Engineers Administrative Appeal Process by completing Section II of this form and sending the form to the division engineer. This form must be received by the division engineer within 60 days of the date of this notice.

D: APPROVED JURISDICTIONAL DETERMINATION: You may accept or appeal the approved jurisdictional determination (JD) or provide new information.

- ACCEPT: You do not need to notify the Corps to accept an approved JD. Failure to notify the Corps within 60 days of the date of this notice, means that you accept the approved JD in its entirety, and waive all rights to appeal the approved JD.
- APPEAL: If you disagree with the approved JD, you may appeal the approved JD under the Corps of Engineers Administrative Appeal Process by completing Section II of this form and sending the form to the division engineer. This form must be received by the division engineer within 60 days of the date of this notice.

E: PRELIMINARY JURISDICTIONAL DETERMINATION: You do not need to respond to the Corps regarding the preliminary JD. The preliminary JD is not appealable. If you wish, you may request an approved JD (which may be appealed), by contacting the Corps district for further instruction. Also you may provide new information for further consideration by the Corps to reevaluate the JD.

SECTION II - REQUEST FOR APPEAL or OBJECTIONS TO AN INITIAL PROFFERED PERMIT

REASONS FOR APPEAL OR OBJECTIONS: (Describe your reasons for appealing the decision or your objections to an initial proffered permit in clear concise statements. You may attach additional information to this form to clarify where your reasons or objections are addressed in the administrative record.)

ADDITIONAL INFORMATION: The appeal is limited to a review of the administrative record, the Corps memorandum for the record of the appeal conference or meeting, and any supplemental information that the review officer has determined is needed to clarify the administrative record. Neither the appellant nor the Corps may add new information or analyses to the record. However, you may provide additional information to clarify the location of information that is already in the administrative record.

POINT OF CONTACT FOR QUESTIONS OR INFORMATION:

If you have questions regarding this decision and/or the appeal process you may contact:
John Davidson
Compliance Section
Team Lead
CESWG-PE-RC
P.O. Box 1229
Galveston, Texas 77553-1229
Telephone: 409-766-3933 FAX: 409-766-6301

If you only have questions regarding the appeal process you may also contact:
Elliott Carman
Regulatory Appeals Review Officer
Southwestern Division USACE (CESWD-PD-O)
1100 Commerce Street, Suite 831
Dallas, Texas 75242
Phone: 469-487-7061 FAX: 469-487-7199

RIGHT OF ENTRY: Your signature below grants the right of entry to Corps of Engineers personnel, and any government consultants, to conduct investigations of the project site during the course of the appeal process. You will be provided a 15 day notice of any site investigation, and will have the opportunity to participate in all site investigations.

Signature of appellant or authorized agent.	Date:	Telephone number:

Houston-Galveston Area Council

November 25, 2013

Mr. Chuck Rivette, P.E.
Director, Planning and Project Development
USA Waste of Texas Landfills, Inc.
800 Gessner, Suite 1100
Houston, TX 77024

Dear Mr. Rivette:

This letter is to advise you that the H-GAC Board of Directors has reviewed your permit amendment request (MFW 1565B) to your existing Type IV landfill permit (MFW 1565A) for the Fairbanks Landfill, located at 8205 Fairbanks N. Houston Road in unincorporated Harris County.

After reviewing staff comments, the H-GAC Board of Directors has found your project to be consistent with comment. This action was taken by the Board at its regular monthly meeting on November 19, 2013.

Please find attached a summary of staff comments, findings, and action taken by the Board of Directors. These comments, findings, and action reflect the progress of the application as it progressed through H-GAC's review process. These comments are also being forwarded to the agency to which the permit amendment request is addressed.

Sincerely,

Charles Wemple
Chief Operations Officer

CW/jrs
Enclosures
cc: Texas Commission on Environmental Quality

Mailing Address
PO Box 22777
Houston, Texas 77227-2777
Phone 713-627-3200

Recycled

Physical Address
3555 Timmons Lane, Suite 120
Houston, Texas 77027-6466
Phone 713-627-3200

Houston-Galveston Area Council

Summary of Comments and Actions

BOARD OF DIRECTORS

MEETING DATE:	November 19, 2013
PROJECT APPLICANT:	USA Waste of Texas Landfills, Inc.
PROJECT TITLE:	Fairbanks Landfill Expansion Proposal
PROJECT NUMBER:	MFW 1565A MFW 1565B
PROPONENTS:	None
SUMMARIZED BY:	Amy Boyers, Resiliency Coordinator
STAFF COMMENTS:	Staff recommends a finding of consistent with H-GAC's regional plans, policies, and review criteria with the following comment from Harris County Pollution Control Services: *The last four violations were a result of prohibited waste being disposed at this landfill; therefore, please expand upon the waste acceptance and/or prohibited waste rejection plan to prevent this type of violation from occurring again.*
PLANS AND PROJECTS REVIEW COMMITTEE RECOMMENDATION:	N/A
MOTION:	Honorable Joe Rinehart, Mayor, City of Lake Jackson
SECOND:	Honorable Kay Mudd, Councilwoman, City of Iowa Colony
VOTE:	Unanimous

Mailing Address
PO Box 22777
Houston, Texas 77227-2777
Phone 713-627-3200

Physical Address
3555 Timmons Lane, Suite 120
Houston, Texas 77027-6466
Phone 713-627-3200

Recycled

Prepared for:

USA Waste of Texas Landfills, Inc.

PERMIT AMENDMENT APPLICATION

PART III – SITE DEVELOPMENT PLAN

NARRATIVE REPORT

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



SEALED FOR THIS PART III NARRATIVE REPORT, AND FOR PERMITTING PURPOSES ONLY.

WITHIN EACH ATTACHMENT, ITEMS THAT REQUIRE A SIGNATURE AND SEAL BY A LICENSED PROFESSIONAL (E.G., ENGINEER, SURVEYOR, OR GEOSCIENTIST) ARE SIGNED, SEALED, AND DATED, AS APPROPRIATE, BY THE RESPONSIBLE PROFESSIONAL.

Prepared by:

Geosyntec consultants

Texas Board of Professional Engineers Firm Registration No. F-1182
3600 Bee Caves Road, Suite 101
Austin, Texas 78746
(512) 451-4003

Submitted August 2013
Revised March 2014

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NARRATIVE REPORT



3/3/2014

SEALED FOR THIS PART III NARRATIVE REPORT, AND FOR PERMITTING PURPOSES ONLY.

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SEALED FOR THIS PART III NARRATIVE REPORT, AND FOR PERMITTING PURPOSES ONLY.

ATTACHMENTS

WITHIN EACH ATTACHMENT, ITEMS THAT REQUIRE A SIGNATURE AND SEAL BY A LICENSED PROFESSIONAL (E.G., ENGINEER, SURVEYOR, OR GEOSCIENTIST) ARE SIGNED, SEALED, AND DATED, AS APPROPRIATE, BY THE RESPONSIBLE PROFESSIONAL.

Attachment 1 General Facility Design
Attachment 2 Facility Surface Water Drainage Report
Attachment 3 Waste Management Unit Design
Attachment 4 Geology Report
Attachment 5 Groundwater Monitoring Plan
Attachment 6 Landfill Gas Management Plan
Attachment 7 Closure Plan
Attachment 8 Post-Closure Plan
Attachment 9 Cost Estimate for Closure and Post-Closure Care

1. INTRODUCTION

1.1 Terms of Reference

USA Waste of Texas Landfills, Inc. is submitting a Permit Amendment Application to laterally and vertically expand the existing Fairbanks Landfill, a Type IV municipal solid waste (MSW) disposal facility (landfill) located in Houston, Harris County, Texas.

The complete Permit Amendment Application is divided into Parts I through IV as required by 30 TAC §330.57. Part I of the Permit Amendment Application presents site and applicant information. Part II presents an existing conditions summary and information on the character of the facility and surrounding area. Part III presents facility design information, detailed investigative reports, schematic designs of the facility, and required plans. Part IV presents the Site Operating Plan (SOP) which describes the general procedures for conducting day-to-day operations at the facility.

This report and accompanying attachments comprise Part III of the Permit Amendment Application for Permit No. MSW-1565B. Part III addresses the items required by 30 TAC §330.63 by discussing the criteria used in the selection and design of this facility for safeguarding the health, welfare, and physical property of the public and the environment. This Part III narrative report includes discussion of the geology, soil conditions, drainage, land use, zoning, adequacy of access roads and highways, and other considerations specific to this facility.

1.2 Existing Conditions

The facility is located on the northwest side of Houston, outside the Houston city limits (within the extraterritorial jurisdiction of the City of Houston) and approximately 14 miles north of downtown Houston. The facility is located approximately two and a half miles north of US 290 (the Northwest Freeway) and one mile east of Beltway 8 (the Sam Houston Tollway). The facility is located at 8205 Fairbanks N Houston Rd, Houston, Texas, 77064.

The facility is an existing Type IV MSW facility owned and operated by USA Waste of Texas Landfills, Inc., with a permit boundary of 118.1 acres and a disposal footprint of 81.6 acres. The facility initially began disposal operations in about 1984. In about 1990, Sanifill of Texas, Inc. became the permittee under then-Permit No. MSW-1565. In May 1998, the permittee changed its corporate name to USA Waste of Texas Landfills, Inc. In October 1998, Permit No. MSW-1565A was issued, which brought the facility area to a permit boundary of 118.1 acres and a waste disposal footprint consisting of a single landfill unit and an area of 84.1 acres.

Subsequently, in 2002, a minor permit amendment was granted that divided the facility into two landfill units and reduced the waste disposal footprint area to 80.0 acres. Presently, both landfill units (i.e., the entire 80-acre permitted waste disposal footprint) have been constructed, waste has been disposed in the landfill, and the facility is nearing its capacity.

The current facility has a minimum buffer distance from the permit boundary to the limit of waste disposal of 50 feet. The entire existing landfill has a liner meeting the regulatory design criteria for a Type IV landfill facility. Also, the final cover system has been installed over approximately 30.6 acres of the existing landfill, (generally along the west, north, and east sides of the landfill) where final filling grades of Permit MSW-1565A have been reached.

Current ancillary site facilities located outside the permitted waste disposal areas are the entrance facilities (entrance/exit road, scales and scale house/office area), perimeter access roads, surface water drainage features, groundwater monitoring wells, and landfill gas monitoring and control systems. Also, the current permit (MSW-1565A), in addition to waste disposal, authorizes the following processing facilities on-site: (i) a special area to collect large/heavy/bulky items (e.g., appliances) for recycling or salvaging; (ii) a composting operation for leaves, grass clippings, or wood waste (no putrescible waste); and (iii) a wood chipping operation.

1.3 Proposed Expansion

A facility layout plan is presented in Part III, Attachment 3, Drawing 3-1. Inspection of Drawing 3-1 shows that the permit boundary and landfill footprint is proposed to increase towards the east and south. The northern and western limits of the landfill have been constructed, and no changes these existing waste limits are proposed. A minor reduction in the permit boundary is proposed on the west side of the site, to eliminate a small area where facility operations have not occurred and will not occur. No changes are proposed to the existing site entrance/exit location. Table III-1, presented below, summarizes the current permit conditions and the proposed changes.

TABLE III-1

SUMMARY OF CURRENT PERMIT AND PROPOSED EXPANSION - FAIRBANKS LANDFILL

Item	Units	Current Condition (Permit 1565A)	Increase due to Expansion	New Condition (Permit 1565B)
Permit Boundary Area	(acres)	118.1	70.9	188.95
Waste Disposal Footprint Area	(acres)	80.0	57.3	137.3
Buffer/Other Area	(acres)	38.1	13.6	51.7
Buffer/Other Area as a Percentage of Permit Boundary	(percent)	32.3%	19.1%	27.3%
Total Waste Disposal Capacity	(cubic yards)	8,326,000	17,886,000	26,212,000
Remaining Capacity as of 26 March 2012 Aerial Flyover	(cubic yards)	98,000	17,886,000	17,984,000
Projected Remaining Site Life	(years)	0.3	26.7	27.0
Maximum Elevation of Final Cover	(ft, msl)	154.0	96.0	250.0
Elevation of Deepest Excavation	(ft, msl)	51.0	No Change	51.0

As indicated on Attachment 3, Drawing 3-1, the two existing waste disposal units will be joined together to form one combined landfill footprint as part of the expansion. The entire combined landfill footprint will have a contiguous tied-in liner (see Attachment 3, Drawing 3-3) meeting the regulatory-prescribed design criteria for a Type IV landfill facility. Details of the liner system design are discussed subsequently in Section 4 of this report.

Table III-1 indicates that of the proposed 188.95-acre permit boundary, the waste footprint of the landfill will occupy approximately 137.3 acres, and the remaining area of about 52 acres will be used as buffers and other site features (e.g., perimeter access road, surface water ponds, main access road with scales and scale-house/office, etc.).

For Permit MSW-1565B, the filling pattern for waste disposal will start by continuing to fill the existing northern landfill area to higher elevations as the geometry allows for this expansion. Construction of new landfill sectors and subsequent waste filling in those sectors will then progress in the numerical sequence of sectors identified on Attachment 3, Drawing 3-1. More detailed phasing plans showing the excavation and filling sequences was previously presented in a series of drawings in Part II, Appendix IIA of this Permit Amendment Application.

As previously discussed in Part II of the Permit Amendment Application (Section 14.1.1 of the Part II narrative report), there is an existing pipeline easement that crosses the site in a

southwest-northeast orientation. This pipeline easement will be relocated to be adjacent to the southern and eastern permit boundaries (see Attachment 3, Drawing 3-1), and the existing easement and associated pipelines will be abandoned. No solid waste unloading, storage, disposal, or processing operations will occur within any easement, buffer zone, or right-of-way that crosses the site. No solid waste disposal will occur within 25 feet of the center line of any utility line or pipeline easement (but no closer than the easement), unless otherwise authorized by the Executive Director.

Right-of-ways (R.O.W.s) as related to compliance with location restrictions were discussed in Section 14.1.1 of the Part II Narrative Report. As discussed, a 100-ft wide corridor on the southern portion of the site has an outdated R.O.W. that was previously established for an older version of a possible road extension called "West Mount Houston Road". West Mount Houston Road was never built, and is no longer part of the Houston Planning Commission's *2012 Major Thoroughfare and Freeway Plan*. Instead, this *Major Thoroughfare and Freeway Plan* shows a different road alignment of a future roadway called "West Road" that will pass adjacent to the south portion of the site. Land acquisition for this new West Road has not taken place yet, so the new R.O.W. does not yet exist. The outdated West Mount Houston Road R.O.W. on the southern portion of the site will be abandoned (i.e., swapped to the new West Road location). The permit boundary will not encroach on the new West Road R.O.W. Documentation of coordination with the Harris County Public Infrastructure Department-Architecture and Engineering Division on this issue to establish an agreed-upon West Road alignment to replace the outdated R.O.W. is presented in Part II, Appendix IIM.

Ancillary site facilities located outside the permitted waste disposal areas are the entrance facilities (entrance/exit road, scales and scale house/office area), perimeter access roads, surface water drainage features, groundwater monitoring wells, and landfill gas monitoring and control systems. In addition to waste disposal, the following recycling areas will be established on-site: (i) a staging area to collect large/heavy/bulky items (e.g., appliances) for recycling/salvaging; (ii) a wood recycling area; and (iii) a construction and demolition (C&D) waste recycling area. These areas are described in the Section 2.3, and their operations are discussed in Part IV (the SOP).

1.4 Land Use and Zoning

An analysis of land use and zoning, and potential impact on the area surrounding the facility, was prepared by the specialty planning firm, TBG Partners Inc. (TBG), Houston, Texas. TBG's Land Use Study is presented in Part II, Appendix IIB.

1.5 Adequacy of Access Roads and Highways

A Transportation Study evaluating the adequacy of roads and highways and related traffic evaluation was performed by HDR Engineering Inc. (HDR) of Houston and Austin, Texas for this project. The Transportation Study and related documentation of coordination with the Texas Department of Transportation (TxDOT) and other local agencies and school districts is provided in Part II, Appendix IIC.

Access will continue to be provided to the landfill at the existing site entrance/exit on Fairbanks North Houston Road. Regional access to the site is primarily from nearby highways US 290 to the south, or Beltway 8 to the north – both of which lead to Fairbanks N Houston Road, which leads to the site. There are no known weight restrictions on these roads in proximity to the facility, other than the maximum legal weight limit of 80,000 pounds.

1.6 Organization of Part III (Site Development Plan)

The remainder of this report is organized as follows:

- the general facility design is presented in Section 2;
- the facility surface water drainage design is discussed in Section 3;
- the waste management unit design is discussed in Section 4;
- geology and soils topics are addressed Section 5;
- groundwater topics are addressed in Section 6;
- the landfill gas management plan is discussed in Section 7;
- the facility closure plan is discussed in Section 8;
- the facility post-closure plan is discussed in Section 9; and
- cost estimates for closure and post-closure care are discussed in Section 10.

The attachments to the Site Development Plan are organized as follows:

- Attachment 1 provides drawings that present additional information on the general facility design (related to waste movement and access) and the on-site recycling areas and disposal areas;
- Attachment 2 is the Facility Surface Water Drainage Report, with related drawings and calculations;
- Attachment 3 provides the Waste Management Unit Design and related drawings, plans, and calculations for the landfill;
- Attachment 4 is the Geology Report;
- Attachment 5 is the Groundwater Monitoring Plan;
- Attachment 6 is the Landfill Gas Management Plan;
- Attachment 7 is the Closure Plan;
- Attachment 8 is the Post-Closure Plan; and
- Attachment 9 is the Cost Estimates for Closure and Post-Closure Care.

2. GENERAL FACILITY DESIGN

2.1 Introduction

Section 2 of this report has been prepared to address the general facility design topics required by 30 TAC §330.63(b).

2.2 Facility Access Control

This section describes how access will be controlled for the facility, pursuant to 30 TAC §330.63(b)(1). The access controls described below are designed to prevent the entry of livestock, protect the public from exposure to potential health and safety hazards, and to discourage unauthorized entry or uncontrolled disposal of solid waste or hazardous materials. Refer to Section 7 of Part IV (the SOP), for operating requirements related to access control, including the required inspection, maintenance, and notification procedures, as required by 30 TAC §330.131.

Access control to prevent unauthorized access, unauthorized dumping, and public exposure to the landfill is provided by: (i) fencing around the perimeter of the facility; (ii) control features at the main entrance/exit gates; (iii) locked gates at other secondary site access point(s) around the facility perimeter; and (iv) site personnel awareness and observations for maintaining access control. The layout of the fencing around the site perimeter and the location of the main entrance/exit gate are shown on Part III, Attachment 3, Drawing 3-1.

Fencing and gates will serve as the primary landfill access controls. To discourage unauthorized entry into the landfill facility, the perimeter of the facility will be protected by fencing that is at minimum composed of 4-ft high, three-strand barbed wire fence, field fence, or other fence materials.

The site is accessed through an entry gate at the main entrance. Entry to the landfill is restricted to only personnel whose entry is authorized by site management (e.g., the facility employees and contractors, authorized waste haulers, TCEQ personnel, properly identified visitors, etc.). Visitors entering the site are directed to the office location for check-in.

Landfill personnel will direct waste transport drivers to the proper disposal area. There, the drivers will be directed to a specific unloading area. Landfill personnel will also direct drivers needing access to other portions of the facility (e.g., construction contractors). Additionally, when appropriate, signs with directional arrows and/or barricades may be placed along site roads to direct traffic and control interior access.

During normal operating hours, facility personnel will be on duty at the scale house and in the vicinity of landfill operations to control access and disposal operations. When the site is closed, the entry gate will be closed to prevent site access, and locked when no personnel are present on site.

2.3 Waste Movement

2.3.1 Flow Diagram and Schematic Layout

The facility is a Type IV MSW Facility. In accordance with 30 TAC §330.5(a)(2) the facility may accept brush, construction waste, demolition waste, and/or rubbish. The facility may not accept putrescible wastes, conditionally exempt small-quantity generator waste, or household wastes. A more detailed description of the waste stream is included in the waste acceptance plan (Section 2 of the Part II narrative report).

Activities that may take place at the facility are: (i) disposal in the landfill; (ii) recycling/salvaging of large/heavy/bulky items (e.g., appliances); (iii) wood recycling (grinding/chipping/mulching); and (iv) recycling/salvaging of construction and demolition (C&D) materials.

A flow diagram indicating the storage, processing, and disposal sequence is presented on Attachment 1, Drawing 1-1.

A schematic layout of the facility, showing the areas dedicated for waste disposal and identifying the recycling activities and their locations, is presented on Attachment 1, Drawing 1-2.

2.3.2 Solid Waste Disposal Facility (Landfill)

Drawing 1-2 in Attachment 1 presents an overview of the site layout and identifies the areas dedicated for waste disposal (i.e., the landfill). The landfill is designed, and will be constructed and operated, to meet all applicable TCEQ requirements for Type IV landfills. Section 4 of this report describes the "Waste Management Unit Design", including the liner and cover system, and related construction details, specifications, and engineering analyses. Additional engineering plans, drawings, specifications, and calculations for the waste management unit design are also referenced in Section 4 and provided as various attachments to Part III. Operational requirements for the landfill are described in Part IV (the SOP).

2.3.3 On-Site Recycling Areas

Staging Area to Collect and Recycle Large/Heavy/Bulky Items (e.g., Appliances). As allowed by Permit MSW-1565A and proposed to continue to be allowed, a special area to stage and store potentially-recyclable large/heavy/bulky items (e.g., appliances, white goods) received/salvaged at the facility may be maintained at the site. This area will either be located on waste within the current landfill footprint, or in areas within the future landfill footprint, as noted on Drawing 1-2. Due to the changing location of access roads and ongoing waste placement, the location of this area may vary over time. The size of the special area to collect and recycle these materials may vary, depending on the amount of materials received at a given time. The items being collected and staged in this area are not expected to be combustible. The items will be removed often enough to prevent them from becoming a nuisance or hazard, to preclude the discharge of any pollutants from the area, and to prevent an excessive accumulation of the material at the site. The collected materials will be removed from the site for recycling within 180 days or less, or disposed of at the working face within 180 days of acceptance at the facility. Collected materials that are inert may be reused by the facility.

Wood Recycling Area. A wood recycling area may be maintained at the site separate from the working face, to facilitate segregation of wood materials (e.g., brush, leaves, grass clippings, other wood materials) and subsequent on-site grinding/chipping/mulching. This area will either be located on waste within the current landfill footprint, or in areas within the future landfill footprint, as noted on Drawing 1-2. Due to the changing location of access roads and ongoing waste placement, the location of this area may vary over time. The stockpile sizes of these materials may vary, depending on the amount of materials received at a given time. The maximum expected inventory of unprocessed combustible material in this area is 5,000 cubic yards, and the maximum expected inventory of processed combustible material in this area is 2,000 cubic yards. The items will be removed often enough to prevent them from becoming a nuisance or hazard, to preclude the discharge of any pollutants from the area, and to prevent an excessive accumulation of the material at the site. The wood materials will be ground/chipped/mulched and removed from the site within 180 days or less, or disposed of at the working face within 180 days of acceptance at the facility. Wood materials may be reused by the facility.

Potentially-Recyclable Construction and Demolition (C&D) Materials Area. A special area to stage and store potentially-recyclable C&D materials received/salvaged at the facility will be established in an area of the site either located on waste within the current landfill footprint, or in areas within the future landfill footprint, as noted on Drawing 1-2. Due to the changing location of access roads and ongoing waste placement, the location of this area may vary over time.

Examples of potentially-recyclable C&D materials include but are not limited to metal, cardboard, plastic, concrete, bricks, shingles, sheetrock, tires, land clearing debris, wood pallets, or other inert materials. The stockpile sizes of these materials may vary, depending on the amount of materials received at a given time. The maximum expected inventory of combustible material in this area is 1,000 cubic yards. The items will be removed often enough to prevent them from becoming a nuisance, to preclude the discharge of any pollutants from the area, and to prevent an excessive accumulation of the material at the site. The collected materials will be removed from the site for recycling within 180 days or less, or disposed of at the working face within 180 days of acceptance at the facility. Inert C&D materials may be reused by the facility.

2.4 Sanitation and Water Pollution Control at Recycling Areas

As described above in Section 2.3, the recycling areas at the site are the staging area for large/heavy/bulky items; the wood recycling area; and the C&D recycling area. These areas are associated with materials that are basically inert, which are not expected to result in the need for washing or other cleaning operations (other than general housekeeping for tidiness, fire prevention, and control of storm water runon and runoff). Also, the materials in these areas will be kept in stockpiles on the ground surface, so there will be no appreciable infrastructure constructed (e.g., there are no floors, walls, structures, sump drains, etc.).

Each of these areas is designed to control surface water drainage in the vicinity of the areas, to prevent runoff onto and off of these areas, and will be operated and maintained to manage runon and runoff during peak discharge from the 25-year, 24-hour storm event and to prevent the off-site discharge of waste and contaminated water. This will be accomplished through the installation of runon diversion berms up-gradient from the recycling areas in the same manner as for the active working face – in accordance with the Contaminated Water Management Plan (Appendix IV-A of the SOP). This will prevent excessive storm water from passing through the area and potentially causing any washouts of the areas or the generation of contaminated water. The facility will implement necessary steps to control and prevent the discharge of contaminated water in accordance with the Contaminated Water Management Plan. No discharge of contaminated water shall occur without obtaining specific written authorization from the TCEQ prior to the discharge. The landfill will be operated consistent with §330.15(h) regarding discharge of solid wastes or pollutants into waters of the United States.

Operational requirements for these areas are described in Part IV (the SOP), including additional discussion of surface water controls, fire protection, and contaminated water management.

2.5 Endangered Species Protection

Pursuant to 30 TAC §330.61(n) and §330.551, a site-specific endangered and threatened species assessment was conducted in 2012 by Berg-Oliver Associates, Inc. (Berg-Oliver) of Houston, Texas for this project. The assessment included a review of state and federal reference information and a field survey for threatened or endangered species and their habitats. Berg-Oliver also corresponded with the United States Fish and Wildlife Service (USFWS) and the Texas Parks and Wildlife Department (TPWD) regarding the project and Berg-Oliver's findings. Berg-Oliver's assessment, and related correspondence with the USFWS and TPWD are provided in Part II, Appendix II-I.

Berg-Oliver's site-specific field survey by a qualified biologist was conducted to check for listed species or suitable habitats for listed species. No federal- or state-listed endangered or threatened species, or any critical habitats for such species, were found at the site. Berg-Oliver's findings show that ongoing facility development and operation is not expected to cause or result in the destruction or adverse modification of critical habitats or contribute to the taking or harming of any endangered or threatened species.

3. FACILITY SURFACE WATER DRAINAGE REPORT

Pursuant to 30 TAC §330.63(c), a Facility Surface Water Drainage Report is included with Part III. This Report is provided in Part III, Attachment 2. The Facility Surface Water Drainage Report has been prepared to demonstrate that the facility design complies with the requirements of 30 TAC §330.303, and to address the applicable requirements of 30 TAC Chapter 330, Subchapter G. The Report includes a narrative description of the drainage conditions and features at the site under pre-development and post-development conditions and addresses flood protection; and is accompanied by engineering design drawings and supporting hydrology calculations and hydraulic structural design calculations for the site drainage features.

4. WASTE MANAGEMENT UNIT DESIGN

4.1 Introduction

Section 4 of this report presents waste management unit design information, pursuant to 30 TAC §330.63(d)(4). The general facility design was previously addressed in Section 2. Attachment 3 of this SDP provides the supporting engineering drawings, plans, specifications, and calculations for the design of the landfill unit.

4.2 Drawings

A series of engineering drawings presenting details of the waste management unit design are included in Attachment 3, and are listed below.

- Drawing 3-1 Facility Layout Plan;
- Drawing 3-2 Overall Base Grading Plan;
- Drawing 3-3 Overall Final Cover Grading Plan
- Drawing 3-4 Landfill Entrance Plan;
- Drawing 3-5 Landfill Cross-Section Location Map;
- Drawing 3-6 Landfill Cross-Section A-A';
- Drawing 3-7 Landfill Cross-Section B-B';
- Drawing 3-8 Landfill Cross-Section C-C';
- Drawing 3-9 Landfill Cross-Section D-D';
- Drawing 3-10 Landfill Cross-Section E-E';
- Drawing 3-11 General Landfill Construction Design Details I; and
- Drawing 3-12 General Landfill Construction Design Details II.

4.3 Provisions for All-Weather Operation

All-weather roadways will be used to provide access during wet weather from the site entrance along Fairbanks North Houston Road (public roadway) to the waste unloading area being used during wet weather. An all-weather road will also be provided around the landfill perimeter. From the site entrance/exit driveway on Fairbanks North Houston Road up to just past the scale area, the site access road is an all-weather asphalt-paved road. After the scale area, the road transitions to an all-weather gravel surface that continues as an internal access road on the landfill to the waste unloading area being used during wet weather. The layout of the entrance facilities and related access roads is shown on Attachment 3, Drawing 3-4. The landfill perimeter access road around the final landfill configuration is shown on Attachment 3, Drawing 3-3.

Additional interior access roads needed to access waste unloading areas will be established by the facility to provide waste vehicle access and facilitate site operations as waste filling progresses. Portions of these interior access roads are shown on the phase development drawings presented previously in the Permit Amendment Application, in Part II Appendix IIA. These interior access roads will lead from the facility entrance road described above and will continue on to the active working face; accordingly their locations will vary as development progresses. Interior roads that will be used by waste vehicles and landfill operations vehicles during wet weather conditions will be surfaced with all-weather material, such as gravel, so that continuous access to waste disposal areas is provided during both wet and dry weather.

The rough gravel road surfacing on the internal roads used to access the active working face will reduce the amount of mud tracked from the disposal area by shaking and pulling mud off the vehicle tires as they exit the disposal area. Then, the paved entrance roads will further minimize tracking of mud from the site onto public roads.

Access road maintenance requirements, including specific provisions addressing control of mud tracking, dust control, and general road cleaning and safety, are provided as required in Part IV (the SOP).

4.4 Proposed Landfill Method

The facility currently operates, and proposes to continue operating, as a multi-level, modified aerial fill landfill, with above and below-grade filling. The general site layout plan is shown in Attachment 1 on Drawing 3-1. Attachment 1, Drawings 3-2 and 3-3 show the liner system base grades and final cover system grades, respectively. Previously in the Permit Amendment Application, in Part II Appendix IIA, phase development drawings were presented showing the

sequence of excavation and filling at various points in time during upcoming landfill development.

The excavation side slopes will be configured at 3 horizontal:1 vertical (3H:1V) down to the cell floor, which is generally flat. The final aerial fill side slopes (i.e., above-grade final slopes) will be configured at 4H:1V slopes (i.e., a 25% grade) up to a landfill top deck area sloped upward at three (3) percent to a ridgeline, as shown on Drawing 3-3. The final cover system will be installed incrementally with the landfill development progression as fill areas reach their maximum final waste grade elevations.

4.5 Landfill Depth and Height Statistics

The elevation of deepest excavation is 51 feet above mean sea level (ft, MSL). The maximum elevation of waste is 248 ft, MSL. The maximum elevation of the final cover is 250 ft, MSL.

4.6 Estimated Rate of Solid Waste Deposition and Site Life

The landfill volume, estimated rate of solid waste deposition, and the resulting site life estimate is presented in Attachment 3B. For reference, a description of the waste characteristics, anticipated facility service area, and a five-year projection of the estimated maximum annual waste acceptance rate is presented in the "waste acceptance plan" in Part II of the Permit Amendment Application as required by 30 TAC §330.61(b).

4.7 Landfill Cross Sections

A series of landfill cross sections is provided in Attachment 3A (see Drawings 3-6 through 3-10). These cross sections have been selected to pass through key site features so as to accurately depict the existing and proposed depths of all fill areas within the site. The sections show the top of the perimeter berm; top of the proposed fill (top of the final cover); maximum elevation of proposed waste fill; top of the wastes; existing ground; bottom of the excavations; side slopes of trenches and fill areas; gas monitoring probes; groundwater monitoring wells, plus the initial and static levels of any water encountered. The cross-sections also show the logs of soil borings that pass near the profile. The 100-year flood elevation in Rolling Fork Creek is identified on the sections that pass through the west side of the site next to the creek.

4.8 Landfill Construction Design Details

Landfill construction design details are also presented in Attachment 3A (see Drawings 3-11 and 3-12), to accompany the previously mentioned cross section. The cross sections call-out the

design details (e.g., liner system, cover system, perimeter berm), which are then presented on the construction design details drawings.

4.9 Liner System Design and Liner Quality Control Plan

The proposed liner system for the facility is shown on an engineering detail on Attachment 3A, Drawing 3-11, and is described as follows (from bottom to top):

- 3-ft thick recompacted clay liner having a coefficient of permeability no greater than 1 x 10^{-7} cm/sec (i.e., $k \leq 1 \times 10^{-7}$ cm/sec); and
- 1-ft thick protective cover layer.

The existing landfill sectors have already been constructed and approved with either the above type of liner system, or for older sectors, in-situ liner on floor areas. Therefore the entire combined landfill footprint, once constructed, will form a contiguous tied-in liner beneath the facility meeting TCEQ's liner design criteria for a Type IV landfill facility.

Pursuant to 30 TAC §330.63(d)(4)(G), a Liner Quality Control Plan (LQCP), prepared to meet the applicable requirements of 30 TAC §330.339, is presented in Attachment 3C. A sector layout plan drawing is provided in the LQCP to identify and show the location of the sectors, as well as to list the dates of their Soil and Liner Evaluation Reports (SLERs). The LCQP also includes available information on the type of installed liners.

4.10 Geotechnical Analyses of Landfill Design

Geotechnical engineering analyses of the landfill design have been conducted to evaluate the structural integrity of the landfill and underlying foundation. These analyses are as follows (with their location within Attachment 3D noted in parentheses):

- Geotechnical Report (Attachment 3D.1), presenting the soils data collected during site investigations, the results of geotechnical laboratory testing, describing the findings on the suitability of soil conditions, and describing the selection of relevant geotechnical parameters. This attachment has been prepared to include, among other things, the geotechnical information required by 30 TAC §330.63(e)(5).
- Slope Stability (Attachment 3D.2), analyzing the ability of the landfill features and foundation materials to resist driving forces which could have the potential to induce sliding of slopes at the site, and the calculated factors of safety against these events.

- Settlement (Attachment 3D.3), calculating the predicted foundation settlements caused by the landfill loads, and evaluating the magnitude of total and differential settlements and whether they are within acceptable tolerances.

- Liner Uplift, Dewatering System, and Ballast Evaluation (Attachment 3D.4), evaluating the conditions that may lead to special liner design constraints and the design of these associated features.

4.11 Final Cover System Design and Quality Control Plan

The proposed final cover system for the facility is shown on an engineering detail on Attachment 3A, Drawing 3-11, and is described as follows (from bottom to top):

- 1.5-ft thick compacted soil layer composed of clayey soil, classified by the Unified Soils Classification System (USCS) as "SC" (sandy clay), "CL" (lean clay), or "CH" (fat clay) and having a coefficient of permeability (i.e., a hydraulic conductivity) no greater than 1×10^{-5} cm/sec (i.e., $k \leq 1 \times 10^{-5}$cm/sec); and

- A 6-inch or 12-inch thick topsoil layer[(1)] capable of sustaining native plant growth, and seeded immediately following the application of final cover.

[(1)]If the underlying compacted soil layer is classified as SC or CL, the minimum topsoil thickness is 6-inches. If the underlying compacted soil layer is classified as CH, the minimum topsoil thickness is 12-inches.

Other types of soil may be used with prior written approval from the Executive Director.

To date, approximately 30.6 acres of the existing landfill have been covered and approved as final capped with a final cover system meeting the above requirements (and using the 6-inch thick topsoil layer specified above). Approval of the landfill expansion for Permit MSW-1656B will result in the ability to fill additional waste to higher elevations, which will result in some of the existing final cover being sacrificed and filled over. A portion of the existing final cover along the perimeter edges of the northern and western slopes will remain in-place. As adjacent areas of the landfill achieve final waste grades, the final cover system will be installed incrementally and tied-in to adjacent completed areas. Once completed, the entire landfill will be capped with a contiguous final cover system of the same type, and that meets TCEQ's standard prescribed final cover system for a Type IV landfill facility.

A Final Cover Quality Control Plan (FCQCP) has been prepared and is included in Attachment 7 (Closure Plan), providing the design and specifications for the final cover, to meet the applicable requirements of 30 TAC §330.453.

4.12 Final Cover Erosion Protection

The final cover system has been designed to minimize soil loss from erosion. The surface of the final cover system will be vegetated. Drainage terraces are specified as part of the surface water management system (see Attachment 2A, Drawing 2-1) to intercept surface water runoff and limit the length of overland sheet flow. The terraces will direct the runoff into downchutes which will convey the runoff into the perimeter ditch/pond system. These surface water conveyance features are designed to handle the calculated design flow rates, velocities, and tractive stresses (design details and calculations are presented in the Facility Surface Water Drainage Report in Attachment 2). Also, a calculation of the predicted soil erosion loss on the final cover system, with results demonstrating that the final cover is designed with adequate resistance to erosion, is presented in Attachment 3E.

It is also noted that the final cover will be periodically inspected for signs of erosion and ponding of water, and maintained/repaired as necessary during the active life and post-closure care period of the site, as described in Part IV (the SOP) and Part III, Attachment 8 (Post-Closure Plan), respectively.

4.13 Filling of Low Areas During Landfill Development

This section has been added at the request of the Texas Commission on Environmental Quality (TCEQ). It is noted that some areas of the site planned for landfill development have existing ground elevations lower than the design elevations that will form the subgrade for the liner system or the design grades of perimeter features (perimeter berm/road, stormwater conveyances, stormwater ponds). These "low areas" will require placement of fill (e.g., compacted fill) to attain the necessary grades. Examples of the areas requiring fill can be seen by inspecting the landfill cross sections presented in Attachment 3A. These cross sections show areas where finished grade of the landfill liner and perimeter features are at a higher elevation than the existing ground topography.

All low areas of the site that will form the subgrade for the liner system or for supporting perimeter features (perimeter berm/road, stormwater conveyances, stormwater ponds) will be filled using the material specifications, construction procedures, and quality assurance/quality control (QA/QC) requirements for compacted fill, as set forth in the LQCP (Attachment 3C). The purpose of this program is to result in a firm, strong, competent fill material that forms a

suitable subgrade to support adequate performance of the landfill and related facility design features.

It is important to note that the areas requiring fill occur around the perimeter areas of the landfill – not beneath the base of the liner system on the interior floor (base) areas of the landfill. The excavations for the base of the landfill liner will be below existing ground, resulting in a landfill founded on virgin (i.e., natural foundation) material. The areas requiring fill around the perimeter will have much less applied load than the interior portions of the landfill. This is relevant to geotechnical considerations of long-term integrity, as discussed further below, since the relatively small fill areas relative to the overall landfill, and the low applied loads, have less effect on slope stability and settlement.

The geotechnical analyses of the facility presented in Attachment 3 include the fill in the analyses. In particular, Attachment 3D.2 includes evaluation of a cross section taken at the location of the highest/steepest perimeter embankment slope of compacted fill. The analysis included searches for slip surfaces passing through the fill, which were found to be less critical (higher calculated factor of safety) than other scenarios – and all scenarios result in adequate calculated factors of safety against sliding. Attachment 3D.3 addresses settlement which includes consideration of fill as a distinct layer, and the liner system integrity due to total and differential settlement is calculated to be acceptable. By following these specifications, compression of the fill would be expected to be a minor contribution to settlement relative to the contribution due to settlement of the underlying foundation layers (as well as very small relative to the settlement of waste over time). Accordingly, the minor settlement of the fill is not expected to affect the integrity of the liner or final cover systems, as further demonstrated in Attachments 3D.2 and 3D.3.

Also note that the phase development drawings presented in Part II (see Drawings IIA-13 through IIA-17) address the timing of installation of the various perimeter areas (berm/road, drainage features) in conjunction with sector development and waste filling. Additionally, in the Drainage Report (Attachment 2, Section 8), a description of the installation timing of drainage features is discussed.

5. GEOLOGY REPORT

A Geology Report is presented in Part III, Attachment 4. This Geology Report was prepared by the professional geoscientist-of-record for the application, with the firm Biggs & Mathews, Inc., Ft. Worth, Texas. The Geology Report addresses the information required in 30 TAC §330.63(e) with the exception of the geotechnical data required by 30 TAC §330.63(e)(5)(A) and (B), which was prepared by Geosyntec's geotechnical engineer and is presented in Part III, Attachment 3D.1.

In summary, the Geology Report includes descriptions of the regional geology and hydrogeology, geologic processes, regional aquifers, subsurface investigations, and addresses geologic faults and seismicity.

The Geotechnical Report prepared by Geosyntec and presented in Part III, Attachment 3D.1 includes data on the geotechnical properties of the subsurface soil materials and a discussion on the suitability of the soils and strata for the uses for which they are intended.

6. GROUNDWATER MONITORING PLAN

A Groundwater Monitoring Plan is presented in Part III, Attachment 5. This Plan was prepared by the professional geoscientist-of-record for the application, with the firm Biggs & Mathews, Inc., Ft. Worth, Texas. The Groundwater Monitoring Plan addresses the information required in 30 TAC §330.63(f) and the applicable requirements of 30 TAC §330.401 through §330.421 for Type IV Landfills. The Plan includes identification of the point of compliance; an analysis of potential contaminant pathways; details of the required groundwater monitoring program; and the groundwater sampling and analysis plan.

7. LANDFILL GAS MANAGEMENT PLAN

Pursuant to 30 TAC §330.63(g), a facility Landfill Gas Management Plan is included with Part III. This Plan is provided in Part III, Attachment 6. The Landfill Gas Management Plan has been prepared to meet the requirements of 30 TAC §330.371 for Type IV Landfills. This includes the requirements for landfill gas monitoring at the perimeter permit boundary and in on-site structures, and procedures to be followed if excessive methane gas levels are measured.

8. CLOSURE PLAN

Pursuant to 30 TAC §330.63(h), a facility Closure Plan is included with Part III. This Plan is provided in Part III, Attachment 7. The Closure Plan has been prepared to meet the requirements of 30 TAC §330.453 (closure requirements for Type IV Landfills). This includes a description of the final cover system, a discussion of closure activities, drawings and sections, and closure specifications for the construction of the landfill final cover.

9. POST-CLOSURE PLAN

Pursuant to 30 TAC §330.63(i), a facility Post-Closure Plan is included with Part III. This Plan is provided in Part III, Attachment 8. The Post-Closure Plan has been prepared to meet the requirements of 30 TAC §330.463. This includes discussions on post-closure care activities to maintain the facility following closure, persons responsible for the activities, and planned post-closure use of the facility.

10. COST ESTIMATES FOR CLOSURE AND POST-CLOSURE CARE

Pursuant to 30 TAC §330.63(j), cost estimates for closure and post-closure care are included with Part III. This information is provided in Part III, Attachment 9. The closure cost estimate has been prepared to meet the requirements of 30 TAC §330.503, and the post-closure care cost estimate has been prepared to meet the requirements of 30 TAC §330.507. Documentation on financial assurance is included with Attachment 9.

ATTACHMENT 1

GENERAL FACILITY DESIGN

LIST OF DRAWINGS		
Drawing No.	Title	Drawing Date (latest revision)
1-1	Flow Diagram	March 2014
1-2	Schematic Plan of General Facility Design	March 2014

MATERIAL ENTERS THE FACILITY

MEASURED/DOCUMENTED AT THE GATE

RANDOM INSPECTION

YES

DIRECTED TO LOAD INSPECTION AREA

ACCEPTABLE FOR FACILITY?

NO

REJECTED/REMOVED BY HAULER

YES

NO

ACCEPTABLE FOR FACILITY?

YES

NO

REJECTED/REMOVED BY HAULER

LARGE / BULKY / HEAVY ITEMS (E.G. WHITE GOODS)

YES

DIRECTED TO LARGE/HEAVY/BULKY ITEM STAGING AREA

LARGE / BULKY / HEAVY ITEMS REMOVED BY RECYCLER OR DISPOSED AT WORKING FACE. REUSABLE MATERIALS MAY BE USED BY FACILITY.

NO

WOOD RECYCLING MATERIAL

YES

DIRECTED TO WOOD RECYCLING AREA

WOOD MATERIALS SORTED, CHIPPED/GROUND/MULCHED, AND SEGREGATED; AND REMOVED FOR REUSE OR DISPOSED AT WORKING FACE. REUSABLE MATERIALS MAY BE USED BY FACILITY

NO

C&D WASTE RECYCLING MATERIAL

YES

DIRECTED TO C&D WASTE RECYCLING AREA

C&D MATERIALS SORTED AND REMOVED BY RECYCLER OR DISPOSED AT WORKING FACE. REUSABLE MATERIAL MAY BE USED BY FACILITY

NO

PROHIBITED WASTE

YES

NO

WASTE DISPOSED AT WORKING FACE

STATE OF TEXAS
SCOTT M. GRAVES
86557
LICENSED PROFESSIONAL ENGINEER

3/3/2014

FOR PERMIT PURPOSES ONLY

REV	DATE	DESCRIPTION	DRN	APP
1	MAR. 2014	REVISED, RESPONSE TO NOD 1	JJV/KH	SMG
-	AUG. 2013	INITIAL SUBMITTAL TO TCEQ	JJV	SMG

USA WASTE OF TEXAS LANDFILLS, INC.

LANDFILL SITE ADDRESS:
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HOUSTON, TEXAS 77064
PHONE: 713.824.6867

Geosyntec consultants

GEOSYNTEC CONSULTANTS, INC.
TEXAS ENG. FIRM REGISTRATION NO. 1182
8217 SHOAL CREEK BLVD, SUITE 200
AUSTIN, TEXAS 78757
PHONE: 512.451.4003

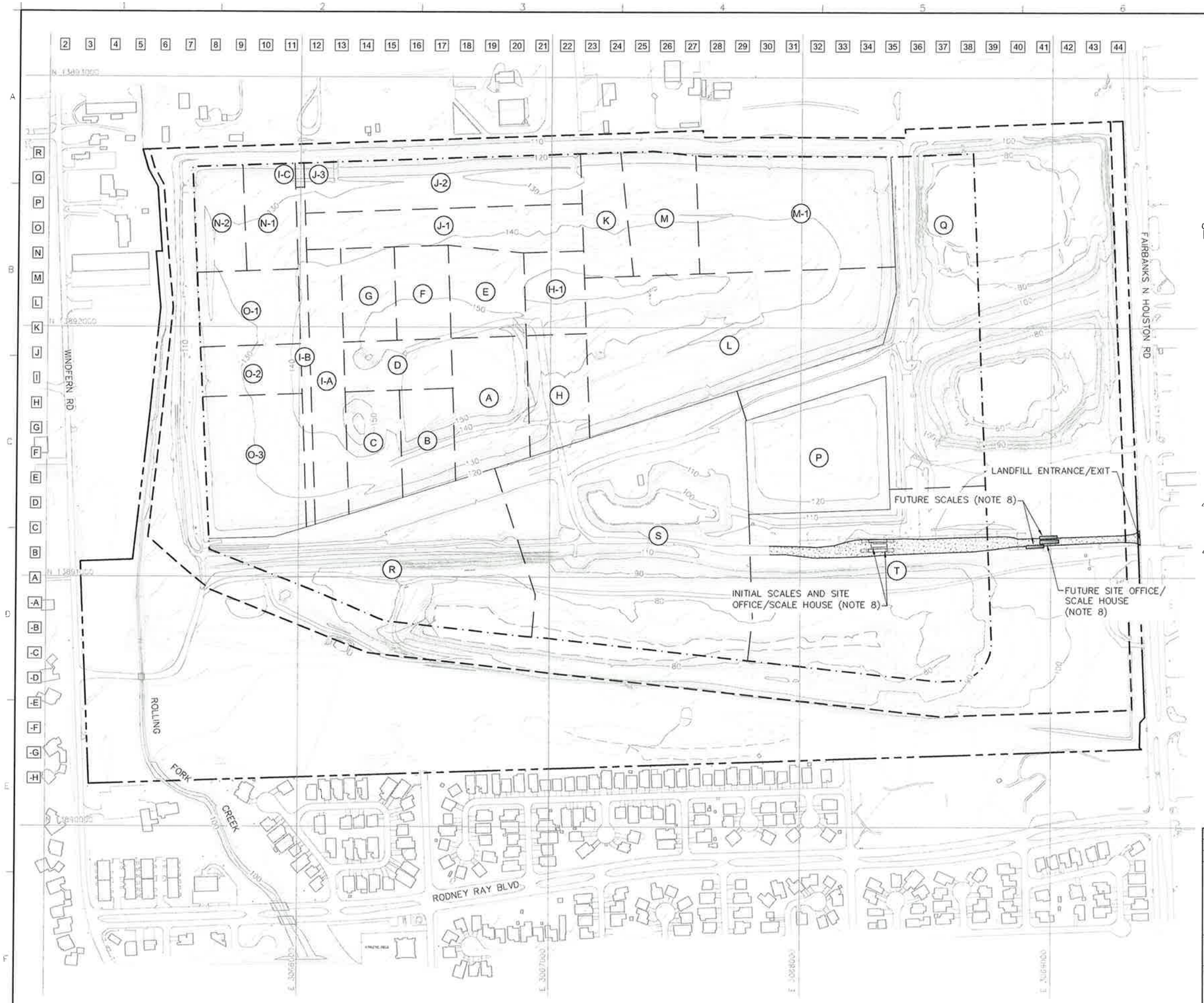
TITLE: FLOW DIAGRAM

PROJECT: FAIRBANKS LANDFILL
PERMIT AMENDMENT APPLICATION – PERMIT NO. MSW-1565B

PROJECT NO.: TXL0263	DESIGN BY: SMG	REVIEWED BY: SMG	PART NO.: III	DRAWING: 1-1
FILE: 0263P1-1	DRAWN BY: JJV	APPROVED BY: SMG		

PERMIT DRAWING

DRAWING: Austin, P:\CADD\Projects\F\Fairbanks Landfill\Permit\Expansion (TXL0263)\Drawings\Dwgs-Rev0\0263P1-1.dwg PLOTTED: Feb 28, 2014 - 11:05am





0 200' 400'
SCALE IN FEET

LEGEND

- 100 — EXISTING GROUND ELEVATION (FT, MSL) (NOTE 1)
- EXISTING ROAD (NOTE 7)
- EXISTING WATER LINE
- N 13891000 E 3099000 — STATE PLANE COORDINATES (NOTE 2)
- 44 — SITE GRID
- PROPERTY BOUNDARY
- EXISTING (PERMIT MSW-1565A) LANDFILL FOOTPRINT
- EXISTING ASPHALT-PAVED SITE ACCESS ROAD (NOTE 7)
- PERMIT BOUNDARY
- PROPOSED LANDFILL FOOTPRINT
- SECTOR BOUNDARY
- (Q) — SECTOR DESIGNATION

NOTES:

1. THE EXISTING TOPOGRAPHIC BASE MAP SHOWN ON THIS DRAWING WAS COMPILED USING PHOTOGRAMMETRIC METHODS BASED ON AERIAL PHOTOGRAPHY PERFORMED ON 26 MARCH 2012 AND PREPARED BY DALLAS AERIAL SURVEYS (DAS), INC.
2. ELEVATIONS ARE IN FEET ABOVE MEAN SEA LEVEL (FT, MSL), AS DEFINED BY THE USGS NATIONAL GEODETIC VERTICAL DATUM (NAVD) OF 1988. STATE PLANE COORDINATE GRID CORRESPONDS TO TEXAS STATE PLANE COORDINATE SYSTEM, TEXAS SOUTH CENTRAL ZONE (4204), NORTH AMERICAN DATUM OF 1983 (NAD-83).
3. EACH LANDFILL DISPOSAL SECTOR WILL RECEIVE THE SAME TYPE OF WASTES, WHICH ARE THOSE WASTES ALLOWED FOR DISPOSAL AT A TYPE IV MSW LANDFILL FACILITY AND AS INDICATED IN THE PERMIT MSW-1565B.
4. THE ACTIVE WASTE DISPOSAL AREA WILL MOVE AS LANDFILLING PROGRESSES. SECTORS A-P ARE ALREADY CONSTRUCTED AND FILLING IS IN PROGRESS. SECTORS Q-T ARE PROPOSED SECTORS FOR THE LATERAL EXPANSION. LANDFILL DEVELOPMENT (EXCAVATION, LINING, AND FILLING) SEQUENCE OF PROPOSED NEW SECTORS WILL BE IN THE ALPHABETICAL ORDER OF THE SECTORS SHOWN. REFER TO DRAWINGS IIA-13 THROUGH IIA-16 FOR PHASE DEVELOPMENT LAYOUT PLANS SHOWING THE FILLING SEQUENCE AND CONFIGURATION. SECTORS MAY BE FURTHER SUBDIVIDED AT THE FACILITY'S DISCRETION.
5. THE RECYCLING AREAS AT THIS SITE ARE:
   - LARGE/HEAVY/BULKY ITEM (E.G. APPLIANCES) STAGING AREA.
   - WOOD RECYCLING AREA.
   - CONSTRUCTION AND DEMOLITION (C & D) WASTE RECYCLING AREA.
6. THE AREAS INDICATED ON NOTE 5 WILL MOVE AS LANDFILLING PROGRESSES, BUT WILL ALWAYS BE LOCATED WITHIN THE LIMITS OF THE PROPOSED LANDFILL FOOTPRINT SHOWN ON THIS DRAWING, TO MAINTAIN THE SET-BACK DISTANCES FROM SITE BUFFERS.
7. MAIN ENTRANCE ROAD IS ASPHALT-PAVED WHERE SHOWN. FROM WHERE THE ASPHALT ENDS, THE ROADS USED TO ACCESS FILL AREAS ARE ALL-WEATHER (E.G. GRAVEL).
8. SCALES AND SITE OFFICE/SCALE HOUSE WILL BE RELOCATED FROM INITIAL LOCATION TO FUTURE LOCATION WHEN LANDFILL DEVELOPMENT AFFECTS THE INITIAL LOCATION (AT THE LATEST). REFER TO PART III, DRAWING 3-4 FOR MORE INFORMATION.



FOR PERMIT PURPOSES ONLY

REV	DATE	DESCRIPTION	DRN	APP
1	MAR. 2014	REVISED, RESPONSE TO NOD 1	JJV/KH	SMG
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PROJECT: FAIRBANKS LANDFILL
PERMIT AMENDMENT APPLICATION – PERMIT NO. MSW-1565B

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ATTACHMENT 2

FACILITY SURFACE WATER DRAINAGE REPORT

Prepared for:
USA Waste of Texas Landfills, Inc.

PERMIT AMENDMENT APPLICATION

PART III – SITE DEVELOPMENT PLAN
ATTACHMENT 2

FACILITY SURFACE WATER DRAINAGE REPORT

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

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1. INTRODUCTION

1.1 Purpose

Pursuant to 30 TAC §330.63(c), this Facility Surface Water Drainage Report (Drainage Report) has been developed as part of the Permit Amendment Application for the proposed expansion of the Fairbanks Landfill, Houston, Texas. This Drainage Report has been prepared to demonstrate that the facility design complies with the requirements of 30 TAC §330.303, and to address the applicable requirements of 30 TAC Chapter 330, Subchapter G. The Report includes a narrative description of the drainage conditions and features at the site under pre-development and post-development conditions and addresses flood control; and is accompanied by engineering design drawings and supporting hydrology calculations and hydraulic structural design calculations for the site drainage features. Specific goals of this Drainage Report are to:

- present an overview of the project, site/watershed setting, and information on the site in relation to the 100-year floodplain;
- describe the current-permitted site conditions and establish the pre-development drainage conditions;
- summarize the proposed surface water management system design and describe the drainage features and components within the facility area;
- describe the post-development drainage conditions;
- describe the hydrologic method and design parameters used to estimate peak flow rates and runoff volumes;
- compare pre-development versus post-development discharges from the site and provide discussion and analyses to demonstrate that the existing pre-development drainage patterns will not be adversely altered as a result of the proposed landfill development;
- describe the hydraulic methods and design parameters used to size the features and components of the surface water management system, and present the structural design of these facilities;
- present the erosion and sediment control information, including requirements for surface water inspections and maintenance;

- address protection from 100-year frequency flooding; and
- present overall conclusions that summarize the results of the drainage analysis and design.

1.2 Project Overview

The Fairbanks Landfill is an existing Type IV Municipal Solid Waste (MSW) Facility located on the northwest side of Houston, outside the Houston city limits and approximately 14 miles north of downtown Houston. The facility is located approximately two and a half miles north of US 290 (the Northwest Freeway) and one mile east of Beltway 8 (the Sam Houston Tollway). Location maps are presented elsewhere in the Permit Amendment Application (e.g., Part II, Appendix IIA). The current-permitted facility (Permit No. MSW-1565A) has a permit boundary of 118.1 acres and a waste disposal footprint occupying 80 acres.

A lateral and vertical expansion of the facility is proposed in this Permit Amendment Application (MSW-1565B). The permit boundary is proposed to increase to 188.95 acres, and the waste disposal footprint area is proposed to increase to approximately 137.3 acres. The remaining acreage not used for waste disposal will be utilized for buffer zones, entrance facilities (entrance/exit road, scales and scale house/office area), perimeter access roads, surface water drainage features, groundwater monitoring wells, and landfill gas monitoring and control systems.

A series of engineering drawings are presented in Attachment 2A of this Drainage Report to present the surface water management system design and associated drainage features. Drawing 2-1 in Attachment 2A introduces the proposed facility drainage design, by presenting the "Surface Water Management System Plan", and shows the location of the landfill and identifies the associated drainage facilities and features.

1.3 Site Setting and Watershed Information

The site is located in central Harris County. In Harris County, the Harris County Flood Control District (HCFCD) manages watershed-wide surface water drainage and flood control issues. The site is part of the White Oak Bayou watershed. White Oak Bayou originates northwest of the site area and flows generally toward the southeast. The Bayou drains areas in northwest portions of the county as well as the City of Jersey Village and portions of the City of Houston. White Oak Bayou joins Buffalo Bayou near downtown Houston. The watershed covers about 111 square miles and includes three primary streams: White Oak Bayou, Little White Oak Bayou, and Cole Creek.

More specifically, Rolling Fork Creek (HCFCD Unit No. E125-00-00) flows in a southerly direction on the western side of the site. Rolling Fork Creek is a tributary of White Oak Bayou (HCFCD Unit No. E100-00-00), and joins White Oak Bayou approximately 1.4 miles south of the site.

Clean surface water runoff from the existing facility is managed through drainage terraces, downchute channels, and perimeter channels which are routed towards an on-site surface water pond; after passing through the surface water pond, the surface water runoff is discharged to Rolling Fork Creek. The proposed landfill expansion will have similar surface water management features, and will continue to route surface water in this same general manner, to pass through surface water ponds and discharge into Rolling Fork Creek in the southwest portion of the site very near the existing site outfall location.

1.4 100-Year Floodplain Information

TCEQ rules for the siting of landfills include a location restriction in 30 TAC §330.547, which specifies that no solid waste disposal operations shall be permitted in Federal Emergency Management Agency (FEMA)-defined 100-year floodways; and that new municipal solid waste management units, existing municipal solid waste units, and lateral expansions that are located in 100-year floodplains must meet certain additional requirements. The facility will meet this location restriction and will not be located in a 100-year floodway, nor will the landfill unit be located in 100-year floodplains. A demonstration of compliance with this location restriction is provided in Part II of the Permit Amendment Application (see Part II Narrative Report, Section 10.1) as required by 30 TAC §330.61(m)(1). An overview of this information is presented below.

The site and vicinity are part of FEMA Flood Insurance Rate Map (FIRM) Panel Number 48201C0445L (June 18, 2007). Map revisions have been subsequently approved, but the 2007 version of the full FIRM panel has not yet been physically revised by FEMA to reflect the post-2007 revisions. These previously approved revisions include the following relevant approved map revisions in the site vicinity:

- Conditional Letter of Map Revision (CLOMR) Case No. 97-06-307R (issued August 25, 1997); and
- Letter of Map Revision (LOMR) Case No. 08-06-1925P (issued February 26, 2009).

A map showing the resulting FEMA defined 100-year floodplain location in relation to the existing Fairbanks Landfill is presented in Part II (see Drawing IIG-1, in Appendix IIG). The conclusions of the floodplain evaluation are as follows:

- the facility's landfill disposal limits are not and will not be within the 100-year floodway;
- the 100-year flood profile elevations in Rolling Fork Creek adjacent to the site range from an elevation of about 108 ft above mean sea level (ft, MSL) next to northern portions of the site, to 105 ft, MSL next to southern portions of the site;
- neither the existing constructed landfill, nor the proposed expansion landfill disposal limits are within the 100-year floodplain; and
- additionally, the limit of fill construction of not just the landfill itself, but also the ancillary landfill-related features proposed by this Permit Amendment Application (e.g., the landfill perimeter berms, the surface water pond berms), are outside of the 100-year floodplain.

Additional information on protection of the facility from flooding (including addressing flood protection freeboard at the landfill perimeter) is discussed in Section 7 of this Report, after details of the proposed design and resulting analyses are presented.

2. DESCRIPTION OF THE PRE-DEVELOPMENT CONDITION

From review of USGS maps showing the topography of the natural conditions of the site prior to development/disturbance activities (e.g., Part II, Appendix IIA, Drawing IIA-2), the conditions before the landfill existed can be described as generally flat, with gradual mild slopes that tend towards the west towards Rolling Fork Creek. The natural ground elevations of the site ranged from approximately an elevation of 115 feet above mean sea level (ft, MSL) in the northeastern part of the site, to just under an elevation of 100 ft, MSL at the downstream side of Rolling Fork Creek in the southwestern portion of the site. As mentioned previously, the existing landfill has been largely developed, which has changed the conditions within the current permit boundary to be those permitted rather than the pre-landfill natural conditions.

Therefore, the pre-development drainage areas encompass the existing facility, the expansion area, and off-site drainage areas that contribute runoff to the site. This will allow a proper comparison to post-development conditions at the common point-of-interest (the discharge point where water exits the site to Rolling Fork Creek), as discussed later in this report. Accordingly, the pre-development conditions are defined as follows:

- Within the current permit boundary (MSW-1565A), the pre-development conditions are the final permitted condition.
- Within the expansion areas being added by Permit MSW-1565B, the pre-development conditions are the natural conditions described above, taken from the USGS topographic map.
- Other off-site areas that contribute runoff onto the site are also delineated using the existing topography of those conditions.

The pre-development conditions and resulting drainage areas are delineated on Drawing 2-2, presented in Attachment 2A of this Drainage Report. Inspection of Drawing 2-2 shows that the pre-development drainage area is 205.2 acres, which flows to a single exit point to Rolling Fork Creek in the southwest portion of the site.

Drawing 2-2 also indicates the calculated peak flow rate and the volume of runoff discharged from the site for the 25-year, 24-hour storm event under pre-development conditions. A description of the hydrologic method and design parameters is presented subsequently in this Report.

3. PROPOSED SURFACE WATER MANAGEMENT SYSTEM

3.1 General

This section summarizes the proposed surface water management system design and describes the drainage features and components within the facility. The facility will have above and below grade waste filling over lined areas. A series of drawings presenting the liner base (excavation) grades, the site configuration during phased development and waste filling, and the landfill completion plan, are presented in Part II of the Permit Amendment Application (see Drawings IIA-12 through IIA-17). As described below, certain permanent components of the overall site surface water management system will be constructed during initial development of a cell, while other components will be installed as portions of the landfill reach final grade or at the time of closure.

As mentioned, specific to this Drainage Report, a series of engineering drawings are presented in Attachment 2A to present the surface water management system design and associated drainage features. Drawing 2-1 in Attachment 2A of this Drainage Report presents the final configuration of the landfill and the related surface water management system features. As shown, the landfill will have overall sideslopes inclined at 4 horizontal to 1 vertical (4H:1V) (i.e., 25%). At the crest of the final cover sideslopes, the final cover grades then continue up at a shallower top-deck grade of three percent (3%), up to a peak (ridgeline) elevation. In this Drainage Report, final cover slope areas with grades of 3% are designated as top deck areas, and final cover slopes with overall grades of 4H:1V are designated as sideslope areas.

3.2 Surface Water Management System Components

Various surface water management system components collect and convey surface water from the final cover system to the discharge point from the site, as described below. The sizing and hydraulic design of these features is described later in this Drainage Report, in Section 5 (which references detailed calculation packages presented as attachments included with this Drainage Report).

Drainage Terraces and Downchutes. Sideslope drainage terraces installed as "tack-on" berms on the final cover sideslope will intercept surface water runoff (i.e., sheet flow) along the up-gradient sideslope areas of the final cover, and convey runoff to downchute channels. Similar drainage terraces will be constructed at the crest of the landfill sideslope, on the top deck of the final cover, to collect and convey sheet flow runoff from the 3% slope top deck surfaces to the downchute channels. Trapezoidal shaped downchute channels oriented essentially perpendicular

to the landfill slopes (i.e., down-slope) will collect the runoff from the top deck and sideslopes and convey this runoff to the landfill perimeter at the toe of the cover system sideslopes. These downchute channels will be lined with an articulated concrete block (ACB) material, or equal, to resist hydraulic forces from the water flowing in these channels.

Perimeter Channel. The western and northern sides of the landfill are existing, and include perimeter channels to convey runoff from drainage terraces and downchutes, and any contributing sheet flow, around the landfill and into surface water ponds. The proposed expansion will continue to route runoff from the western and northern sides of the landfill in this manner, using the same alignment and slopes as the existing perimeter channels. Due to the additional drainage areas contributing to these perimeter channels, they will need to convey larger peak flows than the existing perimeter channels and therefore in some cases will be widened to provide the additional capacity requirements. The perimeter drainage channels around the west and north sides of the site have a single high-point (see Drawing 2-4), approximately mid-way along the northern side of the site. One side of the channel high-point will convey flow eastward, into the Northeast Surface Water Pond. The other side of the channel high-point will convey flow westward and then southward around the landfill perimeter and into a culvert that flows into the South Surface Water Pond.

Culverts. There are three culverts proposed (see Drawing 2-1). Culvert C1 is a box culvert that will receive flow from the perimeter channel on the west side of the landfill, and will convey water into the South Pond. Culvert C2 is a pipe culvert located on the eastern portion of the site beneath the main facility access road that will hydraulically connect the South Pond and the Northeast Pond. Culvert C3 is a pipe culvert that serves as the outfall discharge point from the South Pond into Rolling Fork Creek, on the southwestern side of the site.

Surface Water Ponds. Two surface water ponds are proposed (see Drawing 2-1): a Northeast Surface Water Pond; and a South Surface Water Pond. It is noted that the term "surface water pond" is used because the ponds are intended to provide a detention function (controlling the rate of surface water release from the site), as well as provide a sediment control/water quality function.

The two surface water ponds will be hydraulically connected by the aforementioned Culvert C1, a 24-inch corrugated metal pipe situated beneath the site access road.. As mentioned, the perimeter channel along the western and northern sides of the site will convey runoff into these ponds. Additionally, runoff collected by the drainage terraces and downchutes on the eastern and southern portions of the landfill will convey flow into these ponds. At the eastern end of the perimeter channel where it enters the Northeast Surface Water Pond, a grouted riprap apron will be used for erosion protection. At the southwestern end of the perimeter channel, a culvert (C1) will be used to connect the perimeter channel to the South Surface Water Pond (and will also

have erosion protection). Where the downchutes flow directly into the ponds, the ACB-lined (or equivalent) downchute channels will cross the perimeter road by way of low water crossings, and will connect with the ponds (with the ACB-lining continuing into the pond for erosion protection). The hydraulically-connected surface water ponds are designed to be "wet ponds" – that is, portions of the pond will extend deeper than the lowest outlet point at elevation 99.5 ft MSL. This will result in what is often referred to as a "permanent pool" elevation of the pond of 99.5 ft, MSL (although it is noted that the water surface elevation is not necessarily permanent, and may fluctuate lower than this elevation during, for example, seasonally dry periods). The final discharge point of the facility surface water management system will occur at the outlet location in the southwest portion of the South Surface Water Pond, through aforementioned Culvert C3, a 60-inch corrugated metal pipe. The geometry and appurtenances of the surface water ponds will detain and release the surface water runoff at rates equal to or less than the pre-development discharge rates from the site as described later in this Report.

Active-Area Surface Water Controls. During ongoing landfill development and prior to final cover installation and closure, the site will utilize temporary diversion berms and contaminated water holding areas to maintain the separation of clean runoff from potentially-contaminated water. Temporary diversion berms will be placed up-gradient from active waste areas (i.e., the working face) to intercept clean runoff and route it around active areas to the surface water management system. Also, containment berms will be used to create holding areas down-gradient from the working face to hold any contaminated water that is generated, and prevent its runoff and discharge from the site. The requirements regarding active-area surface water controls are presented in the Contaminated Water Management Plan (Part IV, Appendix IV-A). The calculations for sizing of the active-area surface water controls are presented in this Drainage Report, in Attachment 2F.

Interim Erosion and Sediment Control Measures. Erosion and sediment control is addressed in Section 6 of this Drainage Report. In addition, an Intermediate Cover Erosion and Sediment Control Plan (ICESCP), is provided in Attachment 2H to this Drainage Report, and includes a description of the measures to be utilized during interim conditions at the site.

4. DESCRIPTION OF THE POST-DEVELOPMENT CONDITION

The post-development drainage areas will encompass the proposed permit boundary (i.e., existing facility and the expansion area), and off-site drainage areas that contribute runoff to the site, as follows:

- Within the proposed permit boundary (MSW-1565B), the post-development conditions are the final conditions that incorporate the proposed landfill and the surface water management features described in Section 3.

- Other off-site areas that contribute runoff onto the site are also delineated using existing topography of those conditions.

The post-development conditions and resulting drainage areas are delineated on Drawing 2-3, presented in Attachment 2A of this Drainage Report. The post-development surface water management features at the site and the routing sequence will be as discussed in Section 3. Inspection of Drawing 2-3 shows that the post-development drainage area is 205.2 acres (the same area as the pre-development drainage area), and there is a single exit point to Rolling Fork Creek in the southwest portion of the site (a few feet away from the pre-development exit point).

Drawing 2-3 also indicates the calculated peak flow rate and the volume of runoff discharged from the site for the 25-year, 24-hour storm event under post-development conditions. A description of the hydrologic method and design parameters is presented subsequently in this Report. Also, in Section 5.5.1, comparisons of the pre-development and post-development conditions are made.

5. DRAINAGE CALCULATIONS

5.1 General

In accordance with 30 TAC §330.303(a), the surface water management system has been designed to be capable of passing the peak discharges from the 25-year, 24-hour rainfall event. Design calculations are made to demonstrate that post-development peak discharges exiting the facility are less than pre-development flows exiting the facility. Calculations have been performed to size the drainage features, and to verify that flow velocities and tractive stresses in conveyance components will not cause erosion of the drainage terraces, downchute channels, perimeter channels, culvert outlets, etc. These calculations related to the site surface water management features are presented as additional attachments to the Drainage Report, and are as follows:

- Hydrology calculations (i.e., calculations of peak runoff rates and total runoff volumes for the pre-development conditions and post-development conditions) are presented in Attachment 2B. This attachment also includes the storm routing through the on-site surface water ponds, and the resulting hydrology and hydraulics associated with the detention capabilities of the ponds.

- Hydraulic calculations for sizing and design of the surface water pond appurtenances (i.e., outlet aprons and anti-seep collars) are presented in Attachment 2C.

- Hydraulic calculations for sizing and design of the drainage terraces and downchute channels are presented in Attachment 2D.

- Hydraulic calculations for sizing and design of Culvert C1 and perimeter drainage channels are presented in Attachment 2E.

- Hydrology and hydraulics calculations for active-area surface water controls are presented in Attachment 2F.

It is also noted that an additional calculation package for predicting soil loss and sizing of interim erosion and sediment controls is presented in Attachment 2H.

5.2 Design Storm

As indicated above and pursuant to 30 TAC §330.63(c)(1)(D)(i), the 25-year, 24-hour rainfall depth was utilized as the design storm for the surface water management system design. The rainfall depth-duration frequency relationships for Harris County were obtained from HCFCD (2009). A rainfall depth of 9.6 inches was chosen to represent the 25-year, 24-hour rainfall, as determined by the HCFCD for the Harris County Hydrologic Region 2 for White Oak Bayou (HCFCD, 2009). Additional information concerning the design storm parameters is presented in Attachment 2B to this Drainage Report.

5.3 Hydrologic Methods

The U.S. Army Corps of Engineers Hydrologic Engineering Center – Hydrologic Modeling System (HEC-HMS) computer program was used to model the pre-development conditions and the post-development conditions. HEC-HMS is the successor to and replacement for the HEC-1 program. Modeling was used to calculate surface water runoff volumes, peak flow rates, routing of rainfall event hydrographs through perimeter channels and surface water ponds, and runoff discharge quantities. Attachment 2B of this Drainage Report presents detailed drainage calculations, including a detailed discussion of the parameters used in the analyses and results of the hydrologic modeling efforts.

5.4 Hydraulics

Principles of open channel flow using Manning's equation (Chow, 1959) were used to size the perimeter drainage channels, top deck drainage terraces, sideslope drainage terraces, drainage downchute channels, and drainage culverts based on the peak flows, derived from the HEC-HMS hydrologic modeling.

Manning's Equation in its general form is expressed as:

$$Q = \frac{1.49}{n} A R^{2/3} S_o^{1/2}$$

where:
- Q = discharge (cfs);
- n = manning's roughness coefficient;
- A = area of cross-section of flow (ft^2);
- P = wetted perimeter (ft);

R = hydraulic radius (ft) = A/P; and

S_0 = longitudinal slope (ft/ft).

The average tractive stress for a given depth of flow in a channel is calculated by:

$$\tau_o = \gamma_w RS$$

where:

τ_o = average tractive stress (lb/ft^2);

γ_w = unit weight of water (lb/ft^3);

R = hydraulic radius (ft); and

S = channel slope (ft/ft).

Tractive stresses, as well as flow velocities resulting from peak flows, were calculated to select the type of channel lining that would be required to prevent erosion of the drainage features.

Elevation-area relationships were developed for the surface water ponds and subsequently input to the HEC-HMS model for post-development conditions. The elevation-area relationship is calculated based on the size, depth, and shape of the ponds, while the elevation-outflow relationship is calculated based on the configuration of the outflow control structure.

As mentioned, the computations for sizing surface water management system components are found in the following attachments to this Drainage Report:

- Attachment 2B – Hydrology;
- Attachment 2C – Surface Water Pond Appurtenances Design Calculations;
- Attachment 2D – Drainage Terraces and Downchute Channels; and
- Attachment 2E – Culverts and Perimeter Drainage Channels.

5.5 Calculation Results Summary

5.5.1 Discharge Comparisons

Table 5.5.1-1 summarizes the pre- and post-development peak discharges, total discharge volume, and the time to the peak discharge rate. The pre- and post-development drainage area contributing to the discharge at the site outfall is 205.2 acres.

TABLE 5.5.1-1

SUMMARY OF PEAK DISCHARGE CONDITIONS AT SITE OUTFALL (PRE- VS. POST-DEVELOPMENT COMPARISON)

	PRE-DEVELOPMENT		POST-DEVELOPMENT	
	25-YEAR	100-YEAR	25-YEAR	100-YEAR
PEAK DISCHARGE (CFS)	173.0	271.1	129.8	156.4
TOTAL RUNOFF VOLUME (AC-FT)	122.7	181.8	121.4	179.0
TIME TO PEAK DISCHARGE (MIN)	55	45	50	74
PEAK DISCHARGE VELOCITY (FT/SEC)	13.8	21.6	6.6	8.0

A more detailed description of the analysis and modeling results summarized above are included in Attachment 2B. Examination of the table above indicates that the predicted peak post-development discharge rates are less than the peak pre-development discharge rates at the site outfall. The runoff volumes are similar for pre-development and post-development conditions. The small differences in runoff volumes are due to the slight change in land cover and addition of larger-sized proposed surface water ponds under post-development conditions. The slight lowering of runoff volumes is expected to provide a very minor but beneficial effect to the off-site watershed by discharging less total volume to the Rolling Fork Creek watershed during the evaluated storm events (i.e., a slight alleviation of flood water volumes under post-development conditions). The times to peak discharge are also not substantially different between pre- and post-development conditions, and the peak discharge velocities at the site outfall are less under proposed conditions than under pre-development existing conditions.

Additionally, since the facility is located within the White Oak Bayou watershed, HCFCD manages watershed-wide surface water drainage and flood control issues, a regional watershed drainage evaluation was performed on USA Waste Landfills of Texas, Inc.'s behalf for the proposed expansion design by Jones & Carter, Inc., Houston, Texas. Jones & Carter's drainage impact analysis independently assessed the potential effects of the proposed expansion on the surrounding watershed area and in consideration of HCFCD drainage criteria, and was submitted to the HCFCD for their review. HCFCD reviewed the evaluation and issued a finding that they have no objections to the conclusions that the project will cause no adverse impact to the receiving waterways in storm events up to and including the 100-year event. Documentation from the HCFCD is provided in Attachment 2G of this Drainage Report.

In summary, the proposed outfall will be in the same location as the existing outfall, and surface water runoff under proposed post-development conditions is generally routed towards this outfall

in a similar manner to pre-development conditions. The proposed drainage areas and patterns of runoff will be similar to the existing permitted pre-development drainage patterns. The lower peak discharge rates under post-development conditions are viewed as a benefit given the importance of attenuating runoff in the urban and relatively low-lying Houston area, as confirmed by HCFCD's concurrence with the findings of no adverse impacts to off-site areas. This information demonstrates that the existing pre-development drainage patterns will not be adversely affected by the proposed expansion.

5.5.2 Surface Water Ponds

Surface water generated at the site is routed through the surface water ponds, and the post-development information presented above in Section 5.5.1 represents information at the site outfall (i.e., the outlet of the South Surface Water Pond). The surface water ponds were sized to adequately detain and pass the 25-year, 24-hour storm event while maintaining at least one foot of freeboard, and to hold the 100-year, 24-hour rainfall event without overtopping. Also, while not a TCEQ requirement, Geosyntec adopted an additional design criterion that is specified by HCFCD – namely, that site surface water ponds should have a detention storage capacity of not less than 0.55 acre-feet (ac-ft) per acre of new developed area. The HEC-HMS model was used to calculate surface water runoff volumes, peak flow rates, peak water surface elevations, and routing of rainfall event hydrographs through both the Northeast Pond and the South Pond, as described in Section 5.3 above.

TABLE 5.5.2-1

SURFACE WATER POND WATER LEVELS AND DETENTION CAPACITY

	25-Year Event		**100-Year Event**	
	Northeast Pond	**South Pond**	**Northeast Pond**	**South Pond**
Peak Water Surface Elevation (ft)	102.2	105.7	103.3	107.7
Available Freeboard to Pond Crest (ft)	8.8	5.3	7.7	3.3
Peak Storage Capacity per Pond (ac-ft)	62.0	47.3	80.0	65.3
Combined Peak Storage Capacity (ac-ft)	109.3		145.3	
Minimum HCFCD Required Storage Capacity (ac-ft)	104.8		104.8	

As shown in the above table, adequate freeboard is provided for the 25-year, 24-hour storm. Additionally, the 100-year, 24-hour storm event is maintained below the crest of the ponds and below the elevation of the specified emergency spillway.

5.5.3 Perimeter Channels

Perimeter channels have been designed to convey the peak flows from the 25-year, 24-hour rainfall while maintaining at least one foot of freeboard. Additionally, perimeter channels were designed with the capacity to convey the 100-year, 24-hour rainfall event. Predicted tractive stresses and velocities for peak flows during the 25-year, 24-hour rainfall have been evaluated and channel linings have been selected accordingly. Drawing 2-4, Perimeter Drainage Channel Plans With Stationing, shows the designation and layout of the perimeter drainage channels. Drawing 2-5 presents the perimeter drainage channel profiles. A table summarizing channel widths, depths, and slopes is provided on Drawing 2-10, and calculations pertaining to the perimeter drainage channel design are presented in Attachment 2E to this Drainage Report. Table 5.5.3-1 summarizes the peak 25-year, 24-hour and peak 100-year, 24-hour design flows in the proposed perimeter channels.

TABLE 5.5.3-1

PERIMETER DRAINAGE CHANNEL RESULTS

Channel Segment Designation	25-Yr Peak Flow Rate (ft^3/s)	25-Yr Peak Flow Depth (ft)	25-Yr Peak Flow Velocity (ft/s)	25-Yr Peak Tractive Stress (lb/ft^2)	Freeboard (ft)	Proposed Channel Lining Material
R1	160.89	3.79	2.44	0.21	1.21	Native Vegetation
R2	160.8	3.79	2.44	0.21	1.21	Native Vegetation
R3	323.9	4.67	2.89	0.27	1.33	Native Vegetation
R4	146.5	3.90	2.39	0.20	1.10	Native Vegetation
R5	146.5	3.90	2.39	0.20	1.10	Native Vegetation
R6	262.9	4.02	2.72	0.24	1.23	Native Vegetation

Note: Channel segments R1 and R4 were assumed to be equivalent to channel segments R2 and R5, respectively. These channel segments are immediately down gradient of the perimeter channel highpoint, and subsequently other drainage structures do not discharge directly into these channel segments.

5.5.4 Drainage Terraces

The top deck and sideslope drainage terrace layout is presented on the Facility Surface Water Management Plan, Drawing 2-1. Details of both the top deck and sideslope drainage terraces are presented on Drawing 2-7, and calculations pertaining to the design of these structures are presented in Attachment 2D to this Drainage Report. Drainage terraces have been designed to convey the peak flows from the 25-year, 24-hour storm while maintaining a minimum of one

foot of freeboard. Additionally, the drainage terraces have been designed with the capacity to convey the 100-year, 24-hour rainfall event. Based on the calculated peak tractive stresses, grass lining will be adequate to resist erosion of the channel during a 25-year rainfall event. Table 5.5.4-1 summarizes the peak 25-year, 24-hour design flows for the each of the top deck drainage terraces.

TABLE 5.5.4-1

TOP DECK DRAINAGE TERRACE RESULTS

Terrace Designation	25-Yr Peak Flow Rate (ft^3/s)	25-Yr Peak Flow Depth (ft)	25-Yr Peak Flow Velocity (ft/s)	25-Yr Peak Tractive Stress (lb/ft^2)	Freeboard (ft)	Proposed Channel Lining Material
TD_1	62.7	1.66	1.27	0.08	1.34	Native Vegetation
TD_3	52.5	1.55	1.21	0.07	1.45	Native Vegetation
TD_5	52.9	1.55	1.22	0.07	1.45	Native Vegetation
TD_7	77.5	1.79	1.34	0.08	1.21	Native Vegetation
TD_9	18.3	1.04	0.93	0.05	1.96	Native Vegetation
TD_11	37.0	1.36	1.11	0.06	1.64	Native Vegetation

The sideslope drainage terraces were calculated to convey the peak flows for the 25-year and 100-year rainfall events. Calculations indicate that one foot of freeboard will be maintained during the 25-year rainfall event. The following ranges of results were calculated for all the sideslope drainage terraces:

- Peak 25-Year Design Discharge = 3.37 to 31.51 cfs
- Peak 100-Year Design Discharge = 4.51 to 42.19 cfs
- Channel Slope = 1.99% to 6.25%
- Calculated 25-Year Depth of Flow = 0.51 to 1.47 ft
- Calculated 100-Year Depth of Flow = 0.57 to 1.64 ft
- ***Calculated 25-Year Depth of Flow plus Freeboard < Available Depth of Flow [confirmed acceptable]***

- ***Calculated 100-Year Depth of Flow < Available Depth of Depth of Flow [confirmed acceptable]***
- Allowable Tractive Stress = 1.0 psf
- Calculated 25-Year Tractive Stress = 0.54 to 1.00 psf
- ***Calculated 25-Year Tractive Stress ≤ Allowable Tractive Stress [confirmed acceptable]***

5.5.5 Downchute Channels

Downchute channels have been designed to convey the peak flows from the 25-year, 24-hour rainfall event while maintaining a minimum of one foot of freeboard and the 100-year, 24-hour rainfall event for the layout presented on the Facility Surface Water Management Plan, Drawing 2-1. Details of the downchute channels are presented on Drawings 2-7 through 2-9, and calculations pertaining to the downchute channel designs are presented in Attachment 2D to this Drainage Report. Table 5.5.5-1 summarizes the peak 25-year, 24-hour design calculations for each of the downchute channels. Erosion control at the discharge (ends) of the downchute channels will consist of aprons that are a continuation of the downchute channel lining (e.g., articulated concrete block (ACB)) as described in Attachment 2D and shown in Drawings 2-7, 2-8, and 2-9.

TABLE 5.5.5-1

DOWNCHUTE CHANNEL RESULTS

Downchute Designation	25-Yr Peak Flow Rate (ft^3/s)	25-Yr Peak Flow Depth (ft)	25-Yr Peak Flow Velocity (ft/s)	25-Yr Peak Tractive Stress (lb/ft^2)	Freeboard (ft)	Proposed Channel Lining Material
D1	160.8	0.94	19.44	10.81	1.06	ACB [1]
D2	231.8	0.90	20.16	11.42	1.10	ACB [1]
D3	181.9	0.88	19.40	10.78	1.12	ACB [1]
D4	227.5	0.90	20.04	11.31	1.10	ACB [1]
D5	156.0	0.92	19.27	10.67	1.08	ACB [1]
D6	223.6	0.99	20.67	11.85	1.01	ACB [1]
D7	146.5	0.89	18.92	10.37	1.11	ACB [1]

Note: [1] Channel lock articulating concrete block (ACB) system, or a lining system having equivalent resistance to tractive stress, may be used as the lining material for downchute channels.

5.5.6 Culverts

As mentioned, there are three culverts proposed (see Drawing 2-1). The culverts have been analyzed for both the 25-year, 24-hour rainfall event and the 100-year, 24-hour rainfall event, to confirm that they can adequately function during both storm events. The hydraulic design of Culvert C1 (the box culvert) is presented in Attachment 2E to this Drainage Report. Culvert C1 was designed by utilizing the HY-8 Culvert Analysis Program v.7.3 (HY-8) developed by the Federal Highway Administration. The performance of the culvert is modeled and assessed based on boundary conditions, culvert configuration, peak flow criteria, and tailwater levels in the receiving surface water pond during the high-water levels in the pond predicted to exist at the time the Culvert C1 peak flows occur for the respective design storms analyzed.

Culverts C2 and C3 are for the storm water pond connection, and discharge outlet, respectively. The design analysis for those storm water pond culverts based on their selected size, elevations, and slope is contained within Attachment 2B, rather than a separate culvert design package. This is because the design storm runoff is routed into and through the ponds (via the culverts), and therefore their calculated performance (discharge flows, pond elevations, etc.) accounts for the water levels predicted to exist in the ponds during the design storms as part of the overall site hydrology analysis. Design of the surface water pond appurtenances (which refers to anti-seep collars and riprap aprons at the pond outlet (Culvert C3)) is presented in Attachment 2C.

A table summarizing culvert design parameters and discharge rates is provided on Drawing 2-10.

6. EROSION AND SEDIMENT CONTROL

6.1 General

The facility has been designed to minimize soil erosion losses, thereby providing effective erosional stability to top dome surfaces and external embankment side slopes during all phases of landfill operation, closure, and post-closure care. The surface water management system design described in this Drainage Report accomplishes this utilizing properly-sized and designed drainage terraces, downchute channels, perimeter drainage channels, culverts, and surface water ponds. These features provide for positive drainage of runoff from the final cover system and surrounding site areas and within acceptable tolerances for stresses that could cause erosion. As described in Section 3.2 of this Drainage Report, perimeter drainage channels, surface water ponds, and drainage terraces will be utilized during development and operation of the facility and will ultimately transport any sediment from the final cover or intermediate cover slopes to surface water ponds.

Additionally, temporary grassing/stabilization, diversions, and other best management practices (BMPs) will be used to minimize soil erosion and sedimentation during intermediate conditions. These BMPs along with other measures utilized while landfill slopes have intermediate cover are discussed in the Intermediate Cover Erosion and Sediment Control Plan (ICESCP), which is provided in Attachment 2H to this Drainage Report. As areas of the landfill reach final grade, the final cover system, which includes vegetation and other final long-term surface water management system components located on the sideslopes and the top deck areas, will be installed.

6.2 Soil Loss Minimization

The long-term effects of erosion have been evaluated using the Revised Universal Soil Loss Equation (RUSLE) for the intermediate and final cover surfaces. These analyses are more thoroughly discussed for the intermediate cover and final cover surfaces in Appendix 2H-1 of Attachment 2H and in Attachment 3E of the Site Development Plan, respectfully. When landfill slopes contain intermediate cover prior to receiving final cover, measures will be taken to minimize soil erosion and loss. These measures are discussed in the ICESCP located in Attachment 2H of this Drainage Report. Surface water conveyance structures have been designed for landfill areas with both intermediate and final cover systems. Flow velocities have been estimated for these conveyance structures to determine if erosion controls, other than grassing, are required (e.g., concrete lining, geomembranes, geosynthetic erosion control

materials, riprap lining materials, etc.). As suggested in TxDOT Highway Design Manual, flow conveyance structures with velocities in excess of 5 feet per second have been specified to utilize erosion control materials.

6.3 Seeding and Stabilization Activities

Temporary and permanent stabilization will be used during the construction and operation of the facility to minimize soil erosion and sedimentation. Temporary stabilization will be performed as described in the ICESCP (see Attachment 2H).

Permanent stabilization will be performed in conjunction with final cover system construction (for the landfill) and final closure of the facility (for other disturbed areas), as described in the Closure Plan (Part III, Attachment 7).

6.4. Surface Water Maintenance Plan

6.4.1 General

During site construction activities and site operations, inspection and maintenance of disturbed areas and their surface water management system features will be conducted in accordance with the facility's Texas Pollutant Discharge Elimination System (TPDES) Multi-Sector General storm water permits. Written records of these inspections and maintenance activities will be maintained as required by the TPDES permits, as further discussed in Part IV – Site Operating Plan (SOP), Section 24.

During the post-closure care period for the facility, inspections will be performed as indicated in Section 3 of the Post-Closure Plan located in Attachment 8 to the SDP.

6.4.2 Site Maintenance Activities

In general, the following procedures will be followed when deemed necessary by the inspections performed as part of the TPDES permit and as further discussed in Section 24 of the SOP, to maintain and ensure functionality of the surface water management system and erosion and sedimentation controls:

- Eroded areas or areas with ponding water will be regraded to their original slopes and reseeded or covered with an erosion resistant material. Upgrades to the original design specifications can be considered at this remedial stage depending upon the severity of systems degradation.

- Additional temporary erosion protection and sediment control measures using established BMPs will be implemented (seeding, temporary berms, ditches, silt fences, erosion mat, check dams, silt traps, etc.), as necessary, during operation to minimize the amount of erosion and sedimentation. These measures can be eliminated once the need is gone (i.e., once long-term vegetation is established and permanent conveyances are in place).

- Piped structures (culverts, pond outlets, etc.) will be kept clean of debris to ensure optimal flow capabilities.

- Vegetated water conveyance areas will be mowed periodically to encourage healthy growth and to maintain design flow capacities and erosion resistance.

- Temporary diversion berms will be constructed up gradient of the active working face to limit surface water run-on to waste operations. The temporary containment berms downslope of working areas, interphase berms, or temporary cell berms in interim areas (as appropriate) will also serve to contain surface water runoff down gradient of active working areas. Any surface water that comes in contact with waste will be handled as contaminated water and kept separate from clean runoff.

- Erosion control structures such as surface water ponds will be cleaned periodically (removal of debris and sediment) in order to maintain design capacity. The surface water ponds will be cleaned by removing sediment using a backhoe, front-end loader, dozer or other similar equipment. The excavated sediment will be transported to designated areas of the site for spreading and drying (must be surrounded by adequate temporary erosion controls).

- Areas of distressed vegetation will be identified and revegetated.

- Broken or washed-out drainage terraces, downchute channels, perimeter channels, and culverts will be repaired.

- Excess silt, weeds and other debris from drainage channels and other conveyances will be removed to restore their design configuration, followed by re-vegetating the disturbed areas as appropriate.

The decision on whether or not maintenance or repairs of site surface water features are needed and the timing on implementing any remedies is based on the severity of the problem compared

to the disturbance that will be caused by the repair and seasonal factors (weather patterns, growing season, etc.).

7. PROTECTION FROM FLOODING

As described previously in Section 1.4 of this Drainage Report, the landfill will not be within the 100-year floodway, nor will it be located within the 100-year floodplain. Additionally, the limit of fill construction of not just the landfill itself, but also the perimeter landfill-related features proposed by this Permit Amendment Application (e.g., the landfill perimeter berms, the surface water pond berms), is outside of the 100-year floodplain. Furthermore, the portion of the site closest to Rolling Fork Creek has already been constructed and stabilized with vegetation, and since it is outside of the floodplain, by definition it is not expected to restrict the flow and storage capacity of the 100-year frequency flood; nor are other constructed features at the site.

The FEMA floodplain map and backup information (Part II, Appendix IIG) show that the 100-year flood profile elevations in Rolling Fork Creek adjacent to the site range from an elevation of about 108 ft, MSL next to northern portions of the site, to 105 ft, MSL next to southern portions of the site. All proposed landfill expansion areas are designed with outside-edge of the perimeter berm elevations that are 111.0 ft, MSL or higher. The lowest perimeter elevation of the existing landfill is slightly lower, at elevation 110.6 ft, MSL. In all cases, more than 3-ft of freeboard between the 100-year flood elevation and the limit of waste elevation at the edges of the landfill. Drawing 2-1 shows the location of the 100-year floodplain, and also identifies the calculated flood protection freeboard at the landfill perimeter were it is adjacent to the 100-year floodplain. This is provided as further confirmation that >3-ft of freeboard is provided. Drawing 2-12 provides this information for a typical section along the western perimeter in cross-section view, to further illustrate the flood protection provided adjacent to Rolling Fork Creek.

8. DRAINAGE FEATURE INSTALLATION SCHEDULE

The phased landfill development configurations are illustrated in Part II of the permit amendment application. Specifically, Part II, Attachment 2A, Drawings IIA-13 through IIA-17 show the sequence of development and the layout of the related features at given points in time. The notes on these drawings provide a description of each phase, and address the timing of installation of the final drainage features that have been discussed in this Drainage Report. The remainder of this section provides a summary of the installation schedule for drainage features.

Overall, as the landfill is developed, the landfill will have temporary grassing/stabilization, diversions, and other best management practices (BMPs) installed on top deck and external facing slopes in accordance with the Intermediate Cover Erosion and Sediment Control Plan (ICESCP) provided in Attachment 2H. Areas that have achieved final waste grades will have their final cover system installed incrementally; and the final landfill drainage features (i.e., final cover with topsoil and vegetation, drainage terraces, and downchutes) required for those aeras being final capped will be installed in conjunction with the final cover installation.

With respect to perimeter landfill features (perimeter ditches, culverts, and storm water ponds), those final features will be installed no later than when storm water runoff generated by the landfill expansion areas (i.e., newly added vertical expansion slopes, or new lateral expansion sectors) contributes flow towards those perimeter features. Also, when the perimeter berm/road is to serve as a run-on control feature for active areas, it must be built before the sector becomes active (i.e., before waste placement begins).

More specifically, from the information presented on the aforementioned phase development plans in Part II of the permit amendment application, it is expected that the final perimeter drainage features will be installed according to following approximate schedule:

- Start of Phase 1: The existing drainage features will continue to be used.
- When Phase 1 Waste Filling is Nearing Completion (and prior to construction of Sector Q): The perimeter channel upgrades should be accomplished to achieve the slopes and sizes specified herein for the north and west side perimeter ditches, and the new reach of perimeter channel in the northeast portion of the site should be constructed:
- During Phase 2 Waste Filling: The Northeast Storm Water Pond will be constructed.

- When Phase 2 Waste Filling is Nearing Completion (and in conjunction with building Sector R): The adjacent portion of the South Storm Water Pond will be constructed (including removal of the existing outfall pipe, and installation of the new outfall pipe). Culvert C1 will also be constructed.

- When Phase 3 Waste Filling is Nearing Completion (and in conjunction with building Sector S): The adjacent portion of the South Storm Water Pond will be constructed.

- When Phase 4 Waste Filling is Nearing Completion (and in conjunction with building Sector T): The remainder of the South Storm Water Pond will be constructed

9. CONCLUSION

This Drainage Report has been prepared to demonstrate that the facility design complies with the requirements of 30 TAC §330.303, and to address the applicable requirements of 30 TAC Chapter 330, Subchapter G. The Report is accompanied by engineering design drawings and supporting hydrology calculations and hydraulic structural design calculations for the site drainage features. The following conclusions summarize the results of the drainage analysis and design:

- The drainage design criteria selected meet the requirements of 30 TAC Chapter 330.
- The surface water management system drainage structures (terraces, downchutes, ditches, and culverts) are designed to adequately convey peak flows from the 25-year rainfall event.
- The surface water pond capacities and outlet structure are designed in accordance with the rules for the 25-year rainfall event and with erosion protection to attenuate the velocity and dissipate the energy at the outfall.
- Erosion will be minimized through the interim and permanent design features and best management practices described herein.
- The post-development discharge rates from the site are less than the pre-development discharge rates, and the discharge volumes and time-to-peak discharge are similar.
- The HCFCD has determined that the regional watershed will not be adversely impacted.
- The landfill is not within the 100-year floodway or 100-year floodplain, nor will filling occur in the 100-year floodplain. The landfill is protected from the 100-year frequency flood event.
- The post-development drainage patterns will be similar to the existing pre-development permitted drainage patterns and will direct surface water runoff to the same outfall location. The existing pre-development drainage patterns will not be adversely altered.

ATTACHMENT 2A

SURFACE WATER MANAGEMENT SYSTEM DRAWINGS

LIST OF DRAWINGS		
Drawing No.	Title	Date
2-1	Facility Surface Water Management Plan	March 2014
2-2	Pre-Development Plan With Drainage Patterns	March 2014
2-3	Post-Development Plan With Drainage Patterns	August 2013
2-4	Perimeter Drainage Channel Plan With Stationing	August 2013
2-5	Perimeter Drainage Channel Profile	August 2013
2-6	Surface Water Ponds – Plan View	March 2014
2-7	Surface Water Management System Details I	March 2014
2-8	Surface Water Management System Details II	August 2013
2-9	Surface Water Management System Details III	August 2013
2-10	Surface Water Management System Details IV	March 2014
2-11	Culvert Sections	March 2014
2-12	Rolling Fork Creek and Landfill Perimeter Berm Section	March 2014

PERIMETER CHANNEL

EXISTING FINAL COVER (TO REMAIN)

EXISTING RUN-ON CONTROL CHANNEL (NOTE 5)

EXISTING RUN-ON PERIMETER BERM

DOWNCHUTE DRAINAGE CHANNEL AT EXISTING LANDFILL PERIMETER (TYP) (7, 2-9)

NORTH PERIMETER CHANNEL EXTENSION

PERIMETER BERM ELEV=114.7 FLOODPLAIN ELEV=108.0 6.7 FT FREEBOARD

PERIMETER BERM ELEV=116.1 FLOODPLAIN ELEV=107.5 8.6 FT FREEBOARD

PERIMETER BERM ELEV=110.6 FLOODPLAIN ELEV=106.7 3.9 FT FREEBOARD

(1, 2-12)

WINDFERN RD

4:1 (TYP)

3% (TYP)

TOP DECK DRAINAGE TERRACE (2, 2-7)

TOP DECK DRAINAGE TERRACE AND DOWNCHUTE DRAINAGE CHANNEL INTERSECTION (5, 2-8)

SIDESLOPE DRAINAGE TERRACE (TYP) (1, 2-7)

DOWNCHUTE DRAINAGE CHANNEL (TYP) (3, 2-7)

NORTHEAST SURFACE WATER POND BASE WATER ELEV 99.5 (FT, MSL) (NOTE 8)

FAIRBANKS N HOUSTON RD

SURFACE WATER POND CONNECTION – PLAN VIEW (DRAWING 2-6)

LANDFILL ENTRANCE EXIT

SURFACE WATER OUTFALL

CULVERT C1

CULVERT C2

CULVERT C3

PROPOSED SITE OFFICE /SCALE AREA

SOUTH SURFACE WATER POND OUTLET – PLAN VIEW (DRAWING 2-6)

ROLLING

TYPICAL SIDESLOPE DRAINAGE TERRACE AND DOWNCHUTE DRAINAGE CHANNEL INTERSECTION (TYP) (4, 2-7)

DOWNCHUTE DRAINAGE CHANNEL AT PROPOSED LANDFILL PERIMETER – PLAN (TYP) (6, 2-8)

SOUTH SURFACE WATER POND BASE WATER ELEV 99.5 (FT, MSL) (NOTE 8)

FORK CREEK

RODNEY RAY BLVD

N 13892000

E 3068000

E 3068500

E 3069000

PERMIT DRAWING

N

0 200' 400'
SCALE IN FEET

LEGEND

- EXISTING GROUND ELEVATION (FT, MSL) (NOTES 1,2)
- EXISTING ROAD
- EXISTING WATER LINE
- STATE PLANE COORDINATES (NOTE 2)
- SITE GRID
- PROPERTY BOUNDARY
- PROPOSED PERMIT BOUNDARY
- OVERALL LIMIT OF FINAL COVER
- TOP DECK DRAINAGE TERRACE
- SIDESLOPE DRAINAGE TERRACE
- DOWNCHUTE DRAINAGE CHANNEL
- DRAINAGE FLOW DIRECTION
- PROPOSED GROUND ELEVATION (FT, MSL) (NOTE 3)
- 100-YEAR FLOODPLAIN (NOTE 7)

NOTES:

1. THE EXISTING TOPOGRAPHIC BASE MAP SHOWN ON THIS DRAWING WAS COMPILED USING PHOTOGRAMMETRIC METHODS BASED ON AERIAL PHOTOGRAPHY PERFORMED ON 26 MARCH 2012 AND PREPARED BY DALLAS AERIAL SURVEYS (DAS), INC.
2. ELEVATIONS ARE IN FEET ABOVE MEAN SEA LEVEL (FT, MSL), AS DEFINED THE USGS NATIONAL GEODETIC VERTICAL DATUM (NAVD) OF 1988. STATE PLANE COORDINATE GRID CORRESPONDS TO THE TEXAS STATE PLANE COORDINATE SYSTEM, TEXAS SOUTH CENTRAL ZONE (4204), NORTH AMERICAN DATUM OF 1983 (NAD 83).
3. TOP OF FINAL COVER SYSTEM REFERS TO THE PROPOSED FINISHED GRADE (TOP OF THE TOPSOIL COMPONENT OF THE FINAL COVER SYSTEM). LIMIT OF FINAL COVER SYSTEM REFERS TO THE TOE OF SLOPE OF THE TOPSOIL LAYER.
4. OUTSIDE OF THE LIMIT OF FINAL COVER, THE PROPOSED CONTOURS REFER TO FINISHED GRADE.
5. EXISTING RUN-ON CONTROL CHANNEL IS LOCATED AT TOE OF NORTHERN SLOPE PERIMETER BERM, WITHIN PERMIT BOUNDARY AND WILL BE MAINTAINED AS NEEDED FOR POSITIVE DRAINAGE.
6. INFORMATION ON SURFACE WATER POND APPURTENANCES IS PROVIDED ON SHEET 2-6.
7. 100-YEAR FLOODPLAIN LIMITS ARE FROM FEMA MAPS, AS DESCRIBED IN PART II, NARRATIVE REPORT, SECTIONS 10.1.2 AND 10.1.3.
8. SURFACE WATER PONDS WILL BE "WET" PONDS. ACCORDINGLY, THE BASE WATER ELEVATION REFERS TO THE OUTFALL ELEVATION. THUS, THE DETENTION VOLUME OF THE PONDS IS CALCULATED AS THE STORAGE VOLUME ABOVE THIS BASE WATER ELEVATION.

STATE OF TEXAS
SCOTT M. GRAVES
86557
LICENSED PROFESSIONAL ENGINEER
3/3/2014

FOR PERMIT PURPOSES ONLY

REV	DATE	DESCRIPTION	DRN	APP
1	MAR. 2014	REVISED, RESPONSE TO NOD 1	JJV/KH	SMG
–	AUG. 2013	INITIAL SUBMITTAL TO TCEQ	JJV	SMG

USA WASTE OF TEXAS LANDFILLS, INC.

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AUSTIN, TEXAS 78757
PHONE: 512.451.4003

TITLE:

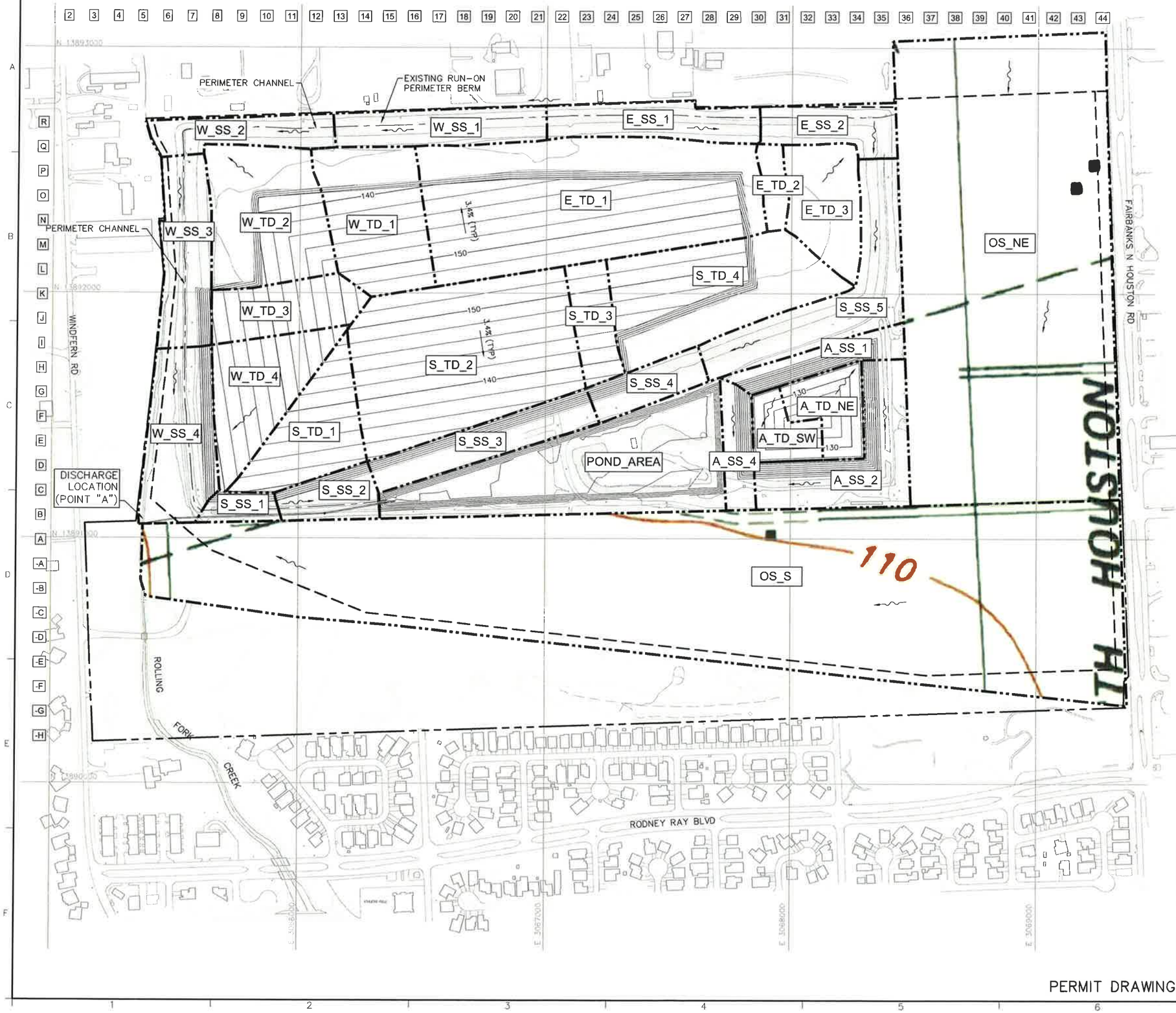
FACILITY SURFACE WATER MANAGEMENT PLAN

PROJECT:

FAIRBANKS LANDFILL
PERMIT AMENDMENT APPLICATION – PERMIT NO. MSW-1565B

PROJECT NO.: TXL0263	DESIGN BY: BK	REVIEWED BY: SMG	PART NO.: III	DRAWING: 2-1
FILE: 0263P2-1	DRAWN BY: JJV	APPROVED BY: SMG		

DRAWING: Austin P:\CADD\Projects\F\Fairbanks Landfill\Permit\Expansion (TXL0263)\Drawings\Dwgs-Rev0\0263P2-1.dwg PLOTTED: Feb 28, 2014 - 11:07am



LEGEND

- EXISTING GROUND ELEVATION (FT, MSL) (NOTES 1,2)
- EXISTING ROAD
- EXISTING WATER LINE
- STATE PLANE COORDINATES (NOTE 2)
- SITE GRID
- PROPERTY BOUNDARY
- PROPOSED PERMIT BOUNDARY
- DRAINAGE FLOW DIRECTION
- PERMITTED GROUND ELEVATION (FT, MSL) (NOTE 2)
- DRAINAGE AREA DESIGNATION
- DRAINAGE AREA

0 200' 400'
SCALE IN FEET

NOTES:

1. THE EXISTING TOPOGRAPHIC BASE MAP SHOWN ON THIS DRAWING WAS COMPILED USING PHOTOGRAMMETRIC METHODS BASED ON AERIAL PHOTOGRAPHY PERFORMED ON 26 MARCH 2012 AND PREPARED BY DALLAS AERIAL SURVEYS (DAS), INC.
2. ELEVATIONS ARE IN FEET ABOVE MEAN SEA LEVEL (FT, MSL), AS DEFINED THE USGS NATIONAL GEODETIC VERTICAL DATUM (NAVD) OF 1988. STATE PLANE COORDINATE GRID CORRESPONDS TO THE TEXAS STATE PLANE COORDINATE SYSTEM, TEXAS SOUTH CENTRAL ZONE (4204), NORTH AMERICAN DATUM OF 1983 (NAD 83).
3. CURRENT PERMITTED SURFACE WATER MANAGEMENT SYSTEM PLAN TAKEN FROM MSW PERMIT 1565A ATTACHMENT 1-H, DRAWING 1-H DATED 14 JULY 2009.
4. THE PURPOSE OF THIS DRAWING IS TO PRESENT THE DRAINAGE AREAS MODELED IN THE RUNOFF CALCULATION PACKAGE, ATTACHMENT 2B, FOR THE PRE-DEVELOPMENT CONDITION.
5. UNITED STATES GEOLOGICAL SURVEY (USGS) TOPOGRAPHIC MAP USED TO MODEL THE NATURAL CONDITIONS ADJACENT TO THE CURRENTLY PERMITTED LANDFILL BOUNDARY.

PRE-DEVELOPMENT DRAINAGE CALCULATIONS					
			25 YR, 24-HR STORM		
DISCHARGE POINT	CONTRIBUTING DRAINAGE AREAS	WATERSHED AREA (AC)	FLOW RATE (CFS)	FLOW VOLUME (AC-FT)	VELOCITY (FT/S)
A	ALL DESIGNATED	205.2	173.0	122.7	13.8

STATE OF TEXAS
SCOTT M. GRAVES
86557
LICENSED
PROFESSIONAL ENGINEER
3/3/2014

FOR PERMIT PURPOSES ONLY

REV	DATE	DESCRIPTION	DRN	APP
1	MAR. 2014	REVISED, RESPONSE TO NOD 1	JJV/KH	SMG
-	AUG. 2013	INITIAL SUBMITTAL TO TCEQ	JJV	SMG

USA WASTE OF TEXAS LANDFILLS, INC.

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AUSTIN, TEXAS 78757
PHONE: 512.451.4003

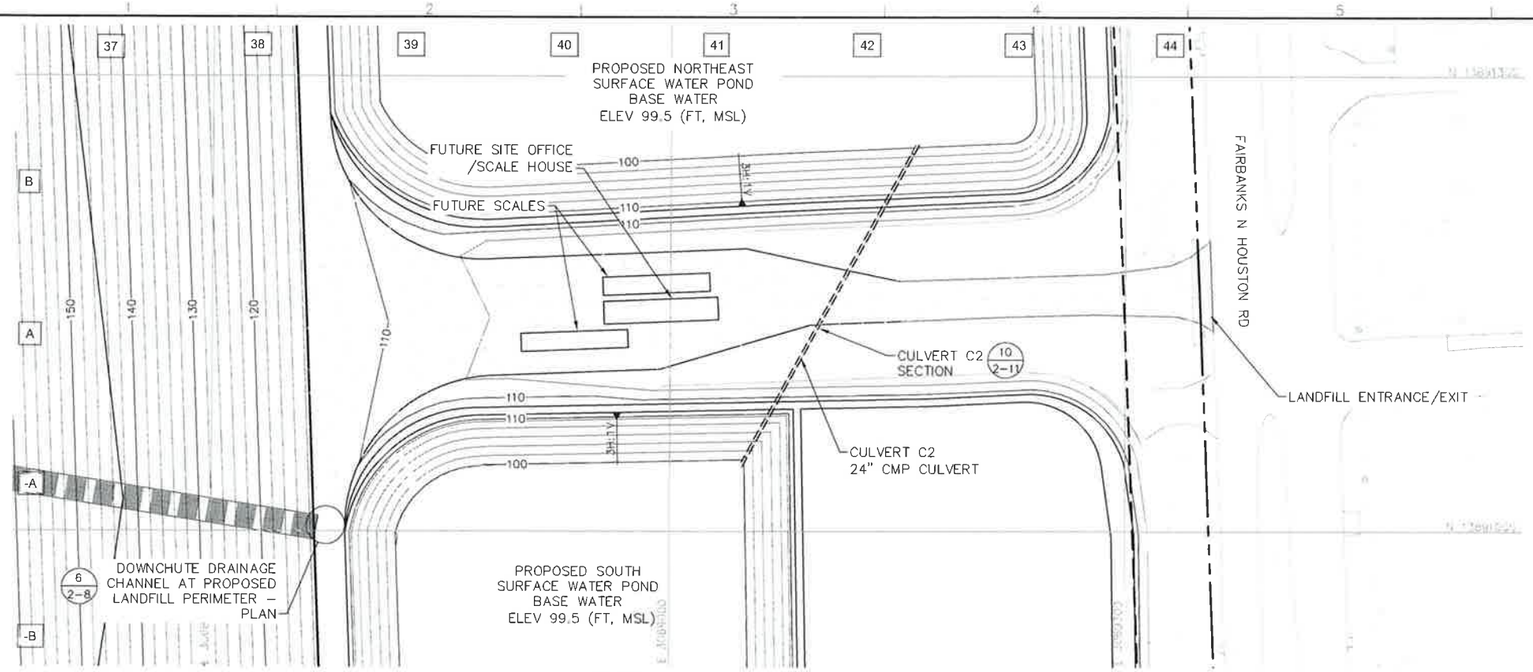
TITLE:
PRE-DEVELOPMENT PLAN WITH DRAINAGE PATTERNS

PROJECT:
FAIRBANKS LANDFILL
PERMIT AMENDMENT APPLICATION - PERMIT NO. MSW-1565B

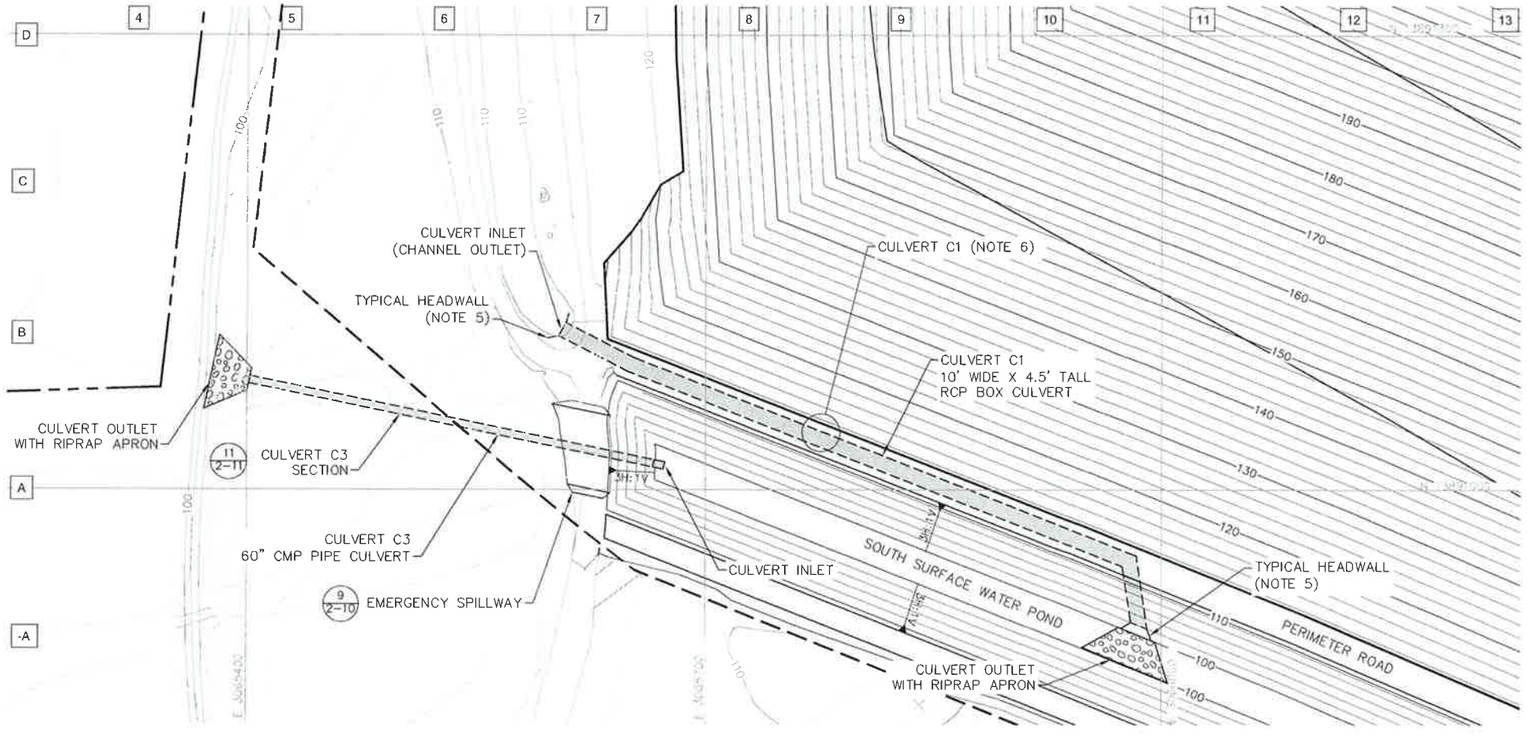
PROJECT NO.: TXL0263	DESIGN BY: BK	REVIEWED BY: SMG	PART NO.: III	DRAWING: 2-2
FILE: 0263P2-2	DRAWN BY: JJV	APPROVED BY: SMG		

PERMIT DRAWING

DRAWING: Austin P:\CADD\Projects\F\Fairbanks Landfill\Permit\Expansion (TXL0263)\Drawings\Dwgs-Rev0\0263P2-2.dwg PLOTTED: Feb 28, 2014 - 11:08am



PLAN
SURFACE WATER PONDS CONNECTION
SCALE: 1" = 100'



PLAN
SOUTH SURFACE WATER POND OUTLET
SCALE: 1" = 100'



LEGEND

- 100 — EXISTING GROUND ELEVATION (FT, MSL) (NOTES 1,2)
- EXISTING ROAD
- EXISTING FENCE
- EXISTING VEGETATION
- EXISTING WATER LINE
- STATE PLANE COORDINATES (NOTE 2)
- 44 SITE GRID
- PROPERTY BOUNDARY
- PROPOSED PERMIT BOUNDARY
- PROPOSED LIMIT OF FINAL COVER
- 200 — PROPOSED GROUND ELEVATION (FT, MSL) (NOTE 3)

NOTES:

1. THE EXISTING TOPOGRAPHIC BASE MAP SHOWN ON THIS DRAWING WAS COMPILED USING PHOTOGRAMMETRIC METHODS BASED ON AERIAL PHOTOGRAPHY PERFORMED ON 26 MARCH 2012 AND PREPARED BY DALLAS AERIAL SURVEYS (DAS), INC.
2. ELEVATIONS ARE IN FEET ABOVE MEAN SEA LEVEL (FT, MSL), AS DEFINED THE USGS NATIONAL GEODETIC VERTICAL DATUM (NAVD) OF 1988. STATE PLANE COORDINATE GRID CORRESPONDS TO THE TEXAS STATE PLANE COORDINATE SYSTEM, TEXAS SOUTH CENTRAL ZONE (4204), NORTH AMERICAN DATUM OF 1983 (NAD 83).
3. OUTSIDE OF THE LIMIT OF FINAL COVER, THE PROPOSED CONTOURS REFER TO FINISHED GRADE.
4. SEE DRAWING 2-10 FOR SURFACE WATER POND FEATURE ELEVATIONS AND DESIGN PARAMETERS.
5. TEXAS DEPARTMENT OF TRANSPORTATION STANDARD DETAIL FW-0 AVAILABLE IN ATTACHMENT 2E TO BE USED FOR HEADWALL INSTALLATION.
6. CULVERT C1 DESIGN PER TEXAS DEPARTMENT OF TRANSPORTATION STANDARD DETAIL SCP-10 AVAILABLE IN ATTACHMENT 2E.

STATE OF TEXAS
SCOTT M. GRAVES
86557
LICENSED
PROFESSIONAL ENGINEER
3/3/2014

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–	AUG. 2013	INITIAL SUBMITTAL TO TCEQ	JJV	SMG

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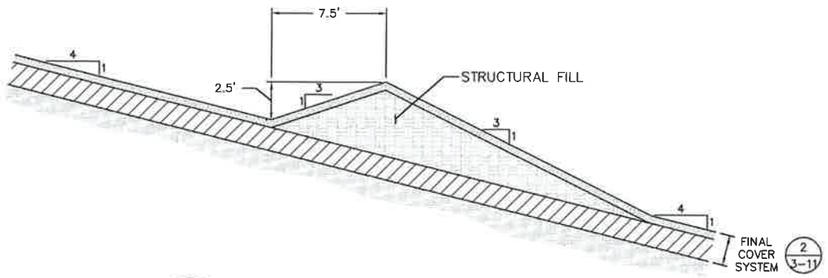
TITLE:
SURFACE WATER PONDS – PLAN VIEW

PROJECT:
FAIRBANKS LANDFILL
PERMIT AMENDMENT APPLICATION – PERMIT NO. MSW-1565B

PROJECT NO.: TXL0263	DESIGN BY: BK	REVIEWED BY: SMG	PART NO.: III	DRAWING: 2-6
FILE: 0263P2-6	DRAWN BY: JJV	APPROVED BY: SMG		

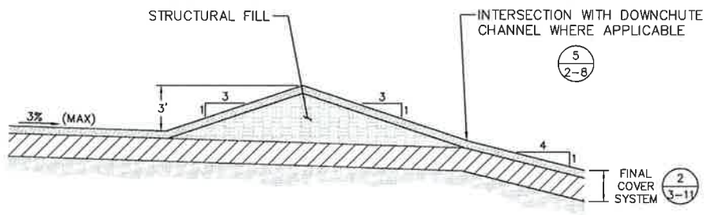
PERMIT DRAWING

DRAWING: Austin P:\CADD\Projects\P\Fairbanks Landfill\Permit\Expansion (TXL0263)\Drawings\Dwgs-Rev0\0263P2-6.dwg PLOTTED: Mar 03, 2014 - 9:08am



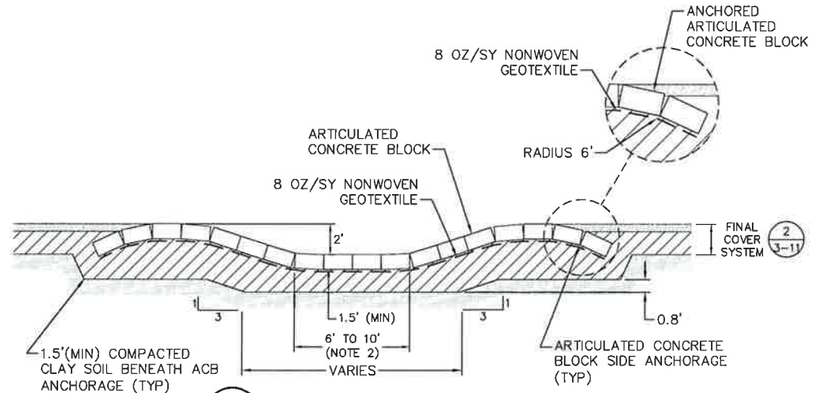
1 / 2-1 DETAIL
SIDESLOPE DRAINAGE TERRACE
SCALE: 1" = 10'

0 5' 10'
SCALE IN FEET



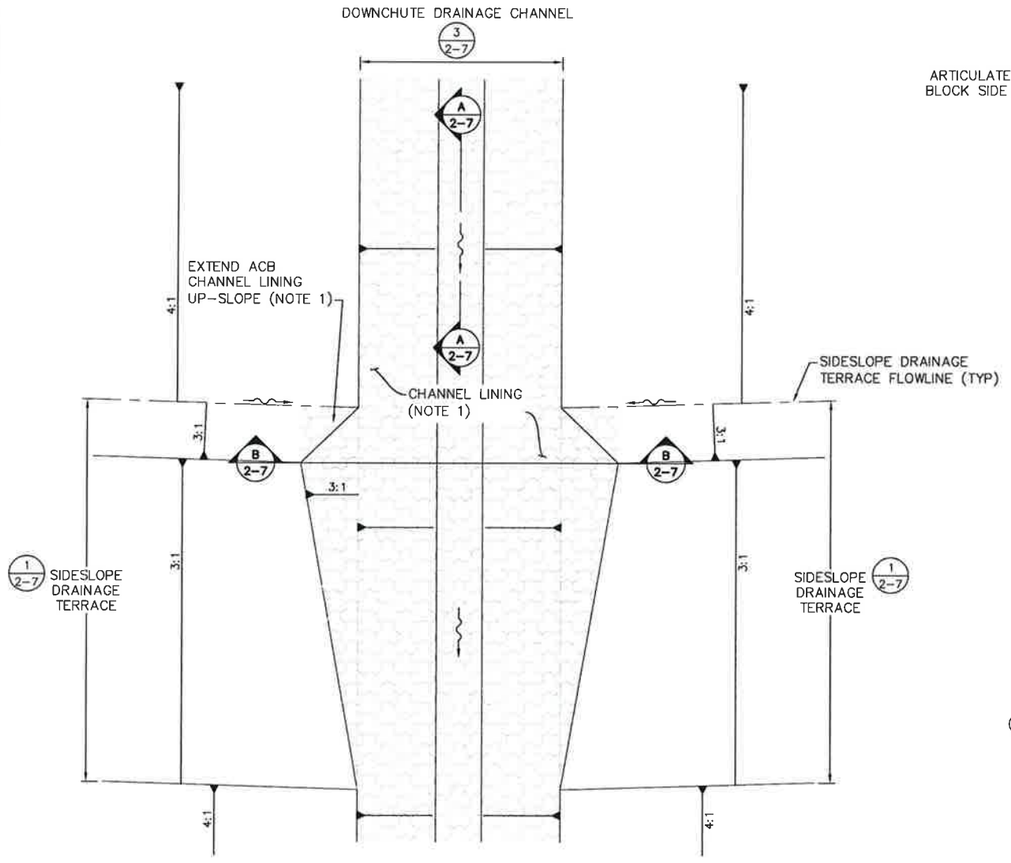
2 / 2-1 DETAIL
TOP DECK DRAINAGE TERRACE
SCALE: 1" = 10'

0 5' 10'
SCALE IN FEET



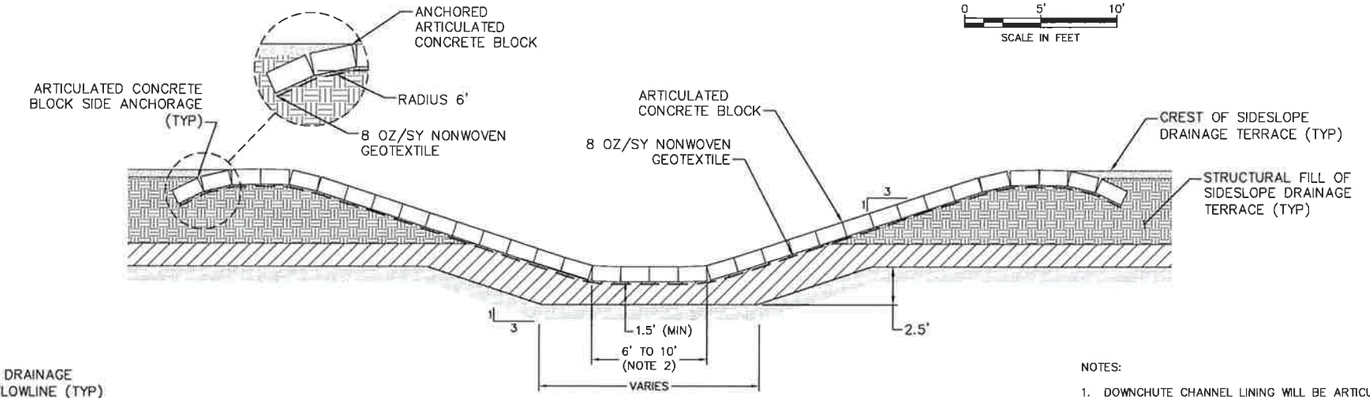
3 / 2-1 DETAIL
DOWNCHUTE DRAINAGE CHANNEL (NOTE 1)
SCALE: 1" = 10'

0 5' 10'
SCALE IN FEET



4 / 2-1 DETAIL
TYPICAL SIDESLOPE DRAINAGE TERRACE AND DOWNCHUTE DRAINAGE CHANNEL INTERSECTION
SCALE: 1" = 20'

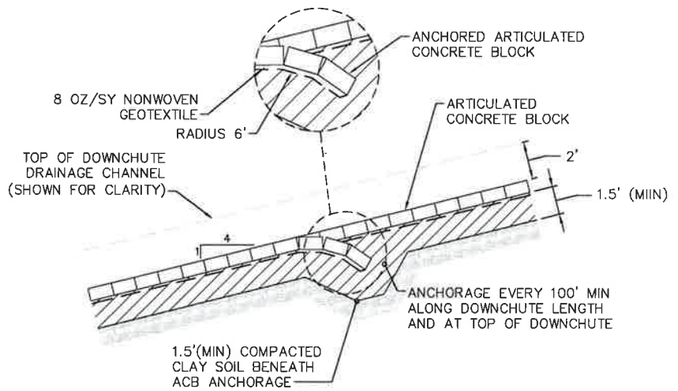
0 10' 20'
SCALE IN FEET



B / 2-7 SECTION
DOWNCHUTE DRAINAGE CHANNEL SECTION (NOTE 1)
SCALE: N.T.S.

NOTES:

1. DOWNCHUTE CHANNEL LINING WILL BE ARTICULATED CONCRETE BLOCK (ACB) OR APPROVED EQUIVALENT ALTERNATE CHANNEL LINING SYSTEM (e.g., GABION/RENO-MATTRESS, RIPRAP, GEOMEMBRANE) WITH A PERMISSIBLE TRACTIVE STRESS OF GREATER THAN OR EQUAL TO 16.5 POUNDS PER SQUARE FOOT.
2. REFER TO PART III, ATTACHMENT 2D FOR DOWNCHUTE CHANNEL WIDTHS, AND DRAWING 2-3 FOR DOWNCHUTE DESIGNATIONS.



A / 2-7 SECTION
DOWNCHUTE DRAINAGE CHANNEL SECTION (NOTE 1)
SCALE: 1" = 8'

0 4' 8'
SCALE IN FEET



FOR PERMIT PURPOSES ONLY

PERMIT DRAWING

REV	DATE	DESCRIPTION	DRN	APP
1	MAR. 2014	REVISED, RESPONSE TO NOD 1	JJV/KH	SMG
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TITLE: SURFACE WATER MANAGEMENT DETAILS I

PROJECT: FAIRBANKS LANDFILL
PERMIT AMENDMENT APPLICATION – PERMIT NO. MSW-1565B

PROJECT NO.: TXL0263	DESIGN BY: BK	REVIEWED BY: SMG	PART NO.: III	DRAWING: 2-7
FILE: 0263P2-8	DRAWN BY: JJV	APPROVED BY: SMG		

DRAWING: Austin P:\ADD\Projects\VF\Fairbanks Landfill\Permit\Expansion (TXL0263)\Drawings\Dwgs-RevO\0263P2-8.dwg PLOTTED: Feb 28, 2014 - 1:52pm

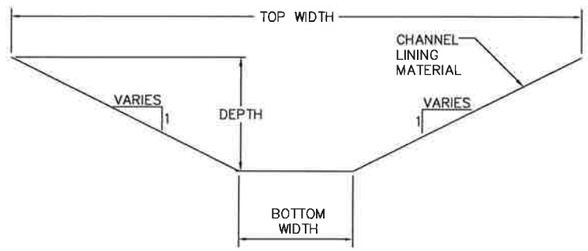
PERIMETER DRAINAGE CHANNEL SCHEDULE

CHANNEL/CULVERT SEGMENT	CHANNEL SHAPE	CHANNEL SLOPE (%)	MANNING'S N VALUE	CHANNEL DIMENSIONS (MINIMUM)				25-YEAR, 24-HR PEAK FLOW, Q (CFS)	100-YEAR, 24-HR PEAK FLOW, Q (CFS)
				BOTTOM WIDTH (FT)	DEPTH (FT)	SIDE SLOPES (H:V)	TOP WIDTH (FT)		
R1	TRAPEZOIDAL	0.15	0.040	6.00	5.00	3:1	36.0	160.8	209.2
R2	TRAPEZOIDAL	0.15	0.040	6.00	5.00	3:1	36.0	160.8	209.2
R3	TRAPEZOIDAL	0.15	0.040	10.00	6.00	3:1	46.0	323.9	436.3
R4	TRAPEZOIDAL	0.15	0.040	4.00	5.00	3:1	34.0	146.5	190.0
R5	TRAPEZOIDAL	0.15	0.040	4.00	5.00	3:1	34.0	146.5	190.0
R6	TRAPEZOIDAL	0.15	0.040	12.00	5.25	3:1	43.5	262.9	333.8

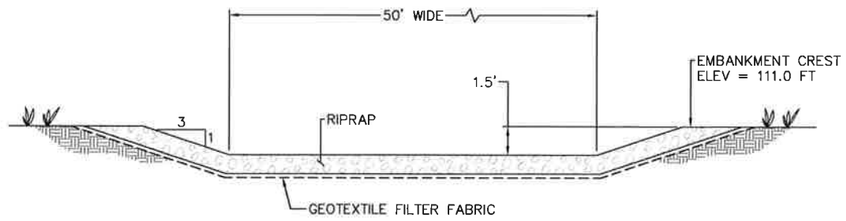
SUMMARY OF CULVERT DESIGN PARAMETERS

CULVERT	25-YEAR, 24-HR PEAK FLOW, Q (CFS)	100-YEAR, 24-YR PEAK FLOW, Q (CFS)	APPROX. LENGTH (FT)	SLOPE (%)	DESCRIPTION	INLET DESCRIPTION	OUTLET DESCRIPTION	INLET ELEVATION (FT, MSL)	OUTLET ELEVATION (FT, MSL)
C1	258.2	333.8	440	1.0	1 – 10' X 4.5' BOX	HEADWALL*	HEADWALL* AND WITH RIPRAP APRON	106.4	102.0
C2	8.9	12.1	200	0.0	1 – 24" PIPE	MITER TO SLOPE	MITER TO SLOPE	99.5	99.5
C3	129.8	156.4	330	0.45	1 – 60" PIPE	MITER TO SLOPE	SQUARE END WITH RIPRAP APRON	99.5	98.0
SEE DRAWING 2-4 FOR CULVERT LOCATIONS									

* HEADWALL CONSISTENT WITH TXDOT STD DETAIL SCP-10 (SEE ATTACHMET 2E)



8 / 2-10 DETAIL
PERIMETER CHANNEL
SCALE: N.T.S.



9 / 2-6 DETAIL
EMERGENCY SPILLWAY
SCALE: 1" = 8'

0 4' 8'
SCALE IN FEET

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LICENSED PROFESSIONAL ENGINEER
STATE OF TEXAS
3/3/2014

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PHONE: 512.451.4003

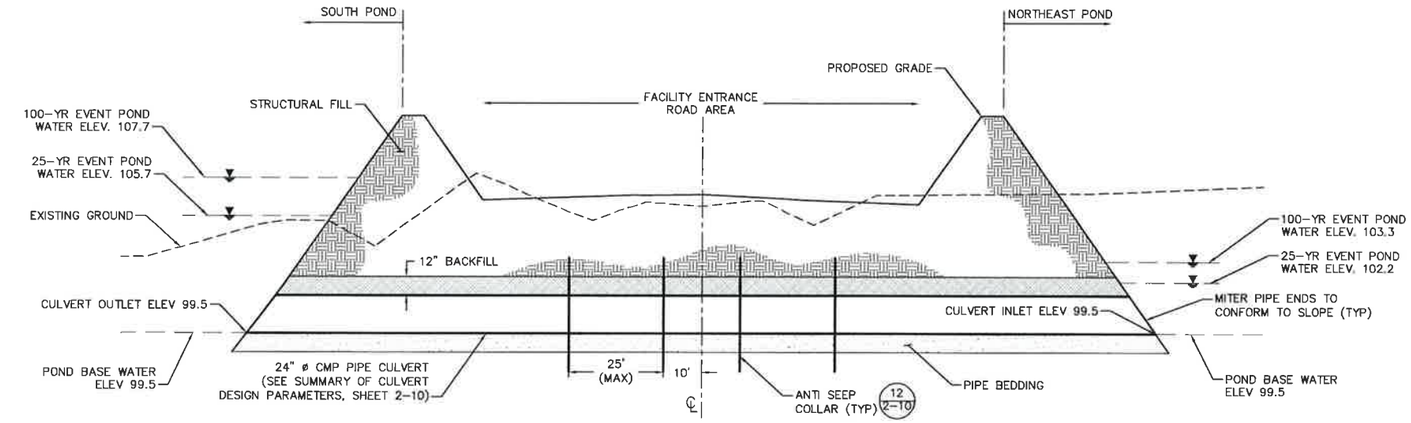
TITLE:
SURFACE WATER MANAGEMENT SYSTEM DETAILS IV

PROJECT:
FAIRBANKS LANDFILL
PERMIT AMENDMENT APPLICATION – PERMIT NO. MSW-1565B

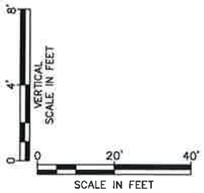
PROJECT NO.: TXL0263	DESIGN BY: BK	REVIEWED BY: SMG	PART NO.: III	DRAWING: 2-10
FILE: 0263P2-11	DRAWN BY: JJV	APPROVED BY: SMG		

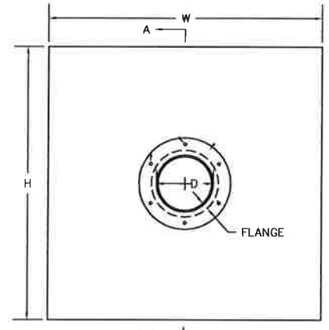
PERMIT DRAWING

DRAWING: Austin P:\CADD\Projects\F\Fairbanks Landfill\Permit\Expansion (TXL0263)\Drawings\Dwgs-Rev0\0263P2-11.dwg PLOTTED: Feb. 28, 2014 - 4:14pm

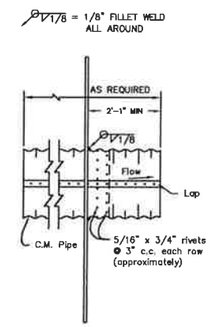


10 / 2-6 DETAIL
CULVERT C2 SECTION
SCALE: N.T.S.





UPSTREAM ELEVATION



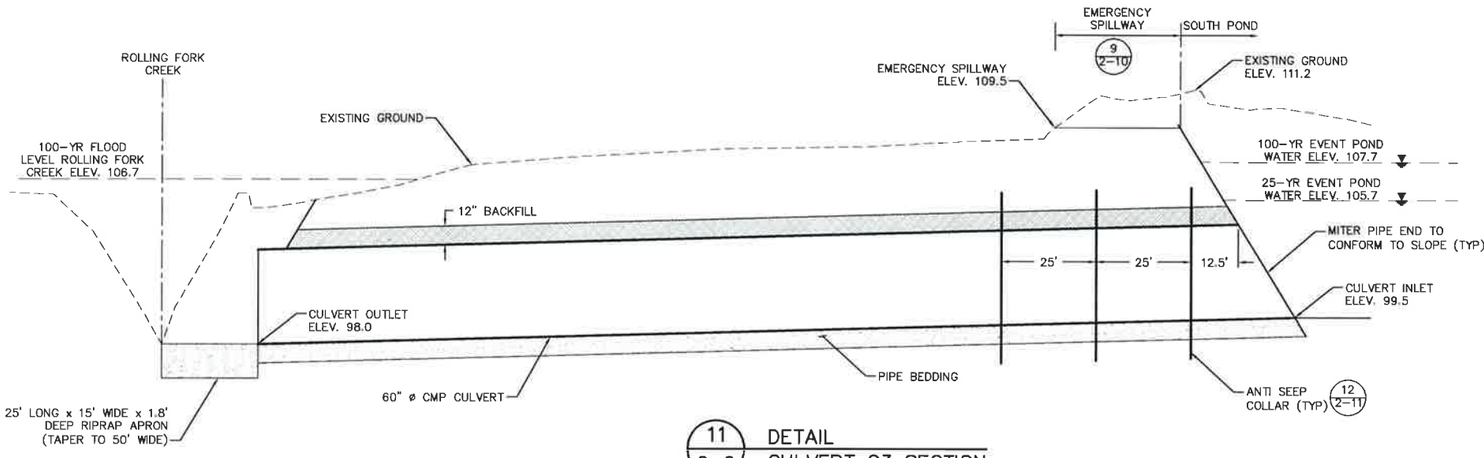
SECTION A-A

CULVERT	PIPE DIAM. (D) (INCHES)	SHEET HEIGHT (H) (INCHES)	SHEET WIDTH (W) (INCHES)
C2	24	72	72
C3	60	108	108

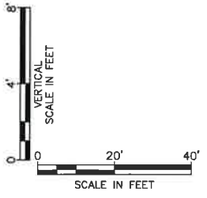
NOTES:

1. MAKE PIPE CONNECTIONS AS NEEDED TO ASSURE A WATERTIGHT SYSTEM.
2. APPLY SILICON CAULK ON THE SEAMS AS NEEDED TO INSURE A GOOD SEAL SO THAT THE COMPLETED INSTALLATION IS WATERTIGHT.

12 / 2-10 DETAIL
ANTI SEEP COLLAR
SCALE: N.T.S.



11 / 2-6 DETAIL
CULVERT C3 SECTION
SCALE: N.T.S.





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PHONE: 512.451.4003

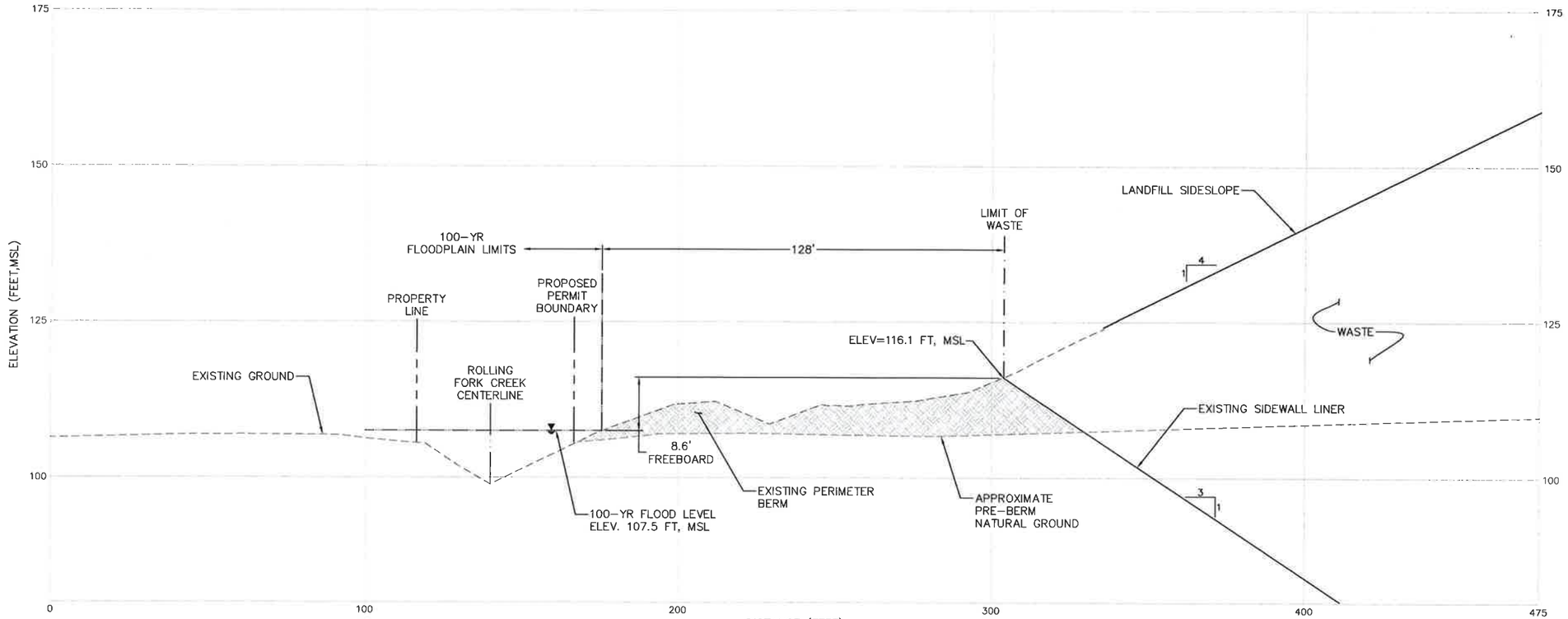
TITLE: CULVERT SECTIONS

PROJECT: FAIRBANKS LANDFILL
PERMIT AMENDMENT APPLICATION – PERMIT NO. MSW-1565B

PROJECT NO.: TXL0263	DESIGN BY: BK	REVIEWED BY: SMG	PART NO.: III	DRAWING: 2-11
FILE: 0263P2-13	DRAWN BY: JJV	APPROVED BY: SMG		

PERMIT DRAWING

DRAWING: Austin P:\CADD\Projects\F\Fairbanks Landfill\Permit\Exposition (TXL0263)\Drawings\Dwgs-Rev0\0263P2-13.dwg PLOTTED: Feb 28, 2014 - 4:44pm



1
2-1 SECTION
ROLLING FORK CREEK AND LANDFILL PERIMETER

0 20' 40'
HORIZONTAL SCALE IN FEET

VERTICAL SCALE IN FEET
20'
10'
0

NOTES:

1. ELEVATIONS ARE IN FEET ABOVE MEAN SEA LEVEL (FT, MSL).
2. EXISTING GROUND SHOWN ON THIS DRAWING IS TAKEN FROM THE TOPOGRAPHIC BASE MAP SHOWN ON DRAWING 3-5.

STATE OF TEXAS
SCOTT M. GRAVES
86557
LICENSED
PROFESSIONAL ENGINEER
3/3/2014

FOR PERMIT PURPOSES ONLY

REV	DATE	DESCRIPTION	DRN	APP
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TEXAS ENG. FIRM REGISTRATION NO. 1182
8217 SHOAL CREEK BLVD, SUITE 200
AUSTIN, TEXAS 78757
PHONE: 512.451.4003

TITLE: ROLLING FORK CREEK AND LANDFILL PERIMETER BERM SECTION

PROJECT: FAIRBANKS LANDFILL
PERMIT AMENDMENT APPLICATION – PERMIT NO. MSW-1565B

PROJECT NO.: TXL0263	DESIGN BY: BK	REVIEWED BY: SMG	PART NO.: III	DRAWING: 2-12
FILE: 0263P2-12	DRAWN BY: JJV	APPROVED BY: SMG		

PERMIT DRAWING

DRAWING: Austin P:\CADD\Projects\T\Fairbanks Landfill\Permit\Expansion (TXL0263)\Drawings\Dwgs-Rev0\0263P2-12.dwg PLOTTED: Feb 28, 2014 - 1:58pm

ATTACHMENT 2B

ON-SITE DRAINAGE ANALYSIS – HYDROLOGY

Written by: B. Klenzendorf Date: 11/26/2012 Reviewed & Revised by: S. Graves Date: 2/25/2014

Client: USAWLTX Project: Fairbanks Landfill Expansion Project No.: TXL0263 Phase No.: 05

ON-SITE DRAINAGE ANALYSIS – HYDROLOGY
FAIRBANKS LANDFILL EXPANSION



SEALED FOR PERMITTING PURPOSES;
CALCULATION PAGES 1 TO 61

GEOSYNTEC CONSULTANTS
TX ENG FIRM REGISTRATION NO. F-1182

1 PURPOSE

The purpose of this calculation package is to present the hydrology analysis for the estimation of surface water runoff from the proposed expansion of the Fairbanks Landfill (Site) in Houston, Texas. The landfill will consist of both a vertical and lateral expansion at the Site. The specific goals of the analysis include calculating peak discharges and total runoff volumes from the Site for the: (i) pre-development conditions and (ii) post-development conditions. The calculated values of peak discharge and runoff volume of the proposed surface water system for the lateral and vertical expansion presented in this permit amendment application are compared against currently permitted pre-development conditions in order to verify that development of the expansion design does not adversely alter, to any significant degree, the drainage patterns of the watershed in the vicinity of the Site.

The following definitions pertain to the two conditions analyzed in this package:

- Pre-Development Conditions – currently permitted conditions of the landfill facility. The existing permitted surface water management system is analyzed, while incorporating the additional areas included in the expansion for this permit amendment application and off-site run-on areas.
- Post-Development Conditions – conditions of the Site once the expansion design has been fully developed, with the final cover and permanent surface water management system installed, while incorporating additional off-site run-on areas.

The proposed surface water management system will maintain similar drainage patterns to the pre-development condition. One discharge location is located at the south surface water pond outlet pipe in the southwest portion of the site, which discharges to Rolling Fork Creek, which flows along the west side of the site. This discharge location is used for evaluation of the post-development conditions and coincides with the 205.2 acre drainage area for pre-development conditions. As mentioned, the post-development drainage area includes the entire proposed facility permit boundary area.

3 DESIGN PARAMETERS

The following engineering data were used in estimating surface water runoff.

3.1 Rainfall

- Rainfall Return Periods, Durations, and Depths – The Harris County Flood Control District (HCFCD) provides rainfall frequency and duration depths for the Harris County Hydrologic Regions. The Site is located in the White Oak Bayou Watershed, and outflow from the Site drains into the Rolling Fork Creek. Table 2B-1 provides a summary of the rainfall depths for various durations and return periods for Harris County Hydrologic Region 2 for White Oak Bayou (HCFCD, 2009). The rainfall depths correspond to the 24-hour duration hypothetical precipitation events described above at a 25-year frequency and 100-year frequency, respectively.

3.2 Drainage Areas and Reaches

- Drainage Areas – The contributing watershed areas for each basin or reach in the pre-development and post-development models are divided into multiple subbasins. Subbasins are defined based on the receiving surface water drainage feature. Subbasins are delineated for the following areas: top deck surfaces draining to the top deck drainage terraces and the drainage downchutes, sideslope surfaces draining to the sideslope drainage terraces and the drainage downchutes and perimeter channel, off-site run-on areas, and surface water pond areas. The Soil Conservation Service (SCS) Curve Number Loss Model was used to estimate the volume of runoff from a given subbasin. The Kinematic Wave Model was used to estimate the direct runoff flow rates from the subbasins. Each subbasin is assigned a curve number representing the type of ground cover for a given soil for the area. The subbasin area, curve number, and Kinematic Wave Model input parameters are

ATTACHMENT 2C

ON-SITE DESIGN – SURFACE WATER POND APPURTENANCES DESIGN CALCULATIONS

Written by: J. McNash Date: 11/16/2012 Reviewed & Revised by: S. Graves Date: 2/25/14

Client: USAWTXL Project: Fairbanks Landfill Expansion Project No.: TXL0263 Phase No.: 05

ON-SITE DESIGN – SURFACE WATER POND APPURTENANCES DESIGN CALCULATIONS
FAIRBANKS LANDFILL EXPANSION



3/3/2014

SEALED FOR PERMITTING PURPOSES,
CALCULATION PAGES 1 TO 11

GEOSYNTEC CONSULTANTS
TX ENG FIRM REGISTRATION NO. F-1182

1 PURPOSE

The purpose of this package is to present the methodology, parameters, and calculations for the design of the appurtenances for the surface water pond outlet structures of the Fairbanks Landfill facility surface water management system. "Appurtenances" refers to: (i) the anti-seep collars of the culvert pipes associated with the surface water ponds; and (ii) riprap apron for the outfall culvert. Note that hydraulic sizing/design of the pond culverts (designated as C2 and C3) is contained within Attachment 2B since their calculated performance (discharge flows, pond elevations, etc.) is based on the hydrology analyses routed through the ponds and associated culvert pipes. The hydraulic design of the other culvert at the site (Culvert C1) is presented in Attachment 2E.

Surface water diversion structures on the final cover system convey runoff through a system of drainage terraces, downchute channels, and perimeter channels to the Northeast and South Surface Water Ponds. The Northeast Surface Water Pond is connected to the South Surface Water Pond through a 24-inch diameter corrugated metal pipe (CMP) (designated as culvert C2) at a constant elevation of 99.5 ft MSL. The South Surface Water Pond outlet will be the overall site outfall location where surface water is ultimately discharged and leaves the site. This outfall will be in the same location as the current (existing) site outfall, but under final design conditions of the proposed expansion when all ponds are in-place, the existing 48-inch diameter CMP, will be removed and replaced with a 60-inch diameter CMP. Refer to Attachment 2, Section 8 for information on the timing of this culvert replacement, and information on the installation schedule for drainage

features in general. As with the existing outfall, this proposed outfall will be located at the southwest corner of the South Surface Water Pond (designated as culvert C3 in this design package). The modeling and design supporting the surface water management system is described in Attachment 2B: *On-Site Drainage Analysis – Hydrology*. The appurtenance designs supporting the outlet control structure of Culvert C3 include anti-seep collars and a riprap outlet apron as discussed herein.

2 METHODOLOGY

2.1 Anti-Seep Collar Design

Anti-seep collars are required for penetrations through a basin berm to control seepage. The methodology utilized to design the anti-seep collars follows the guidance provided in the *Kentucky Division of Water Engineering Memorandum No.* 5, (KDNREP, 1999) and the Tennessee Department of Transportation Drainage Manual (TDOT, 2007). Although these guidance documents are from different states, the methods provided are appropriate and have a sound technical basis for design at this site. The memorandum recommends placing anti-seep collars along the portion of the outlet structure culverts within the saturated zone spaced at distances of no more than 25-feet, which provide an increase in flow length along the pipe of 15%. This relationship may be described as (KDNREP, 1999):

$$\frac{L_s+2nV}{L_s} \geq 1.15 \qquad (1)$$

where:

L_s = length of pipe within the saturated zone (ft),

V = vertical and horizontal projection of the collar (ft), and

n = number of anti-seep collars.

The length of pipe in the saturated zone, L_s, is computed based on the following assumptions: (i) the groundwater table is located below the elevation of the outlet pipe; (ii) the phreatic surface slopes at a 4H:1V slope from the elevation of ponded surface water runoff due to the 25-year, 24-hour rainfall event; and (iii) the side slopes of the surface water ponds are sloped at 3H:1V.

Based on these assumptions, L_s can be computed as follows (TDOT, 2007):

$$L_s = y \times (z + 4) \times \left(1 + \frac{S}{0.25 - S}\right) \quad (2)$$

where:

L_s = length of pipe within saturated zone (ft);

y = depth of surface water in the pond after a 25-year, 24-hour rainfall event;

z = embankment side slope (i.e., 3H:1V, z = 3); and

S = slope of the outlet pipe (ft/ft).

Figure 2C-1 further depicts the geometry behind the calculation of L_s.

2.2 Riprap Outlet Apron Design

The riprap apron at the outlet culvert is designed to protect against erosion and scour from the South Surface Water Pond outflows. The riprap apron was sized from the outflow based on the 25-year, 24-hour rainfall event. The design guidance from the Federal Highway Administration (FHWA) provides a methodology for calculating the required length of apron (L_a) and d_{50} of the riprap based on the culvert diameter and flow rate. The d_{50} is the stone size of the riprap for which to 50% of the riprap stones are smaller than d_{50} by mass. The riprap size is calculated using the following equation (FHWA, 2006):

$$d_{50} = 0.2D\left(\frac{Q}{D^{2.5}\sqrt{g}}\right)^{4/3}\frac{D}{TW} \quad (3)$$

where:

d_{50} = riprap size (ft),

Q = design discharge (cfs),

D = culvert diameter (ft),

TW = tailwater depth (ft), and

g = gravitational constant.

The tailwater depth should be limited to between 0.4D and D. FHWA (2006) recommends the use of a tailwater depth equal to 0.4D if the tailwater is unknown.

The required length and depth of the riprap apron can be estimated based on the culvert

rise and riprap size as provided in Table 2C-1. The width of the riprap apron at the outlet was selected as 3D as recommended by the FHWA (2006) detail for riprap aprons. The apron width will also widen from the outlet along the required length at a rate of 1 ft width per 3 ft length at each edge. Figure 2C-2 provides the typical geometry for the riprap apron.

3 DESIGN PARAMETERS

3.1 Anti-Seep Collar Design Parameters

Anti-seep collars were designed for the culverts between the Northeast Surface Water Pond and the South Surface Water Pond (C2) and for the outflow of the South Surface Water Pond (C3) located at the southwest corner of the facility. The side slopes of the surface water ponds are 3H:1V. These ponds will have a permanent pool elevation of 99.5 ft MSL.

The Northeast and South Surface Water Ponds are connected by a 24-inch diameter corrugated metal pipe. The inlet and outlet invert elevations of culvert C2 are 99.5 ft MSL (i.e., a 0% pipe slope).

The outfall culvert C3 from the South Surface Water Pond has an inlet invert elevation, outlet invert elevation, and length of pipe of 99.5 ft MSL, 98.0 ft MSL, and 330 ft, respectively. Therefore, the slope (S) of the outflow pipe is calculated as 0.0045 ft/ft.

The elevation of surface water due to the 25-year, 24-hour rainfall event was calculated as 105.7 ft MSL for the South Surface Water Pond, as shown in Attachment 2B. The depth, y, of surface water within the pond was then calculated as 6.2 ft (i.e., y = 105.7 ft – 99.5 ft = 6.2 ft).

3.2 Riprap Outlet Apron Design Parameters

The South Surface Water Pond discharges runoff through Culvert C3 (a 60-inch diameter CMP) that conveys a maximum outflow of 129.8 cfs during a 25-year, 24-hour rainfall event, as calculated in Attachment 2B. The rip-rap apron was designed with this peak flow rate.

4 RESULTS

4.1 Anti-Seep Collars

Based on the design parameters above, the length of the pipe within the saturated zone, L_s, was calculated as:

$$L_s = 6.2 \text{ ft} \times (3 + 4) \times \left(1 + \frac{0.0045}{0.25 - 0.0045}\right) = 44.2 \text{ ft}$$

Anti-seep collars should be spaced no more than 25 ft apart. Therefore, a minimum of two seep collars (n = 2) is necessary for the outflow culvert. The minimum vertical and horizontal projection (V) of the each seep collar was back calculated by Equation (1).

$$\frac{44.2 \text{ ft} + (2)(2)V}{44.2 \text{ ft}} = 1.15 \rightarrow V = 1.65 \text{ ft}$$

The vertical and horizontal projection of each seep collar was calculated as 1.65 ft. Based on recommendations by Tennessee Department of Transportation (TDOT), the anti-seep collar should extend at least two feet in all directions around the outflow pipe (TDOT, 2007). Thus, the vertical and horizontal projection (V) of the anti-seep collar was rounded up to two feet.

The first anti-seep collar should be constructed approximately 12.5 feet from the up gradient end of the outflow pipe (C3), and the second anti-seep collar should be spaced 25 feet from the first collar or 37.5 feet from the up gradient end of the outflow pipe for the South Surface Water Pond. The anti-seep collars should extend two feet in every direction from the pipe. Using the same methodology above, anti-seep collars should be constructed 12.5 feet and 37.5 feet from the down gradient end of culvert C2.

4.2 Rip-Rap Outlet Apron

Equation (3) provides the calculations to size the riprap apron for the South Surface Water Pond outlet at C3. The calculations were performed based on a 60-inch diameter pipe (i.e., D = 5 feet), a design flow rate of Q = 129.8 cfs, and a recommended tailwater depth of TW = 0.4D = 2.0 feet. Based on Equation (3) a minimum d_{50} size for the riprap of 0.76 feet is selected. The minimum apron length was selected based on Table 2C-1. The riprap size corresponds to a riprap class 3, resulting in an apron length of 5D = 25 feet and an apron

depth of $2.4d_{50}$ = 1.8 feet. FHWA (2006) recommends an apron width of 3D = 15 feet at the up gradient end of the apron near the pipe outlet and a 3:1 expansion resulting in an apron width of 50 feet at the down gradient end of the apron. If the receiving channel from the culvert is less than the previously calculated widths, the entire width channel should be lined with riprap.

Meanwhile, design of riprap aprons were not considered for the inlet or outlet of Culvert C2, because the 24" culvert connects the Northeast and South Surface Water Ponds with a flat slope and is situated at the bottom water level of the ponds. Due to the flat slope and configuration/location, design of a riprap apron was not considered necessary for C2. Additionally, the design of the riprap apron of the outlet of Culvert C1 is provided in Attachment 2E.

5 REFERENCES

FHWA (2006). *Hydraulic Design of Energy Dissipators for Culverts and Channels*, Federal Highway Administration, US Department of Transportation, Hydraulic Engineering Circular No. 14, Third Edition.

KDNREP (1999). *Engineering Memorandum No. 5*, Kentucky Department of Natural Resources and Environmental Protection, Division of Water, reprinted June 1999.

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TABLES

- Table 2C-1. Riprap Classes and Apron Dimensions (from FHWA, 2006)

Table 2C-1. Riprap Classes and Apron Dimensions (from FHWA, 2006)

Class	D_{50} (mm)	D_{50} (in)	Apron Length[1]	Apron Depth
1	125	5	4D	$3.5D_{50}$
2	150	6	4D	$3.3D_{50}$
3	250	10	5D	$2.4D_{50}$
4	350	14	6D	$2.2D_{50}$
5	500	20	7D	$2.0D_{50}$
6	550	22	8D	$2.0D_{50}$

[1]D is the culvert rise.

FIGURES

- Figure 2C-1. Anti-Seep Collar Design Schematic (not to scale)
- Figure 2C-2. Placed Rip-Rap Apron Standard Detail (FHWA, 2006)

Figure 2C-1. Anti-Seep Collar Design Schematic (not to scale)

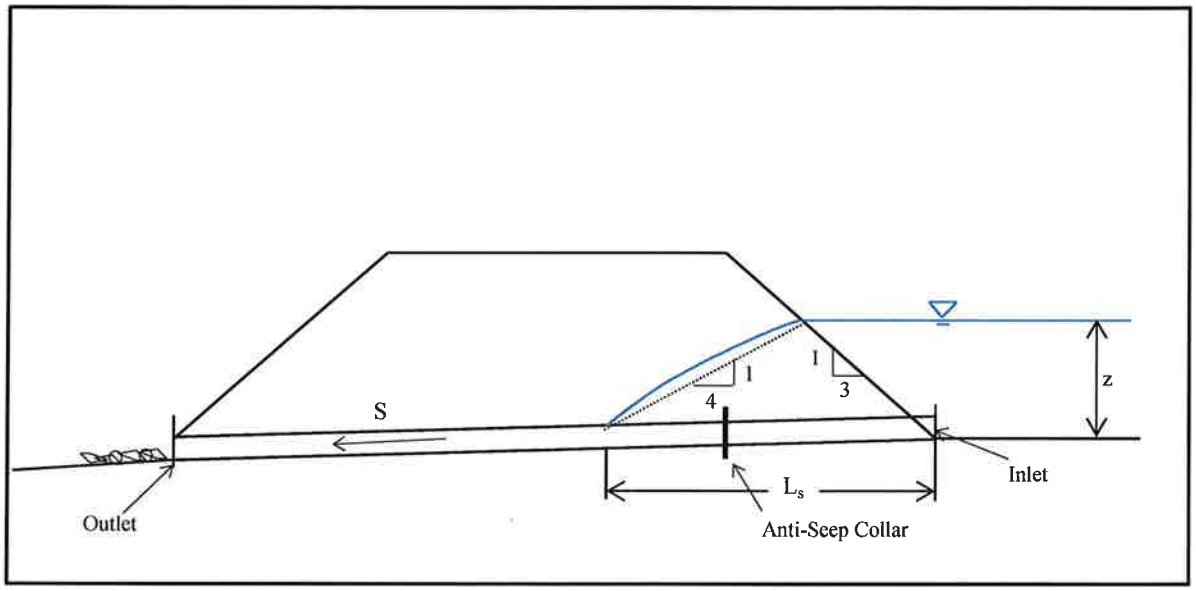
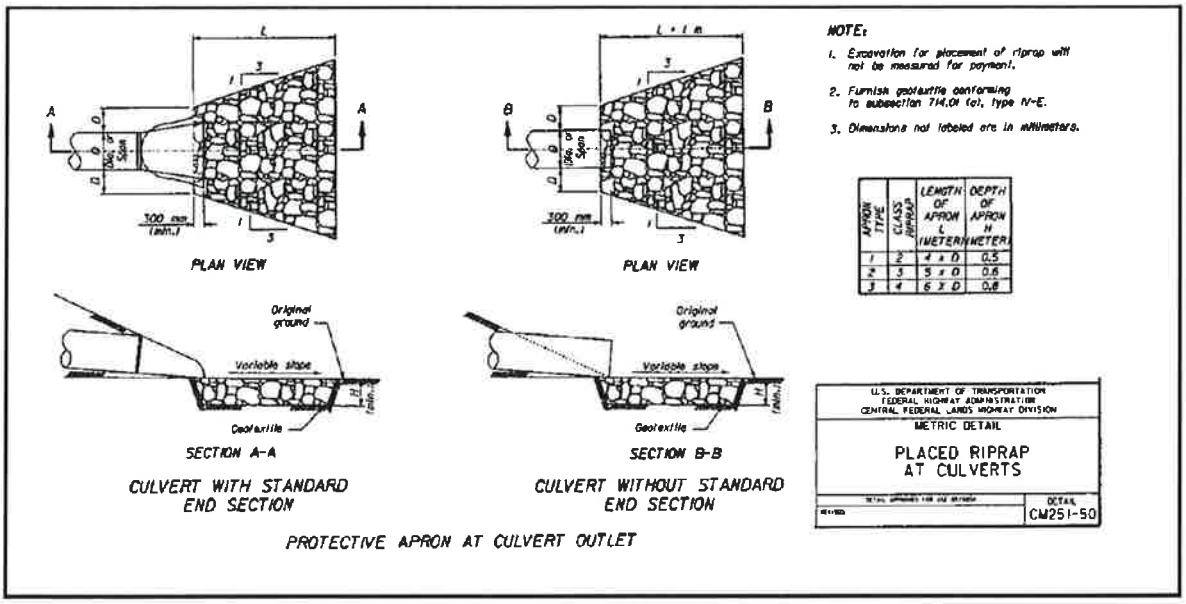


Figure 2C-2. Placed Rip-Rap Apron Standard Detail (FHWA, 2006)



APRON TYPE	CLASS RIPRAP	LENGTH OF APRON L (METER)	DEPTH OF APRON H (METER)
1	2	4 x D	0.3
2	3	5 x D	0.6
3	4	6 x D	0.8

ATTACHMENT 2D

ON-SITE DESIGN – DRAINAGE TERRACES AND DOWNCHUTE CHANNELS

Written by: J. McNash Date: 10/31/2012 Reviewed & Revised by: S. Graves Date: 2/25/2014

Client: USAWLTX Project: Fairbanks Landfill Expansion Project No.: TXL0263 Phase No.: 05

ON-SITE DESIGN – DRAINAGE TERRACES AND DOWNCHUTE CHANNELS FAIRBANKS LANDFILL EXPANSION



3/3/2014

SEALED FOR PERMITTING PURPOSES,
CALCULATION PAGES 1 TO 35

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

1 PURPOSE

The purpose of this calculation package is to present the design of the top deck drainage terraces, side slope drainage terraces, and downchute channels for the facility surface water management system for the Fairbanks Landfill. As part of the facility surface water management system design, sheet flow runoff from the final cover system is intercepted by drainage terraces located at the base of the top deck surface and on the 4 horizontal: 1 vertical (4H:1V) final cover side slopes. Top deck and side slope drainage terraces convey runoff to downchute channels. These downchute channels subsequently convey the runoff to perimeter drainage channels located at the toe of the 4H:1V side slopes, and ultimately into two surface water ponds. The Facility Surface Water Management Plan shows the layout of each of these features and can be found in Drawing 2-1 of that Plan.

2 METHODOLOGY

The top deck drainage terraces and side slope drainage terraces are designed as grass-lined v-shaped channels (i.e., trapezoidal channels with bottom width equal to zero), and are sized to convey runoff from the 25-year, 24-hour design rainfall event with one foot of freeboard and to convey the 100-year, 24-hour design rainfall event without overtopping. Additionally, the average velocity and the average tractive stress are calculated based on the predicted peak flow for each rainfall event. The top deck drainage terraces are located at the base of the 3% top deck surfaces; while, the side slope drainage terraces are spaced a maximum of 200-feet apart horizontally on the 4H:1V final cover side slopes (see Drawing 2-1 in Attachment 2A). Typical terrace and downchute cross-sections for the final cover system are shown on the drawings presented in Attachment 2 (the Facility Surface Water

Drainage Report) of the Site Development Plan (SDP). The hydraulic design of the terrace and downchute drainage features meets or exceeds the design criteria described herein.

Downchute channels are evaluated as articulated concrete block lined trapezoidal channels in this calculation package. The downchute channels are designed to convey the 25-year, 24-hour design rainfall event with one foot of freeboard (and to convey the 100-year, 24-hour rainfall event without overtopping) down the 4H:1V final cover side slopes and into the perimeter drainage channels or surface water ponds. The peak 25-year, 24-hour design storm discharge and resulting calculated average tractive stresses are used to design the lining system of the downchute channels.

The capacity of each downchute channel and drainage terrace is calculated by solving Manning's equation for the depth of flow within each channel or terrace. Manning's equation (Chow, 1959) is expressed as:

$$Q = \frac{1.49}{n} A R^{2/3} S^{1/2} \quad (1)$$

where:

Q = discharge (cfs),

n = Manning's roughness coefficient,

A = area of cross-section of flow (ft^2),

P = wetted perimeter (ft),

R = hydraulic radius = A/P (ft), and

S = longitudinal slope (ft/ft).

The average tractive stresses in the downchute or drainage terrace for various flows are estimated by Equation (2) (HCFCD, 2001).

$$\tau_o = \gamma_w RS \quad (2)$$

where:

τ_o = average tractive stress (lb/ft^2),

γ_w = unit weight of water (lb/ft^3),

R = hydraulic radius = A/P (ft), and

S = channel slope (ft/ft).

The top deck drainage terraces and downchute channels were modeled within the HEC-HMS model, as discussed in Attachment 2B. Each top deck drainage area was modeled as a separate sub-basin; while groups of side slope drainage terraces were modeled as sub-basins to simplify the overall model. Each sub-basin was routed to a downchute within the HEC-HMS model to compute the peak discharges within each top deck and downchute channel. The locations and contributing areas of the top deck drainage terraces and downchute channels are shown on Figure 2D-1 in this calculation package (taken from Drawing 2-3 of Attachment 2A).

As mentioned above, for simplicity of modeling, the side slope drainage terraces were not explicitly modeled as individual elements within the site-wide HEC-HMS model. Instead, for sizing design purposes, the peak flow for each side slope drainage terrace was computed outside of the HEC-HMS model using the Rational Method. While this approach simplified the overall HEC-HMS model, it still resulted in side slope drainage terrace contributions that are accurately represented in the model through the use of the Kinematic Wave Model option, as described in Attachment 2B. Because the Kinematic Wave Model combines the individual flows from each side slope drainage terrace prior to the flow entering the downchute channel, a different modeling approach was needed to estimate the peak flow rates within each side slope drainage terrace. The Rational Method was used specifically for calculating peak flow rates within the small-acreage individual side slope drainage terraces in order to size the terraces. In addition, the drainage area contributing to each side slope drainage terrace was approximated as the length of the side slope drainage terrace multiplied by 200-ft (i.e., the maximum 200-feet spacing) as a simplifying assumption. This generally overestimates the drainage area to each feature since the 200-ft spacing is a maximum, but some locations have less than 200-ft spacing –

which makes the use of this approach more conservative. The Rational Method calculates the peak flow as follows (TxDOT, 2009):

$$Q = C \times I \times A \quad (3)$$

where:

Q = peak runoff rate (cfs),

C = runoff coefficient,

I = rainfall intensity (in/hr), and

A = drainage area (acres).

Rainfall intensity is calculated by the following equation (TxDOT, 2009):

$$I = \frac{b}{(t_c + d)^e} \quad (4)$$

where:

I = design rainfall intensity (in/hr),

t_c = time of concentration (min), and

b, d, e = coefficients for specific frequencies listed by Texas county.

The values for b, d, and e are obtained from TxDOT (2009). For a 25-year rainfall event in Harris County, b = 81, d = 7.7, and e = 0.724. For a 100-year rainfall event in Harris County, b = 91, d = 7.9, and e = 0.706.

The time of concentration is the time for runoff to flow from the most hydraulically remote point of the drainage area to the point under investigation. The time of concentration is estimated by dividing the longest drainage path by the velocity of runoff. For a conservative design approach, a minimum time of concentration of 10 minutes was used to calculate the rainfall intensity. TxDOT (2009) recommends 10 minutes for the minimum time of concentration because small areas with exceedingly short times of concentration could result in design rainfall intensities that are unrealistically high.

Based on these values, the rainfall intensity for the Fairbanks Landfill is calculated as 10.1 in/hr and 11.9 in/hr for the 25-year and 100-year rainfall events, respectively, for a time of concentration equal to 10 minutes.

3 DESIGN PARAMETERS

The design parameters, including channel geometry, channel length, Manning's roughness coefficient, and calculated peak discharges for the 25-year and 100-year events (Attachment 2B), are summarized for each downchute channel and top deck drainage terrace in Table 2D-1 and Table 2D-2, respectively.

The side slope drainage terraces are spaced at a 200-ft (maximum) interval in the final cover system design (see Drawing 2-1 in Attachment 2A). Each side slope drainage terrace was analyzed using representative contributing area based on the layout of each terrace segment and using the aforementioned 200-ft maximum (which is also typical) terrace spacing. As mentioned, the use of the 200-ft spacing was a conservative, simplifying assumption since some terraces or portions thereof are spaced less than 200-ft apart. A runoff coefficient (C) was selected based on information provided by TxDOT (2009) for rural watersheds, as shown in Table 2D-3. The runoff coefficients provided apply to storms of up to a 10-year frequency. The total runoff coefficient is based on the sum of the four runoff components in Table 2D-3. A runoff coefficient adjustment factor is required for higher frequency storm events. The adjustment factor, C_f, for a 25-year event is 1.1, whereas the adjustment factor for a 100-year event is 1.25. The runoff coefficient is calculated using the following equation:

$$C = C_f \times (C_r + C_i + C_v + C_s) \qquad (5)$$

The following runoff coefficients are estimated for the relatively steeper 4H:1V side slope drainage areas for a 25-year and 100-year event, respectively:

$$C_{25} = 1.1 \times (0.26 + 0.16 + 0.04 + 0.12) = 0.638$$

$$C_{100} = 1.25 \times (0.26 + 0.16 + 0.04 + 0.12) = 0.725$$

The side slope drainage terraces are designed as a v-shaped tack-on berms constructed on the 4H:1V side slopes of the final cover system. Thus, the side slopes of the terrace are 4H:1V on the final cover side and 3H:1V on the berm side and each terrace has a depth of 2.50 ft. The nominal longitudinal slope of each side slope drainage terrace is approximately 3% and most terraces are laid out to this longitudinal slope. However, due to final cover geometry and to maintain the 200-ft spacing between terraces, the longitudinal slopes range from 1.99% to 6.25% depending on location on the final cover – and each of these site-specific conditions was analyzed to confirm that the terrace design is adequate for the contributing drainage area and terrace slope. Figure 2D-1 shows the

location of each side slope drainage terrace (SSDT), top deck (TD), and downchute (D) structures on the final cover system.

Each drainage structure is designed to maintain one foot of freeboard during the 25-year, 24-hour design rainfall event. Additionally, each terrace and downchute channel is designed to convey the peak flow during the 100-year, 24-hour design rainfall event without overtopping.

The downchute channel design evaluation is for an articulated concrete block (ACB) channel-lining to resist erosive forces, consistent with the *Design Manual for Articulating Concrete Block Systems* (HCFCD, 2001). The method relates the tested critical shear stress of an ACB system on a horizontal plane to the design conditions, and then accounts for slope by checking that the frictional resistance is adequate to prevent sliding. The critical shear stress for a horizontal bottom width surface for the example ACB type selected for this design computation package is calculated as 16.5 psf as shown in Table 2D-5 (Ayres Associates, 2001). The maximum tractive stress for a 25-year, 24-hour design event is calculated as 11.85 psf, which is less than the critical shear stress. Geosyntec also computed and verified that the frictional resistance against sliding was greater than the driving force of the water and the slope conditions. The peak flows applied to the design of each downchute channel are based on the flows from the entire top deck and side slope areas for the 25-year, 24-hour design rainfall event as provided in Attachment 2B. This is considered conservative as the sum of these flows will only influence the performance of the lining materials at the down gradient end of each downchute channel as opposed to the entire length of the downchute channel.

Permissible tractive stresses for grass lined channels range from 0.35 psf to 3.70 psf depending on the retardation class of vegetation. Retardation Class C (which includes Bermuda and Crab grasses among others) is selected for the design of grass lined channels (as shown in Table 2D-5) and has a maximum permissible tractive stress of 1.0 psf (as shown in Table 2D-6 from TxDOT, 2009). The Manning's roughness coefficients are selected from TxDOT (2009) for the grass lined channels and these values are provided in Table 2D-7.

4 RESULTS

The depth of flow, velocity, and average tractive stress for the peak discharges into each downchute channel, top deck drainage terrace, and each side slope drainage terrace were

calculated using Equations (1) and (2). These calculations for the downchutes and top deck terraces were performed using the spreadsheets presented in Appendix 2D-1 and Appendix 2D-2, and results are summarized in Table 2D-8 and Table 2D-9 for downchute channels and top-deck terraces, respectively. The calculations for the side slope terraces were performed using the spreadsheet-based table presented as Table 2D-10. Figure 2D-1 provides location and layout of each drainage structure discussed within this calculation package.

- Each downchute channel and drainage terrace was calculated to contain the capacity to convey the flows from the 25-year, 24-hour and the 100-year, 24-hour design rainfall events.
- Each downchute channel and drainage terrace was designed to maintain one foot of freeboard for the 25-year, 24-hour design rainfall event.
- For each downchute channel, the average tractive stresses were calculated to remain below 11.85 psf during the 25-year, 24-hour design rainfall event. The average tractive stress for each drainage terrace was calculated to remain below 1.0 psf during the 25-year, 24-hour design rainfall event.

5 REFERENCES

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TxDOT (2009). *Hydraulic Design Manual*, Texas Department of Transportation, revised March 2009.

TABLES

- Table 2D-1. Design Parameter Summary for Downchute Channels
- Table 2D-2. Design Parameter Summary for Top Deck Drainage Terraces
- Table 2D-3. Runoff Coefficients for Rural Watersheds
- Table 2D-4. Channel Lock ACB Performance Variables
- Table 2D-5. Retardation Class for Lining Materials
- Table 2D-6. Permissible Shear Stresses for Various Linings
- Table 2D-7. Manning's Roughness Coefficients
- Table 2D-8. Summary of Calculated Results for the Downchute Channels
- Table 2D-9. Summary of Calculated Results for the Top Deck Drainage Terraces
- Table 2D-10. Summary of Calculated Results for the Side Slope Drainage Terraces

Table 2D-1. Design Parameter Summary for Downchute Channels

Downchute Channel Segment	Channel Shape	Longitudinal Channel Slope (%)	Manning's Roughness Coefficient [1]	Channel Dimensions (minimum)			25-yr, 24-hr Peak Flow, Q (cfs) [2]	100-yr, 24-hr Peak Flow, Q (cfs) [2]
				Base Width (ft)	Depth (ft)	Side Slopes (H:V)		
D1	Trapezoidal	25	0.030	6.00	2.00	3:1	160.8	209.2
D2	Trapezoidal	25	0.030	10.00	2.00	3:1	231.8	299.6
D3	Trapezoidal	25	0.030	8.00	2.00	3:1	181.9	235.3
D4	Trapezoidal	25	0.030	10.00	2.00	3:1	227.5	294.4
D5	Trapezoidal	25	0.030	6.00	2.00	3:1	156.0	201.1
D6	Trapezoidal	25	0.030	8.00	2.00	3:1	223.6	283.8
D7	Trapezoidal	25	0.030	6.00	2.00	3:1	146.5	190.0

Notes:

1. Manning's roughness coefficients were selected from the *Policy Criteria and Procedure Manual* (HCFCD, 2010).
2. The calculation of peak flows for the design rainfall events is presented in Attachment 2B.

Table 2D-2. Design Parameter Summary for Top Deck Drainage Terraces

Drainage Terrace	Channel Shape	Longitudinal Channel Slope (%)	Manning's Roughness Coefficient [1]	Channel Dimensions (minimum)				25-yr, 24-hr Peak Flow, Q (cfs) [2]	100-yr, 24-hr Peak Flow, Q (cfs) [2]
				Base Width (ft)	Depth (ft)	Left Side Slope (H:V)	Right Side Slope (H:V)		
TD_1	V-Shaped	0.15	0.040	0.00	3.00	3:1	33:1	62.7	85.3
TD_3	V-Shaped	0.15	0.040	0.00	3.00	3:1	33:1	52.5	71.6
TD_5	V-Shaped	0.15	0.040	0.00	3.00	3:1	33:1	52.9	72.5
TD_7	V-Shaped	0.15	0.040	0.00	3.00	3:1	33:1	77.5	105.4
TD_9	V-Shaped	0.15	0.040	0.00	3.00	3:1	33:1	18.3	24.6
TD_11	V-Shaped	0.15	0.040	0.00	3.00	3:1	33:1	37.0	50.3

Notes:

1. Manning's roughness coefficients are selected from the *Policy Criteria and Procedure Manual* (HCFCD, 2010).
2. The calculation of peak flows for the design rainfall events is presented in Attachment 2B.

Table 2D-3. Runoff Coefficients for Rural Watersheds

(from TxDOT, 2009)

	Extreme	High	Normal	Low
Relief - C_f	*0.28-0.35* steep, rugged terrain with average slopes above 30%	0.20-0.28 hilly, with average slopes of 10-30%	0.14-0.20 rolling, with average slopes of 5-10%	0.08-0.14 relatively flat land, with average slopes of 0-5%
Soil Infiltration - C_i	0.12-0.16 no effective soil cover either rock or thin soil mantle of negligble infiltration capacity	0.08-0.12 slow to take up water, clay or shallow loam soils of low infiltration capacity or poorly drained	0.06-0.08 normal: well drained light or medium textured soils, sandy loams	0.04-0.06 deep sand or other soil that takes up water readily, very light well drained soils
Vegetal Cover - C_v	0.12-0.16 no effective plan cover, bare or very sparse cover	0.08-0.12 poor to fair: clean cultivation, crops or poor natural cover, less than 20% of drainage area over good cover	0.06-0.08 fair to good: about 50% of area in good grassland or woodland, not more than 50% of area in culitvated crops	0.04-0.06 good to excellent: about 90% of drainage area in good grassland, woodland, or equivalent cover
Surface - C_s	0.10-0.12 negligible: surface depression few and shallow, drainageways steep and small, no marshes	0.08-0.10 well defined system of small drainageways, no ponds or marshes	0.06-0.08 normal: considerable surface depression storage lakes and ponds and marshes	0.04-0.06 much surface storage, drainage system not sharply defined: large floodplain storage of large number of ponds or marshes
NOTE: The total runoff coefficient based on the four runoff components is $C = C_r + C_i + C_v + C_s$				

Table 2D-4. Channel Lock ACB Performance Variables

(from Ayres, 2001)

Block Type	Weight in Air (typ.)[2] (lbs.)	Buoyant Weight W_s (lbs.)	χ^1 (in)	χ^2 (in)	χ^3 (in)	χ^4 (in)	b (in)	τ_c at 0° (lb/ft^2)
450[1]	52	27.0	2.25	7.25	3.60	7.25	14.5	11.6
550	64	33.3	2.75	7.25	4.40	7.25	14.5	13.3
800	93	48.4	4.00	7.25	6.40	7.25	14.5	16.5

Notes: 1. Tested block
2. Based on block volume and assuming concrete density of 130 lb/ft^3

Table 2D-5. Retardation Class for Lining Materials

(from TxDOT, 2009)

Retardance Class	Cover	Condition
A	Weeping Lovegrass	Excellent stand, tall (average 30 in. or 760 mm)
	Yellow Bluestem Ischaemum	Excellent stand, tall (average 36 in. or 915 mm)
B	Kudzu	Very dense growth, uncut
	Bermuda grass	Good stand, tall (average 12 in. or 305 mm)
	Native grass mixture little bluestem, bluestem, blue gamma, other short and long stem midwest grasses	Good stand, unmowed
	Weeping lovegrass	Good Stand, tall (average 24 in. or 610 mm)
	Lespedeza sericea	Good stand, not woody, tall (average 19 in. or 480 mm)
	Alfalfa	Good stand, uncut (average 11 in or 280 mm)
	Weeping lovegrass	Good stand, unmowed (average 13 in. or 330 mm)
	Kudzu	Dense growth, uncut
	Blue gamma	Good stand, uncut (average 13 in. or 330 mm)
C	Crabgrass	Fair stand, uncut (10-to-48 in. or 55-to-1220 mm)
	Bermuda grass	Good stand, mowed (average 6 in. or 150 mm)
	Common lespedeza	Good stand, uncut (average 11 in. or 280 mm)
	Grass-legume mixture: summer (orchard grass redtop, Italian ryegrass, and common lespedeza)	Good stand, uncut (6-8 in. or 150-200 mm)
	Centipedegrass	Very dense cover (average 6 in. or 150 mm)
	Kentucky bluegrass	Good stand, headed (6-12 in. or 150-305 mm)
D	Bermuda grass	Good stand, cut to 2.5 in. or 65 mm
	Common lespedeza	Excellent stand, uncut (average 4.5 in. or 115 mm)
	Buffalo grass	Good stand, uncut (3-6 in. or 75-150 mm)
	Grass-legume mixture: fall, spring (orchard grass Italian ryegrass, and common lespedeza)	Good Stand, uncut (4-5 in. or 100-125 mm)
	Lespedeza sericea	After cutting to 2 in. or 50 mm (very good before cutting)
E	Bermuda grass	Good stand, cut to 1.5 in. or 40 mm
	Bermuda grass	Burned stubble

Table 2D-6. Permissible Shear Stresses for Various Linings (from TxDOT, 2009)

Protective Cover	(lb./sq.ft.)	tp (N/m^2)
Retardance Class A Vegetation (See the "Retardation Class for Lining Materials" table above)	3.70	177
Retardance Class B Vegetation (See the "Retardation Class for Lining Materials" table above)	2.10	101
Retardance Class C Vegetation (See the "Retardation Class for Lining Materials" table above)	1.00	48
Retardance Class D Vegetation (See the "Retardation Class for Lining Materials" table above)	0.60	29
Retardance Class E Vegetation (See the "Retardation Class for Lining Materials" table above)	0.35	17
Woven Paper	0.15	7
Jute Net	0.45	22
Single Fiberglass	0.60	29
Double Fiberglass	0.85	41
Straw W/Net	1.45	69
Curled Wood Mat	1.55	74
Synthetic Mat	2.00	96
Gravel. D_{50} = 1 in. or 25 mm	0.40	19
Gravel. D_{50} = 2 in. or 50 mm	0.80	38

Table 2D-7. Manning's Roughness Coefficients

(from HCFCD, 2010)

4.3 Manning's Equation, Continued

Manning's "n" Values 4.3.5

Manning's "n" value represents the relative roughness of the channel, conduit, or overbank area. Values to use for design purposes are in the table below. Submit justification when a different "n" value is used.

Description	Manning's "n" Value
Channel	
Grass-Lined	0.040[1]
Riprap-Lined	0.040[1]
Articulated Concrete Block - Grassed	0.040[1]
Articulated Concrete Block - Bare	0.030
Concrete-Lined	0.015
Natural or Overgrown Channels	Usually 0.050 – 0.080
Overbanks	
Some flow	Usually 0.080 – 0.150
Ineffective flow areas	0.99[2]
Conduit[3]	
Concrete Pipe	0.013
Concrete Box	0.013
Corrugated Metal Pipe	0.024

[1] For design flows larger than 10,000 cfs, an "n" value of 0.035 may be used.

[2] Use the ineffective flow area option in HEC-RAS

[3] If the conduit is maintained by another jurisdiction, the "n" value specified by that jurisdiction can be used.

Table 2D-8. Summary of Calculated Results for the Downchute Channels

Downchute Channel Segment	25-yr, 24-hr Peak Flow, Q (cfs)	Depth of Flow (ft)	Hydraulic Radius (ft)	Average Velocity (ft/s)	Avg. Tractive Stress (psf)	Freeboard (ft)	100-yr, 24-hr Peak Flow, Q (cfs)	Depth of Flow (ft)	Hydraulic Radius (ft)	Average Velocity (ft/s)	Avg. Tractive Stress (psf)
D1	160.8	0.94	0.69	19.44	10.81	1.06	209.2	1.08	0.78	20.99	12.12
D2	231.8	0.90	0.73	20.16	11.41	1.10	299.6	1.04	0.83	21.86	12.88
D3	181.9	0.88	0.69	19.40	10.78	1.12	235.3	1.01	0.78	20.99	12.13
D4	227.5	0.90	0.72	20.04	11.31	1.10	294.4	1.03	0.82	21.74	12.78
D5	156.0	0.92	0.68	19.27	10.67	1.08	201.1	1.06	0.76	20.75	11.92
D6	223.6	0.99	0.76	20.67	11.85	1.01	283.8	1.12	0.85	22.21	13.20
D7	146.5	0.89	0.67	18.92	10.37	1.11	190.0	1.03	0.75	20.41	11.63

Table 2D-9. Summary of Calculated Results for the Top Deck Drainage Terraces

Top Deck Drainage Terrace	25-yr, 24-hr Peak Flow, Q (cfs)	Depth of Flow (ft)	Hydraulic Radius (ft)	Average Velocity (ft/s)	Avg. Tractive Stress (psf)	Freeboard (ft)	100-yr, 24-hr Peak Flow, Q (cfs)	Depth of Flow (ft)	Hydraulic Radius (ft)	Average Velocity (ft/s)	Avg. Tractive Stress (psf)
TD_1	62.7	1.66	0.82	1.27	0.08	1.34	85.3	1.86	0.93	1.37	0.09
TD_3	52.5	1.55	0.77	1.21	0.07	1.45	71.6	1.74	0.87	1.31	0.08
TD_5	52.9	1.55	0.77	1.22	0.07	1.45	72.5	1.75	0.87	1.32	0.08
TD_7	77.5	1.79	0.89	1.34	0.08	1.21	105.4	2.01	1.00	1.44	0.09
TD_9	18.3	1.04	0.52	0.93	0.05	1.96	24.6	1.17	0.58	1.00	0.05
TD_11	37.0	1.36	0.68	1.11	0.06	1.64	50.3	1.53	0.76	1.20	0.07

Table 2D-10. Summary of Calculated Results for the Side Slope Drainage Terraces

Side Slope Drainage Terrace (SSDT)	Length (ft)	Slope (%)	Max Contributing Drainage Area (Ac.)	Q_{25} (cfs)	Q_{100} (cfs)	d_{25} (ft)	d_{100} (ft)	τ_{25} (psf)	τ_{100} (psf)	V_{25} (fps)	V_{100} (fps)	Drainage Basin
SSDT-1	404	3.71%	1.85	11.95	16.00	0.91	1.01	1.01	1.13	4.13	4.44	*12_SS*
SSDT-2	478	2.00%	2.20	14.15	18.94	1.09	1.21	0.65	0.73	3.42	3.68	
SSDT-3	224	5.00%	1.03	6.64	8.89	0.69	0.77	1.03	1.15	3.99	4.29	
SSDT-4	474	2.00%	2.18	14.02	18.77	1.08	1.21	0.65	0.73	3.41	3.67	
SSDT-5	479	3.01%	2.20	14.18	18.99	1.01	1.12	0.91	1.01	3.98	4.29	*2_SS*
SSDT-6	389	2.00%	1.79	11.51	15.41	1.01	1.12	0.60	0.67	3.24	3.49	
SSDT-7	484	3.01%	2.22	14.32	19.18	1.01	1.13	0.91	1.02	4.00	4.30	
SSDT-8	372	1.99%	1.71	11.00	14.73	0.99	1.11	0.59	0.66	3.20	3.45	
SSDT-9	389	3.49%	1.79	11.51	15.41	0.91	1.01	0.95	1.06	4.00	4.30	*4_SS*
SSDT-10	1,286	2.00%	4.89	31.51	42.19	1.47	1.64	0.88	0.98	4.18	4.49	
SSDT-11	600	2.01%	2.76	17.76	23.78	1.18	1.32	0.71	0.79	3.62	3.90	
SSDT-12	384	3.40%	1.76	11.36	15.21	0.91	1.01	0.92	1.03	3.95	4.25	
SSDT-13	938	2.01%	2.87	18.49	24.76	1.20	1.34	0.72	0.81	3.66	3.94	
SSDT-14	424	3.66%	1.95	12.54	16.78	0.93	1.04	1.02	1.14	4.16	4.47	
SSDT-15	945	2.00%	4.34	27.96	37.44	1.40	1.57	0.84	0.94	4.05	4.36	*6_SS*
SSDT-16	278	4.41%	1.28	8.24	11.03	0.77	0.85	1.01	1.13	4.01	4.32	
SSDT-17	904	2.00%	4.15	26.76	35.83	1.38	1.54	0.83	0.93	4.01	4.31	
SSDT-18	114	6.25%	0.52	3.37	4.51	0.51	0.57	0.96	1.07	3.66	3.94	
SSDT-19	1,062	2.01%	4.87	31.41	42.06	1.47	1.64	0.88	0.98	4.18	4.49	*8_SS*
SSDT-20	849	2.01%	3.90	25.11	33.63	1.35	1.50	0.81	0.91	3.95	4.25	
SSDT-21	569	3.13%	2.61	16.84	22.54	1.07	1.19	1.00	1.12	4.22	4.54	
SSDT-22	569	3.00%	2.61	16.83	22.53	1.08	1.20	0.97	1.08	4.15	4.47	
SSDT-23	621	2.01%	2.85	18.37	24.59	1.20	1.34	0.72	0.80	3.65	3.93	*10_SS*
SSDT-24	592	2.01%	2.72	17.53	23.47	1.18	1.31	0.71	0.79	3.61	3.88	
SSDT-25	634	3.18%	2.91	18.76	25.11	1.11	1.24	1.06	1.18	4.36	4.69	
SSDT-26	485	3.67%	2.23	14.35	19.22	0.98	1.09	1.07	1.20	4.31	4.63	
SSDT-27	562	2.00%	2.58	16.62	22.25	1.16	1.29	0.69	0.77	3.56	3.83	*13_SS*
SSDT-28	434	1.99%	1.99	12.83	17.18	1.05	1.17	0.63	0.70	3.33	3.58	
SSDT-29	685	2.01%	3.14	20.26	27.13	1.24	1.39	0.75	0.83	3.74	4.03	
SSDT-30	494	2.02%	2.27	14.61	19.56	1.10	1.23	0.67	0.74	3.46	3.72	

Note:

1. Figure 2D-1 provides the location of each side slope drainage terrace and side slope sub-basin area (denoted by "XX_SS"). The "Drainage Basin" column refers to the name of the sub-basin modeled in the HEC-HMS model in Attachment 2B.
2. SSDT-11 and SSDT-14 flow into SSDT-10 and SSDT-13, respectively. The length and calculated peak flows (Q_{25} and Q_{100}) were computed with sum of the lengths of the side slope drainage terraces.

FIGURES

- Figure 2D-1. Final Cover Surface Water Management Plan

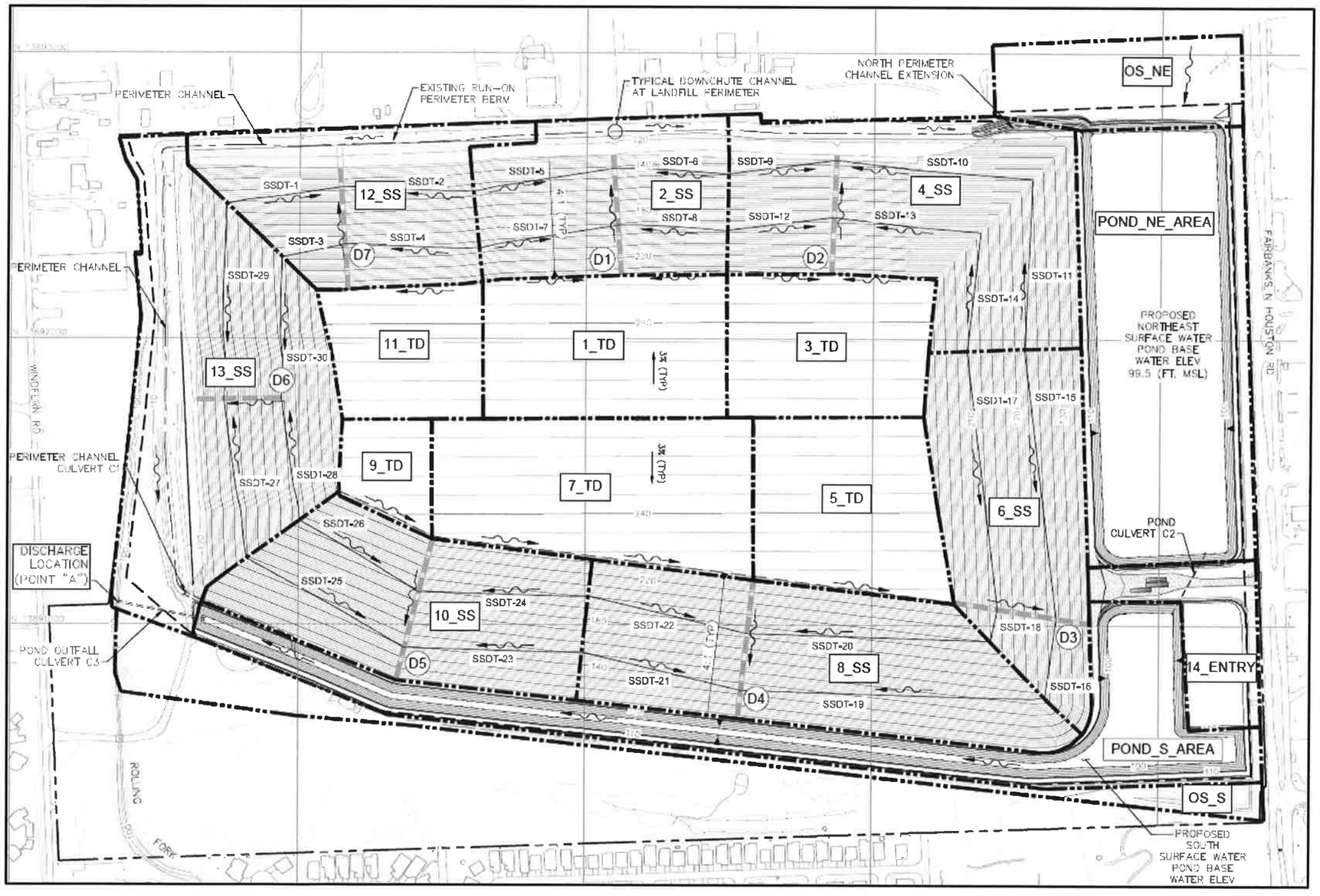


Figure 2D-1. Final Cover Surface Water Management Plan (from Att 2A, Drawing 2-3)

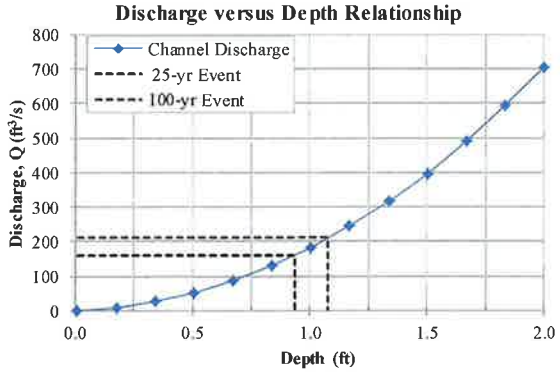
Appendix 2D-1
Downchute Channel Calculations

Design/Check: Trapezoidal/Triangular Channel
Methodology: Manning's Equation
Project: Fairbanks Landfill Expansion
Ditch ID: **Downchute, D1**

Peak Discharge, Q_{max}=	160.80	cfs (25-yr Event)
Peak Discharge, Q_{max}=	209.20	cfs (100-yr Event)
Bottom Width, B =	6.00	ft
Left Side Slope, Z_1 =	3.00	horizontal :1 vertical
Right Side Slope, Z_2 =	3.00	horizontal :1 vertical
Manning's Roughness Coeff., n =	0.030	
Longitudinal Channel Slope, S_o =	0.2500	ft/ft

Depth of Flow Y ft	Area of Flow A ft^2	Wetted Perimeter P ft	Hydraulic Radius R=A/P ft	Average Velocity V ft/s	Discharge (Flow Rate) Q=AV ft^3/s	Avg. Tractive Stress τ_o lb/ft^2	Comments
0.01	0.06	6.06	0.01	1.15	0.1	0.16	
0.18	1.15	7.11	0.16	7.36	8.4	2.52	
0.34	2.40	8.16	0.29	10.98	26.4	4.59	
0.51	3.82	9.21	0.41	13.80	52.7	6.47	
0.67	5.40	10.26	0.53	16.19	87.4	8.21	
0.84	7.15	11.31	0.63	18.29	130.7	9.86	
1.01	9.06	12.36	0.73	20.19	182.9	11.44	
1.17	11.14	13.41	0.83	21.95	244.4	12.96	
1.34	13.38	14.45	0.93	23.59	315.6	14.44	
1.50	15.79	15.50	1.02	25.14	396.8	15.89	
1.67	18.36	16.55	1.11	26.61	488.6	17.30	
1.83	21.10	17.60	1.20	28.02	591.2	18.70	
2.00	24.00	18.65	1.29	29.38	705.2	20.08	
0.94	8.27	11.93	0.69	19.44	160.80	10.81	Q (25-yr Event)
1.08	9.97	12.82	0.78	20.99	209.20	12.12	Q (100-yr Event)

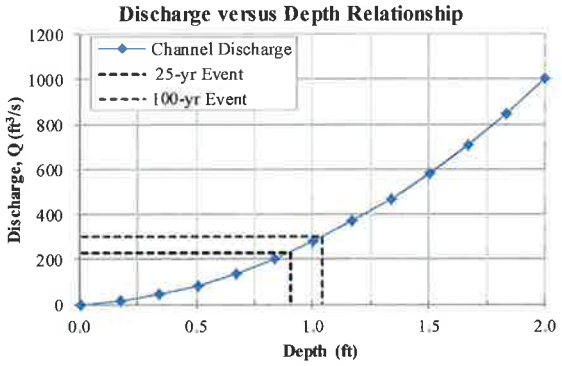
Discharge versus Depth Relationship



Design/Check: Trapezoidal/Triangular Channel
Methodology: Manning's Equation
Project: Fairbanks Landfill Expansion
Ditch ID: **Downchute, D2**

Peak Discharge, Q_{max}=	231.80	cfs (25-yr Event)
Peak Discharge, Q_{max}=	299.60	cfs (100-yr Event)
Bottom Width, B =	10.00	ft
Left Side Slope, Z_1 =	3.00	horizontal :1 vertical
Right Side Slope, Z_2 =	3.00	horizontal :1 vertical
Manning's Roughness Coeff., n =	0.030	
Longitudinal Channel Slope, S_o =	0.2500	ft/ft

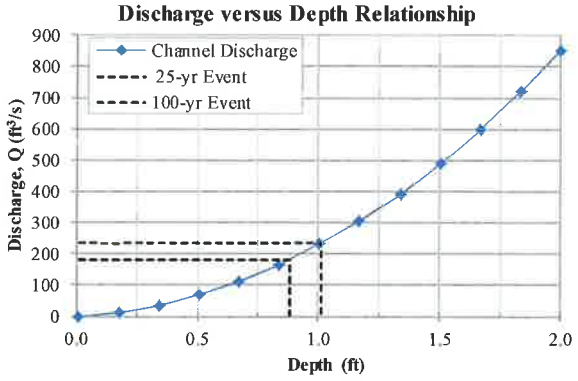
Depth of Flow Y ft	Area of Flow A ft^2	Wetted Perimeter P ft	Hydraulic Radius R=A/P ft	Average Velocity V ft/s	Discharge (Flow Rate) Q=AV ft^3/s	Avg. Tractive Stress τ_o lb/ft^2	Comments
0.01	0.10	10.06	0.01	1.15	0.1	0.16	
0.18	1.85	11.11	0.17	7.51	13.9	2.60	
0.34	3.77	12.16	0.31	11.36	42.8	4.83	
0.51	5.85	13.21	0.44	14.42	84.3	6.91	
0.67	8.09	14.26	0.57	17.02	137.8	8.85	
0.84	10.50	15.31	0.69	19.32	202.9	10.71	
1.01	13.08	16.36	0.80	21.39	279.8	12.48	
1.17	15.82	17.41	0.91	23.30	368.7	14.18	
1.34	18.73	18.45	1.01	25.08	469.6	15.83	
1.50	21.80	19.50	1.12	26.75	583.0	17.44	
1.67	25.03	20.55	1.22	28.33	709.1	19.00	
1.83	28.43	21.60	1.32	29.83	848.2	20.54	
2.00	32.00	22.65	1.41	31.27	1000.7	22.04	
0.90	11.50	15.72	0.73	20.16	231.80	11.41	Q (25-yr Event)
1.04	13.71	16.60	0.83	21.86	299.60	12.88	Q (100-yr Event)



Design/Check: Trapezoidal/Triangular Channel
Methodology: Manning's Equation
Project: Fairbanks Landfill Expansion
Ditch ID: **Downchute, D3**

Peak Discharge, Q_{max}=	181.90	cfs (25-yr Event)
Peak Discharge, Q_{max}=	235.30	cfs (100-yr Event)
Bottom Width, B =	8.00	ft
Left Side Slope, Z_1 =	3.00	horizontal :1 vertical
Right Side Slope, Z_2 =	3.00	horizontal :1 vertical
Manning's Roughness Coeff., n =	0.030	
Longitudinal Channel Slope, S_o =	0.2500	ft/ft

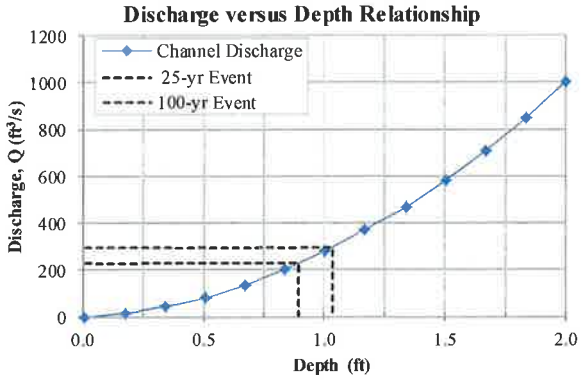
Depth of Flow Y ft	Area of Flow A ft^2	Wetted Perimeter P ft	Hydraulic Radius R=A/P ft	Average Velocity V ft/s	Discharge (Flow Rate) Q=AV ft^3/s	Avg. Tractive Stress τ_o lb/ft^2	Comments
0.01	0.08	8.06	0.01	1.15	0.1	0.16	
0.18	1.50	9.11	0.16	7.45	11.2	2.57	
0.34	3.08	10.16	0.30	11.21	34.6	4.73	
0.51	4.83	11.21	0.43	14.17	68.5	6.73	
0.67	6.75	12.26	0.55	16.67	112.5	8.59	
0.84	8.83	13.31	0.66	18.88	166.7	10.35	
1.01	11.07	14.36	0.77	20.88	231.1	12.03	
1.17	13.48	15.41	0.87	22.72	306.2	13.65	
1.34	16.05	16.45	0.98	24.43	392.2	15.22	
1.50	18.79	17.50	1.07	26.04	489.3	16.75	
1.67	21.70	18.55	1.17	27.57	598.1	18.24	
1.83	24.77	19.60	1.26	29.03	718.9	19.71	
2.00	28.00	20.65	1.36	30.43	851.9	21.15	
0.88	9.37	13.57	0.69	19.40	181.90	10.78	Q (25-yr Event)
1.01	11.21	14.42	0.78	20.99	235.30	12.13	Q (100-yr Event)



Design/Check: Trapezoidal/Triangular Channel
Methodology: Manning's Equation
Project: Fairbanks Landfill Expansion
Ditch ID: **Downchute, D4**

Peak Discharge, Q_{max} =	227.50	cfs (25-yr Event)
Peak Discharge, Q_{max} =	294.40	cfs (100-yr Event)
Bottom Width, B =	10.00	ft
Left Side Slope, Z_1 =	3.00	horizontal :1 vertical
Right Side Slope, Z_2 =	3.00	horizontal :1 vertical
Manning's Roughness Coeff., n =	0.030	
Longitudinal Channel Slope, S_o =	0.2500	ft/ft

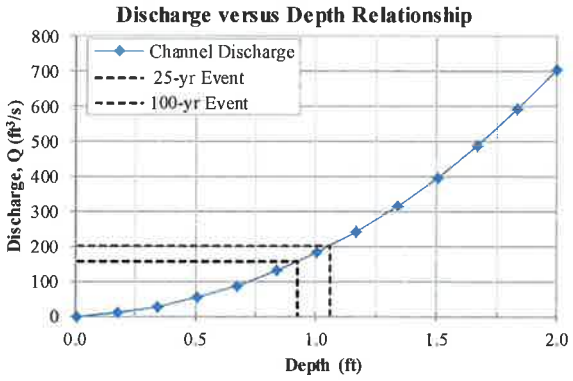
Depth of Flow Y ft	Area of Flow A ft^2	Wetted Perimeter P ft	Hydraulic Radius R=A/P ft	Average Velocity V ft/s	Discharge (Flow Rate) Q=AV ft^3/s	Avg. Tractive Stress τ_o lb/ft^2	Comments
0.01	0.10	10.06	0.01	1.15	0.1	0.16	
0.18	1.85	11.11	0.17	7.51	13.9	2.60	
0.34	3.77	12.16	0.31	11.36	42.8	4.83	
0.51	5.85	13.21	0.44	14.42	84.3	6.91	
0.67	8.09	14.26	0.57	17.02	137.8	8.85	
0.84	10.50	15.31	0.69	19.32	202.9	10.71	
1.01	13.08	16.36	0.80	21.39	279.8	12.48	
1.17	15.82	17.41	0.91	23.30	368.7	14.18	
1.34	18.73	18.45	1.01	25.08	469.6	15.83	
1.50	21.80	19.50	1.12	26.75	583.0	17.44	
1.67	25.03	20.55	1.22	28.33	709.1	19.00	
1.83	28.43	21.60	1.32	29.83	848.2	20.54	
2.00	32.00	22.65	1.41	31.27	1000.7	22.04	
0.90	11.35	15.66	0.72	20.04	227.50	11.31	Q (25-yr Event)
1.03	13.54	16.54	0.82	21.74	294.40	12.78	Q (100-yr Event)



Design/Check: Trapezoidal/Triangular Channel
Methodology: Manning's Equation
Project: Fairbanks Landfill Expansion
Ditch ID: **Downchute, D5**

Peak Discharge, Q_{max} =	156.00	cfs (25-yr Event)
Peak Discharge, Q_{max} =	201.10	cfs (100-yr Event)
Bottom Width, B =	6.00	ft
Left Side Slope, Z_1 =	3.00	horizontal :1 vertical
Right Side Slope, Z_2 =	3.00	horizontal :1 vertical
Manning's Roughness Coeff., n =	0.030	
Longitudinal Channel Slope, S_o =	0.2500	ft/ft

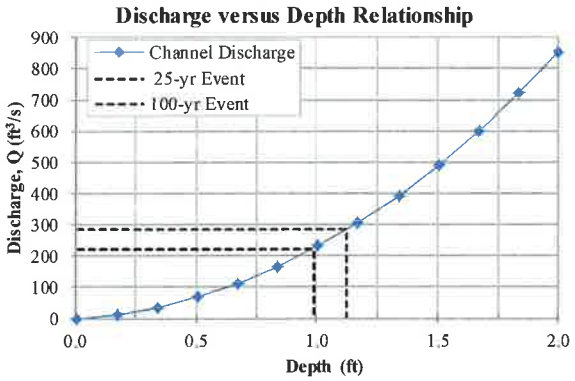
Depth of Flow Y ft	Area of Flow A ft^2	Wetted Perimeter P ft	Hydraulic Radius R=A/P ft	Average Velocity V ft/s	Discharge (Flow Rate) Q=AV ft^3/s	Avg. Tractive Stress τ_o lb/ft^2	Comments
0.01	0.06	6.06	0.01	1.15	0.1	0.16	
0.18	1.15	7.11	0.16	7.36	8.4	2.52	
0.34	2.40	8.16	0.29	10.98	26.4	4.59	
0.51	3.82	9.21	0.41	13.80	52.7	6.47	
0.67	5.40	10.26	0.53	16.19	87.4	8.21	
0.84	7.15	11.31	0.63	18.29	130.7	9.86	
1.01	9.06	12.36	0.73	20.19	182.9	11.44	
1.17	11.14	13.41	0.83	21.95	244.4	12.96	
1.34	13.38	14.45	0.93	23.59	315.6	14.44	
1.50	15.79	15.50	1.02	25.14	396.8	15.89	
1.67	18.36	16.55	1.11	26.61	488.6	17.30	
1.83	21.10	17.60	1.20	28.02	591.2	18.70	
2.00	24.00	18.65	1.29	29.38	705.2	20.08	
0.92	8.09	11.84	0.68	19.27	156.00	10.67	Q (25-yr Event)
1.06	9.69	12.68	0.76	20.75	201.10	11.92	Q (100-yr Event)



Design/Check: Trapezoidal/Triangular Channel
Methodology: Manning's Equation
Project: Fairbanks Landfill Expansion
Ditch ID: **Downchute, D6**

Peak Discharge, Q_{max} =	223.60	cfs (25-yr Event)
Peak Discharge, Q_{max} =	283.80	cfs (100-yr Event)
Bottom Width, B =	8.00	ft
Left Side Slope, Z_1 =	3.00	horizontal :1 vertical
Right Side Slope, Z_2 =	3.00	horizontal :1 vertical
Manning's Roughness Coeff., n =	0.030	
Longitudinal Channel Slope, S_o =	0.2500	ft/ft

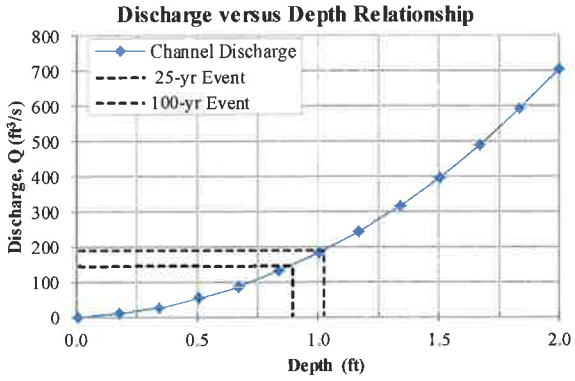
Depth of Flow Y ft	Area of Flow A ft^2	Wetted Perimeter P ft	Hydraulic Radius R=A/P ft	Average Velocity V ft/s	Discharge (Flow Rate) Q=AV ft^3/s	Avg. Tractive Stress τ_o lb/ft^2	Comments
0.01	0.08	8.06	0.01	1.15	0.1	0.16	
0.18	1.50	9.11	0.16	7.45	11.2	2.57	
0.34	3.08	10.16	0.30	11.21	34.6	4.73	
0.51	4.83	11.21	0.43	14.17	68.5	6.73	
0.67	6.75	12.26	0.55	16.67	112.5	8.59	
0.84	8.83	13.31	0.66	18.88	166.7	10.35	
1.01	11.07	14.36	0.77	20.88	231.1	12.03	
1.17	13.48	15.41	0.87	22.72	306.2	13.65	
1.34	16.05	16.45	0.98	24.43	392.2	15.22	
1.50	18.79	17.50	1.07	26.04	489.3	16.75	
1.67	21.70	18.55	1.17	27.57	598.1	18.24	
1.83	24.77	19.60	1.26	29.03	718.9	19.71	
2.00	28.00	20.65	1.36	30.43	851.9	21.15	
0.99	10.82	14.24	0.76	20.67	223.60	11.85	Q (25-yr Event)
1.12	12.78	15.11	0.85	22.21	283.80	13.20	Q (100-yr Event)



Design/Check: Trapezoidal/Triangular Channel
Methodology: Manning's Equation
Project: Fairbanks Landfill Expansion
Ditch ID: **Downchute, D7**

Peak Discharge, Q_{max} =	146.50	cfs (25-yr Event)
Peak Discharge, Q_{max} =	190.00	cfs (100-yr Event)
Bottom Width, B =	6.00	ft
Left Side Slope, Z_1 =	3.00	horizontal :1 vertical
Right Side Slope, Z_2 =	3.00	horizontal :1 vertical
Manning's Roughness Coeff., n =	0.030	
Longitudinal Channel Slope, S_o =	0.2500	ft/ft

Depth of Flow Y ft	Area of Flow A ft^2	Wetted Perimeter P ft	Hydraulic Radius R=A/P ft	Average Velocity V ft/s	Discharge (Flow Rate) Q=AV ft^3/s	Avg. Tractive Stress τ_o lb/ft^2	Comments
0.01	0.06	6.06	0.01	1.15	0.1	0.16	
0.18	1.15	7.11	0.16	7.36	8.4	2.52	
0.34	2.40	8.16	0.29	10.98	26.4	4.59	
0.51	3.82	9.21	0.41	13.80	52.7	6.47	
0.67	5.40	10.26	0.53	16.19	87.4	8.21	
0.84	7.15	11.31	0.63	18.29	130.7	9.86	
1.01	9.06	12.36	0.73	20.19	182.9	11.44	
1.17	11.14	13.41	0.83	21.95	244.4	12.96	
1.34	13.38	14.45	0.93	23.59	315.6	14.44	
1.50	15.79	15.50	1.02	25.14	396.8	15.89	
1.67	18.36	16.55	1.11	26.61	488.6	17.30	
1.83	21.10	17.60	1.20	28.02	591.2	18.70	
2.00	24.00	18.65	1.29	29.38	705.2	20.08	
0.89	7.74	11.64	0.67	18.92	146.50	10.37	Q (25-yr Event)
1.03	9.31	12.49	0.75	20.41	190.00	11.63	Q (100-yr Event)

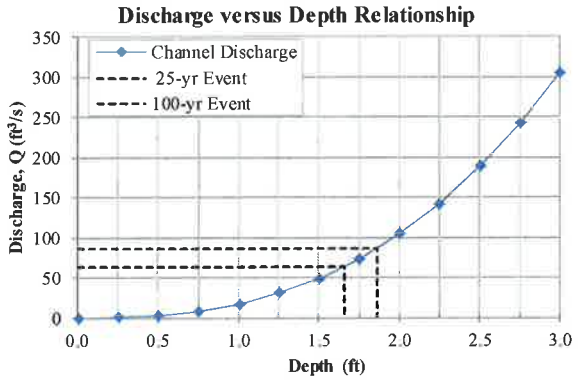


Appendix 2D-2
Drainage Terrace Calculations

Design/Check: Trapezoidal/Triangular Channel
Methodology: Manning's Equation
Project: Fairbanks Landfill Expansion
Ditch ID: **Top Deck Drainage Terrace, TD_1**

Peak Discharge, Q_{max}=	62.70	cfs (25-yr Event)
Peak Discharge, Q_{max}=	85.30	cfs (100-yr Event)
Bottom Width, B =	0.00	ft
Left Side Slope, Z_1 =	3.00	horizontal :1 vertical
Right Side Slope, Z_2 =	33.00	horizontal :1 vertical
Manning's Roughness Coeff., n =	0.040	
Longitudinal Channel Slope, S_o =	0.0015	ft/ft

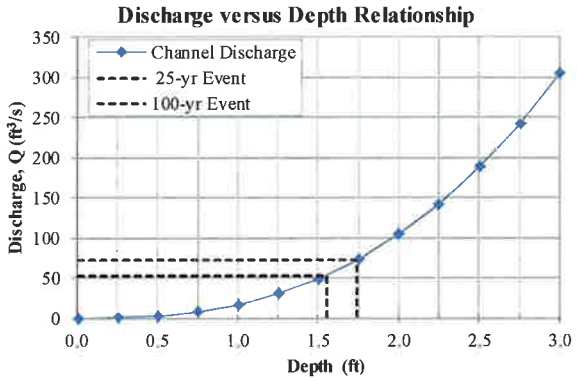
Depth of Flow Y ft	Area of Flow A ft^2	Wetted Perimeter P ft	Hydraulic Radius R=A/P ft	Average Velocity V ft/s	Discharge (Flow Rate) Q=AV ft^3/s	Avg. Tractive Stress τ_o lb/ft^2	Comments
0.01	0.00	0.36	0.00	0.04	0.0	0.00	
0.26	1.21	9.38	0.13	0.37	0.4	0.01	
0.51	4.65	18.39	0.25	0.58	2.7	0.02	
0.76	10.33	27.40	0.38	0.75	7.8	0.04	
1.01	18.24	36.42	0.50	0.91	16.6	0.05	
1.26	28.39	45.43	0.62	1.05	29.9	0.06	
1.51	40.77	54.45	0.75	1.19	48.5	0.07	
1.75	55.39	63.46	0.87	1.32	73.0	0.08	
2.00	72.24	72.48	1.00	1.44	104.0	0.09	
2.25	91.33	81.49	1.12	1.56	142.2	0.10	
2.50	112.65	90.50	1.24	1.67	188.1	0.12	
2.75	136.21	99.52	1.37	1.78	242.3	0.13	
3.00	162.00	108.53	1.49	1.88	305.3	0.14	
1.66	49.43	59.95	0.82	1.27	62.70	0.08	Q (25-yr Event)
1.86	62.26	67.29	0.93	1.37	85.30	0.09	Q (100-yr Event)



Design/Check: Trapezoidal/Triangular Channel
Methodology: Manning's Equation
Project: Fairbanks Landfill Expansion
Ditch ID: **Top Deck Drainage Terrace, TD_3**

Peak Discharge, Q_{max} =	52.50	cfs (25-yr Event)
Peak Discharge, Q_{max} =	71.60	cfs (100-yr Event)
Bottom Width, B =	0.00	ft
Left Side Slope, Z_1 =	3.00	horizontal :1 vertical
Right Side Slope, Z_2 =	33.00	horizontal :1 vertical
Manning's Roughness Coeff., n =	0.040	
Longitudinal Channel Slope, S_o =	0.0015	ft/ft

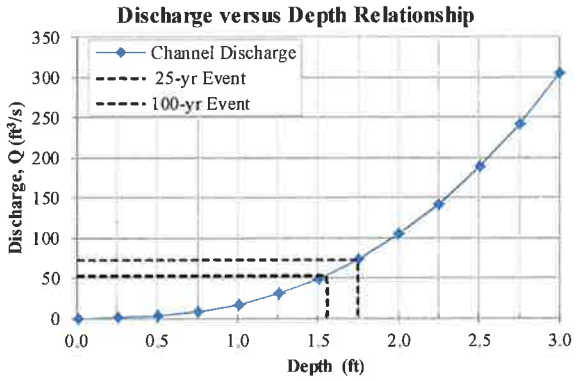
Depth of Flow Y ft	Area of Flow A ft^2	Wetted Perimeter P ft	Hydraulic Radius R=A/P ft	Average Velocity V ft/s	Discharge (Flow Rate) Q=AV ft^3/s	Avg. Tractive Stress τ_o lb/ft^2	Comments
0.01	0.00	0.36	0.00	0.04	0.0	0.00	
0.26	1.21	9.38	0.13	0.37	0.4	0.01	
0.51	4.65	18.39	0.25	0.58	2.7	0.02	
0.76	10.33	27.40	0.38	0.75	7.8	0.04	
1.01	18.24	36.42	0.50	0.91	16.6	0.05	
1.26	28.39	45.43	0.62	1.05	29.9	0.06	
1.51	40.77	54.45	0.75	1.19	48.5	0.07	
1.75	55.39	63.46	0.87	1.32	73.0	0.08	
2.00	72.24	72.48	1.00	1.44	104.0	0.09	
2.25	91.33	81.49	1.12	1.56	142.2	0.10	
2.50	112.65	90.50	1.24	1.67	188.1	0.12	
2.75	136.21	99.52	1.37	1.78	242.3	0.13	
3.00	162.00	108.53	1.49	1.88	305.3	0.14	
1.55	43.27	56.09	0.77	1.21	52.50	0.07	Q (25-yr Event)
1.74	54.60	63.01	0.87	1.31	71.60	0.08	Q (100-yr Event)



Design/Check: Trapezoidal/Triangular Channel
Methodology: Manning's Equation
Project: Fairbanks Landfill Expansion
Ditch ID: **Top Deck Drainage Terrace, TD_5**

Peak Discharge, Q_{max} =	52.90	cfs (25-yr Event)
Peak Discharge, Q_{max} =	72.50	cfs (100-yr Event)
Bottom Width, B =	0.00	ft
Left Side Slope, Z_1 =	3.00	horizontal :1 vertical
Right Side Slope, Z_2 =	33.00	horizontal :1 vertical
Manning's Roughness Coeff., n =	0.040	
Longitudinal Channel Slope, S_o =	0.0015	ft/ft

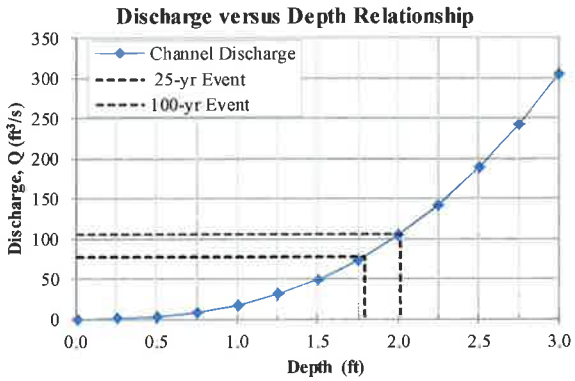
Depth of Flow Y ft	Area of Flow A ft^2	Wetted Perimeter P ft	Hydraulic Radius R=A/P ft	Average Velocity V ft/s	Discharge (Flow Rate) Q=AV ft^3/s	Avg. Tractive Stress τ_o lb/ft^2	Comments
0.01	0.00	0.36	0.00	0.04	0.0	0.00	
0.26	1.21	9.38	0.13	0.37	0.4	0.01	
0.51	4.65	18.39	0.25	0.58	2.7	0.02	
0.76	10.33	27.40	0.38	0.75	7.8	0.04	
1.01	18.24	36.42	0.50	0.91	16.6	0.05	
1.26	28.39	45.43	0.62	1.05	29.9	0.06	
1.51	40.77	54.45	0.75	1.19	48.5	0.07	
1.75	55.39	63.46	0.87	1.32	73.0	0.08	
2.00	72.24	72.48	1.00	1.44	104.0	0.09	
2.25	91.33	81.49	1.12	1.56	142.2	0.10	
2.50	112.65	90.50	1.24	1.67	188.1	0.12	
2.75	136.21	99.52	1.37	1.78	242.3	0.13	
3.00	162.00	108.53	1.49	1.88	305.3	0.14	
1.55	43.52	56.25	0.77	1.22	52.90	0.07	Q (25-yr Event)
1.75	55.12	63.31	0.87	1.32	72.50	0.08	Q (100-yr Event)



Design/Check: Trapezoidal/Triangular Channel
Methodology: Manning's Equation
Project: Fairbanks Landfill Expansion
Ditch ID: **Top Deck Drainage Terrace, TD_7**

Peak Discharge, Q_{max} =	77.50	cfs (25-yr Event)
Peak Discharge, Q_{max} =	105.40	cfs (100-yr Event)
Bottom Width, B =	0.00	ft
Left Side Slope, Z_1 =	3.00	horizontal :1 vertical
Right Side Slope, Z_2 =	33.00	horizontal :1 vertical
Manning's Roughness Coeff., n =	0.040	
Longitudinal Channel Slope, S_o =	0.0015	ft/ft

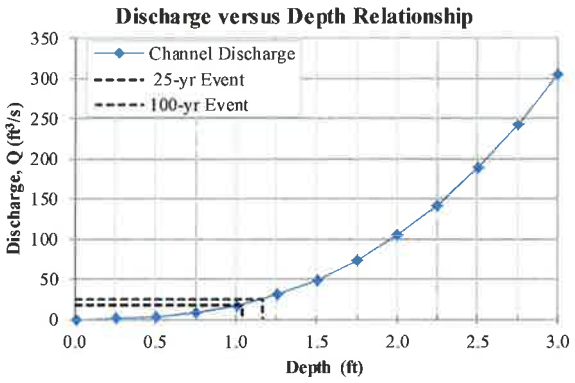
Depth of Flow Y ft	Area of Flow A ft^2	Wetted Perimeter P ft	Hydraulic Radius R=A/P ft	Average Velocity V ft/s	Discharge (Flow Rate) Q=AV ft^3/s	Avg. Tractive Stress τ_o lb/ft^2	Comments
0.01	0.00	0.36	0.00	0.04	0.0	0.00	
0.26	1.21	9.38	0.13	0.37	0.4	0.01	
0.51	4.65	18.39	0.25	0.58	2.7	0.02	
0.76	10.33	27.40	0.38	0.75	7.8	0.04	
1.01	18.24	36.42	0.50	0.91	16.6	0.05	
1.26	28.39	45.43	0.62	1.05	29.9	0.06	
1.51	40.77	54.45	0.75	1.19	48.5	0.07	
1.75	55.39	63.46	0.87	1.32	73.0	0.08	
2.00	72.24	72.48	1.00	1.44	104.0	0.09	
2.25	91.33	81.49	1.12	1.56	142.2	0.10	
2.50	112.65	90.50	1.24	1.67	188.1	0.12	
2.75	136.21	99.52	1.37	1.78	242.3	0.13	
3.00	162.00	108.53	1.49	1.88	305.3	0.14	
1.79	57.94	64.91	0.89	1.34	77.50	0.08	Q (25-yr Event)
2.01	72.97	72.84	1.00	1.44	105.40	0.09	Q (100-yr Event)



Design/Check: Trapezoidal/Triangular Channel
Methodology: Manning's Equation
Project: Fairbanks Landfill Expansion
Ditch ID: **Top Deck Drainage Terrace, TD_9**

Peak Discharge, Q_{max} =	18.30	cfs (25-yr Event)
Peak Discharge, Q_{max} =	24.60	cfs (100-yr Event)
Bottom Width, B =	0.00	ft
Left Side Slope, Z_1 =	3.00	horizontal :1 vertical
Right Side Slope, Z_2 =	33.00	horizontal :1 vertical
Manning's Roughness Coeff., n =	0.040	
Longitudinal Channel Slope, S_o =	0.0015	ft/ft

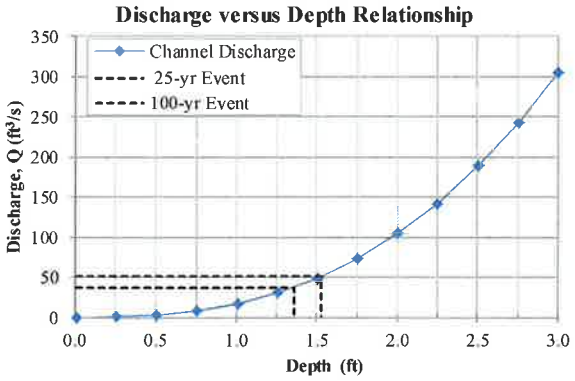
Depth of Flow Y ft	Area of Flow A ft^2	Wetted Perimeter P ft	Hydraulic Radius R=A/P ft	Average Velocity V ft/s	Discharge (Flow Rate) Q=AV ft^3/s	Avg. Tractive Stress τ_o lb/ft^2	Comments
0.01	0.00	0.36	0.00	0.04	0.0	0.00	
0.26	1.21	9.38	0.13	0.37	0.4	0.01	
0.51	4.65	18.39	0.25	0.58	2.7	0.02	
0.76	10.33	27.40	0.38	0.75	7.8	0.04	
1.01	18.24	36.42	0.50	0.91	16.6	0.05	
1.26	28.39	45.43	0.62	1.05	29.9	0.06	
1.51	40.77	54.45	0.75	1.19	48.5	0.07	
1.75	55.39	63.46	0.87	1.32	73.0	0.08	
2.00	72.24	72.48	1.00	1.44	104.0	0.09	
2.25	91.33	81.49	1.12	1.56	142.2	0.10	
2.50	112.65	90.50	1.24	1.67	188.1	0.12	
2.75	136.21	99.52	1.37	1.78	242.3	0.13	
3.00	162.00	108.53	1.49	1.88	305.3	0.14	
1.04	19.63	37.78	0.52	0.93	18.30	0.05	Q (25-yr Event)
1.17	24.51	42.21	0.58	1.00	24.60	0.05	Q (100-yr Event)



Design/Check: Trapezoidal/Triangular Channel
Methodology: Manning's Equation
Project: Fairbanks Landfill Expansion
Ditch ID: **Top Deck Drainage Terrace, TD_11**

Peak Discharge, Q_{max} =	37.00	cfs (25-yr Event)
Peak Discharge, Q_{max} =	50.30	cfs (100-yr Event)
Bottom Width, B =	0.00	ft
Left Side Slope, Z_1 =	3.00	horizontal :1 vertical
Right Side Slope, Z_2 =	33.00	horizontal :1 vertical
Manning's Roughness Coeff., n =	0.040	
Longitudinal Channel Slope, S_o =	0.0015	ft/ft

Depth of Flow Y ft	Area of Flow A ft^2	Wetted Perimeter P ft	Hydraulic Radius R=A/P ft	Average Velocity V ft/s	Discharge (Flow Rate) Q=AV ft^3/s	Avg. Tractive Stress τ_o lb/ft^2	Comments
0.01	0.00	0.36	0.00	0.04	0.0	0.00	
0.26	1.21	9.38	0.13	0.37	0.4	0.01	
0.51	4.65	18.39	0.25	0.58	2.7	0.02	
0.76	10.33	27.40	0.38	0.75	7.8	0.04	
1.01	18.24	36.42	0.50	0.91	16.6	0.05	
1.26	28.39	45.43	0.62	1.05	29.9	0.06	
1.51	40.77	54.45	0.75	1.19	48.5	0.07	
1.75	55.39	63.46	0.87	1.32	73.0	0.08	
2.00	72.24	72.48	1.00	1.44	104.0	0.09	
2.25	91.33	81.49	1.12	1.56	142.2	0.10	
2.50	112.65	90.50	1.24	1.67	188.1	0.12	
2.75	136.21	99.52	1.37	1.78	242.3	0.13	
3.00	162.00	108.53	1.49	1.88	305.3	0.14	
1.36	33.28	49.19	0.68	1.11	37.00	0.06	Q (25-yr Event)
1.53	41.90	55.20	0.76	1.20	50.30	0.07	Q (100-yr Event)



ATTACHMENT 2E

ON-SITE DESIGN – CULVERTS AND PERIMETER DRAINAGE CHANNELS

Written by: J. McNash Date: 11/5/2012 Reviewed & Revised by: S. Graves Date: 2/25/2014

Client: USAWTXL Project: Fairbanks Landfill Expansion Project No.: TXL0263 Phase No.: 05

ON-SITE DESIGN – CULVERTS AND PERIMETER DRAINAGE CHANNELS FAIRBANKS LANDFILL EXPANSION



3/3/2014

SEALED FOR PERMITTING PURPOSES,
CALCULATION PAGES 1 TO 29

GEOSYNTEC CONSULTANTS
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1 PURPOSE

The purpose of this calculation package is to present the design of the perimeter drainage channels and for the box culvert (designated as Culvert C1) for the proposed facility surface water management system for the Fairbanks Landfill. There are two other culverts designed at the site, designated as Culverts C2 and C3. Culverts C2 and C3 are for the storm water pond connections and discharge outlet, and the design analysis for those storm water pond culverts based on their selected size, elevations, and slope is contained within the Attachment 2B calculations. Also note that the design of the surface water pond appurtenances (which refers to anti-seep collars and riprap aprons at the pond outlet (Culvert C3)) is presented in Attachment 2C.

Perimeter drainage channels are located at the toe of the 4 horizontal: 1 vertical (4H:1V) side slopes of the final cover system around the north and west sides of the landfill. The perimeter drainage channels convey surface water runoff to the on-site surface water ponds located to the northeast and south of the landfill. The North Perimeter Drainage Channel conveys surface water from the north and east areas of the final cover system through a series of reaches (designated as R1, R2, and R3) to the Northeast Surface Water Pond. The West Perimeter Drainage Channel conveys surface water from the western areas of the final cover to the South Surface Water Pond through a series of reaches (designated as R4, R5, and R6) and a culvert (designated as C1).

A reach is defined as a segment of a perimeter drainage channel with a selected slope,

width, and depth. The West and North Perimeter Drainage Channels are separated by a local high point on the northern edge of the final cover system. Surface water from the southern areas of the final cover is conveyed directly into the South Surface Water Pond through downchute channels, which are discussed in Attachment 2D of the Facility Surface Water Drainage Report (Drainage Report). Also, Drawing 2-1 in Attachment 2A of the Drainage Report shows a plan view of the facility surface water management system.

2 METHODOLOGY

Perimeter Channels

The North Perimeter Drainage Channel and the West Perimeter Drainage Channel are to be grass-lined trapezoidal channels conveying flows to the surface water ponds. Final cover areas contributing to each perimeter channel reach are modeled in the computer program HEC-HMS for the post-development site conditions, and subsequently peak discharges are computed for each reach. The details including the methodology and design parameters of this analysis are provided in the *On-Site Drainage Analysis – Hydrology* calculations located in Attachment 2B of the Drainage Report. Each reach is designed to convey the peak surface water discharge of the 25-year, 24-hour design rainfall event flowing to the channel segment, while maintaining a minimum of one foot of freeboard in the channel during this rainfall event. In addition, each reach was designed with the capacity to convey the peak discharge from the 100-year, 24-hour rainfall event without overtopping. Calculations of surface water discharge for these rainfall events are provided in Attachment 2B of the Drainage Report.

Drawing 2-4 in Attachment 2A of the Drainage Report shows the perimeter drainage channel plans with reach designations for each perimeter channel segment. Drawing 2-5 provides perimeter drainage profiles for the North and West Perimeter Drainage Channels. The typical cross-section of a perimeter drainage channel and a channel schedule for the perimeter drainage channels is provided in Drawing 2-10. The channel geometry and peak discharge during the design rainfall events are used to calculate the peak velocity and the peak tractive stress during the design rainfall on the lining of the channel.

It should be noted that channel reaches located along the northern and western portions of the currently permitted landfill have already been constructed. The design associated with this facility expansion considers the existing channel profile (i.e., design slopes and elevations) from the currently permitted surface water plan for the site. However, in

several cases, these reaches will need to be enlarged to accommodate increased peak discharge rates flowing from the landfill expansion.

The capacity of each drainage channel segment is calculated and assessed by solving Manning's equation. Manning's equation (Chow, 1959) is expressed as:

$$Q = \frac{1.49}{n} A R^{2/3} S^{1/2} \quad (1)$$

where:

Q = discharge (cfs),

n = Manning's roughness coefficient,

A = area of cross-section of flow (ft^2),

P = wetted perimeter (ft),

R = hydraulic radius = A/P (ft), and

S = longitudinal slope (ft/ft).

The peak average tractive stresses in the channel for various depths of flow are estimated using the following equation (HCFCD, 2001):

$$\tau_o = \gamma_w R S \quad (2)$$

where:

τ_o = average tractive stress (lb/ft^2),

γ_w = unit weight of water (lb/ft^3),

R = hydraulic radius = A/P (ft), and

S = channel slope (ft/ft).

Culvert C1

Culvert C1 is designed by utilizing the HY-8 Culvert Analysis Program v.7.3 (HY-8). HY-8 was originally developed by the Federal Highway Administration (FHWA) and has since been updated and revised to its current version (Version 7.3). The performance of a

culvert is modeled and assessed based on boundary conditions, culvert configuration, and peak flow criteria. HY-8 is applied for the surface water drainage system to model the Culvert C1 conveying the peak discharge from West Perimeter Drainage Channel into the South Surface Water Pond. The performance of the box culvert is assessed for two tailwater conditions based on the modeled water surface elevation within the South Surface Water Pond coinciding with the peak discharge within the culvert for the 25-year, 24-hour rainfall event (Case I) and the 100-year, 24-hour rainfall event (Case II). The HEC-HMS model developed to compute the peak inflows for each Case is discussed within Attachment 2B of the Drainage Report. Results from the HY-8 model are reviewed to verify that the computed headwater elevation does not overtop the berm at the culvert inlet during the peak discharge.

Riprap Apron Design

The riprap aprons at the outlet culvert of C1 within this Attachment and at the outlet of R3 into the surface water pond are designed to protect against erosion and scour peak surface water runoff. Meanwhile, the riprap apron for Culvert C3 is provided in Attachment 2C as part of the pond appurtenance design package. The riprap apron for Culvert C1 is sized from the outflow based on the 25-year, 24-hour rainfall event. The design guidance from the Federal Highway Administration (FHWA) provides a methodology for calculating the required length of apron (L_a) and d_{50} of the riprap based on the culvert diameter and flow rate, and this methodology was adopted for use in the site designs. The d_{50} is the stone size of the riprap for which to 50% of the riprap stones are smaller than d_{50} by mass. The riprap size is calculated using the following equation (FHWA, 2006):

$$d_{50} = 0.2D\left(\frac{Q}{D^{2.5}\sqrt{g}}\right)^{4/3}\frac{D}{TW} \qquad (3)$$

where:

d_{50} = riprap size (ft),

Q = design discharge (cfs),

D = culvert diameter (ft),

TW = tailwater depth (ft), and

g = gravitational constant.

The tailwater depth should be limited to between 0.4D and D. FHWA (2006) recommends the use of a tailwater depth equal to 0.4D if the tailwater is unknown.

The required length and depth of the riprap apron can be estimated based on the culvert rise and riprap size as provided in Table 2E-1. The width of the riprap apron at the outlet was selected as 3D as recommended by the FHWA (2006) detail for riprap aprons. The apron width will also widen from the outlet along the required length at a rate of 1 ft width per 3 ft length at each edge. Figure 2E-2 provides the typical geometry for the riprap apron.

3 DESIGN PARAMETERS

The design parameters for each reach and culvert, including channel geometry and calculated peak discharges as computed by the HEC-HMS model described in Attachment 2B to the Drainage Report for the 25-year and 100-year events, are summarized in Table 2E-2. Reaches R1 and R4 are directly adjacent to the local high point, and subsequently downchute channels do not flow directly into these reaches (see Drawing 2-1). Therefore, the design parameters (i.e., the 25-year, 24-hour peak discharge and channel geometry) for reaches R1 and R4, were conservatively assumed to be equivalent to the reaches immediately downstream, R2 and R5, respectively.

Permissible peak tractive stresses for grass lined channels range from 0.35 psf to 3.70 psf depending on the retardation class of vegetation. Retardation Class C (which includes Bermuda and Crab grasses among others) was selected for the design of grass lined channels (as shown in Table 2E-3) and has a maximum permissible tractive stress of 1.0 psf (as shown in Table 2E-4 from TxDOT, 2009).

The concrete box culvert C1 is designed under the following parameters to convey both the peak 25-year, 24-hour rainfall discharge and 100-year, 24-hour rainfall discharge. The proposed culvert has a span of 10 feet, a rise of 4.5 feet, and a length of 440 feet. The inlet invert and outlet invert elevations are 106.4 ft MSL and 102.0 ft MSL, respectively, resulting in a culvert slope of 1.0%. A Manning's roughness coefficient is selected as 0.013 for concrete box culverts, based on guidance in Table 2E-5 from Harris County Flood Control District (HCFCD, 2010). The peak inflow into the culvert and tailwater conditions are computed by HEC-HMS for the design cases, as discussed in Attachment 2B. The peak inflow from reach R6 into the culvert (C1) is calculated as 258.2 cfs and

333.8 cfs for the 25-year, 24-hour rainfall (Case I) and 100-year, 24-hour rainfall (Case II) rainfall events, respectively. The water surface elevations in the South Surface Water Pond (i.e., tailwater conditions) coinciding with the peak discharge within the culvert (i.e., coincident tailwater conditions) are 104.1 ft MSL and 105.7 ft MSL for the 25-year, 24-hour and 100-year, 24-hour rainfall events, respectively.

The inflow structure into the culvert influences the conveyance of surface water through the culvert. The box culvert inflow structure was modeled with a beveled 45 degree wingwall. The culvert headwall is to be installed according to the TxDOT standard detail FW-0 for concrete wingwalls with flared wings. The box culvert shall be in accordance with TxDOT standard detail SCP-10 for precast 10-ft span single box culverts. TxDOT standard details for wingwalls and precast culverts are available in Figures 2E-1 and 2E-2, respectively. For the purposes of riprap apron design, the outlet C1 was considered as two representative 4.5 ft diameter culverts each conveying half the peak inflow of C1. Also for the purposes of riprap apron design, the tailwater depth is considered 0.4 times the diameter or 1.8 ft, as the peak tailwater depth during the 25-year, 24-hour rainfall event results in what was judged to be an overly small minimum d_{50}.

A riprap apron was also sized for the outflow of reach R3 into the Northeast Surface Water Pond. The invert elevation of reach R3 into the surface water pond is 104.46 ft MSL, and the peak discharge during the 25-year, 24-hour rainfall event is 323.9 cfs. This 10 ft (base width) by 6 ft (channel depth) trapezoidal channel was considered as two representative 4.95 ft circular culverts (corresponding to the peak depth of flow within the channel). Each representative culvert is assumed to convey half the 25-year, 24-hour peak discharge, solely for the purposes of riprap apron design. Since the invert elevation of R3 is above the peak pond elevation for the 25-year, 24-hour rainfall event, the tailwater depth was taken as 0.4 times the diameter of the representative culvert.

4 RESULTS

The depth of flow, velocity, and average tractive stress for the calculated discharge for each perimeter drainage channel during the design rainfall event were calculated using Equations (1) and (2). Calculations for each perimeter channel reach were performed using spreadsheets that are presented in Appendix 2E-1, and the results are summarized in Table 2E-6. For both design cases, the performance of the culvert (C1) from HY-8 modeling is presented in Table 2E-7, and shown on Figures 2E-3 and 2E-4.

- The available freeboard in all perimeter channel reaches is calculated to be greater than one foot during the 25-year, 24-hour rainfall event.
- Each perimeter channel reach was calculated to be able to convey the 100-year, 24-hour rainfall event without overtopping as presented in Table 2E-6.
- The average tractive stress within each of the perimeter channel reaches is calculated to remain below the maximum one (1) psf during the 25-year, 24-hour rainfall event.
- Culvert C1 contains the capacity to convey the flow from the West Perimeter Drainage Channel to the South Surface Water Pond without overtopping the perimeter berm at the culvert inlet wingwall.

The minimum d_{50} size of the riprap apron was computed by Equation (3) for the outflow of C1 and R3 as 0.96 feet and 1.04 feet, respectively. The calculated minimum d_{50} of the riprap aprons corresponds to a riprap class 4 for the outflow of C1 and R3. Based on Table 2E-1, the riprap apron length at the outlet of C1 and R3 should be at least 6D in length. The width of the box culvert at C1 and R3 are 10 feet and are selected for sizing the length of the apron. Thus, these riprap apron length should be at least 60 feet in length. Furthermore, the apron depth should be $2.2d_{50}$ = 2.2 feet deep for the culvert and 2.3 ft deep for the outlet of R3. FHWA (2006) recommends an apron width of 3D = 30 feet at the up gradient end of the apron near the culvert outlet and a 3:1 apron length to apron width expansion resulting in an apron width of 70 feet at the down gradient end of the apron.

5 REFERENCES

Chow, V.T (1959). *Open Channel-Hydraulics,* McGraw-Hill.

FHWA (2006). *Hydraulic Design of Energy Dissipators for Culverts and Channels*, Federal Highway Administration, US Department of Transportation, Hydraulic Engineering Circular No. 14, Third Edition.

HCFCD (2001). *Design Manual for Articulating Concrete Block Systems*, Houston, Texas, Harris County Flood Control District, September 2001.

HCFCD (2010). *Policy Criteria and Procedure Manual*, Harris County Flood Control District, December 2010.

TxDOT (2009). *Hydraulic Design Manual*, Texas Department of Transportation, revised

March 2009.

TABLES

- Table 2E-1. Riprap Classes and Apron Dimensions (from FHWA, 2006)
- Table 2E-2. Design Parameter Summary for Perimeter Drainage Channels and Culverts
- Table 2E-3. Retardation Class for Lining Materials (from TxDOT, 2009)
- Table 2E-4. Permissible Shear Stress for Various Linings (from TxDOT, 2009)
- Table 2E-5. Manning's n Values (from HCFCD, 2010)
- Table 2E-6. Channel Capacity Calculation Results
- Table 2E-7. Culvert C1 Capacity Analysis Results

Table 2E-1. Riprap Classes and Apron Dimensions

(from FHWA, 2006)

Class	D_{50} (mm)	D_{50} (in)	Apron Length[1]	Apron Depth
1	125	5	4D	$3.5D_{50}$
2	150	6	4D	$3.3D_{50}$
3	250	10	5D	$2.4D_{50}$
4	350	14	6D	$2.2D_{50}$
5	500	20	7D	$2.0D_{50}$
6	550	22	8D	$2.0D_{50}$

[1]D is the culvert rise.

Table 2E-2. Design Parameter Summary for Perimeter Drainage Channels and Culverts

Perimeter Channel/Culvert	Channel Shape	Longitudinal Channel Slope (%)	Manning's Roughness Coefficient, n [1]	Channel Dimensions (minimum)			25-Year, 24-hr Peak Flow, Q (cfs)[2]	100-Year, 24-hr Peak Flow, Q (cfs)[2]
				Bottom Width (ft)	Depth (ft)	Side Slopes (H:V)		
R1	Trapezoidal	0.15	0.040	6.00	5.00	3:1	160.8	209.2
R2	Trapezoidal	0.15	0.040	6.00	5.00	3:1	160.8	209.2
R3	Trapezoidal	0.15	0.040	10.00	6.00	3:1	323.9	436.3
R4	Trapezoidal	0.15	0.040	4.00	5.00	3:1	146.5	190.0
R5	Trapezoidal	0.15	0.040	4.00	5.00	3:1	146.5	190.0
R6	Trapezoidal	0.15	0.040	12.00	5.25	3:1	262.9	343.9
C1 [3]	Box	1.00	0.013	10.00	4.50	-	258.2	333.8

Notes:

1. Manning's roughness coefficients were selected from the *Policy Criteria and Procedure Manual* (HCFCD, 2010).
2. The calculation of peak flows for the design rainfall events is presented in Attachment 2B.
3. Inlet control was modeled with a 45 degree beveled wingwall.

Table 2E-3. Retardation Class for Lining Materials

(from TxDOT, 2009)

Retardance Class	Cover	Condition
A	Weeping Lovegrass	Excellent stand, tall (average 30 in. or 760 mm)
	Yellow Bluestem Ischaemum	Excellent stand, tall (average 36 in. or 915 mm)
B	Kudzu	Very dense growth, uncut
	Bermuda grass	Good stand, tall (average 12 in. or 305 mm)
	Native grass mixture little bluestem, bluestem, blue gamma, other short and long stem midwest grasses	Good stand, unmowed
	Weeping lovegrass	Good Stand, tall (average 24 in. or 610 mm)
	Lespedeza sericea	Good stand, not woody, tall (average 19 in. or 480 mm)
	Alfalfa	Good stand, uncut (average 11 in or 280 mm)
	Weeping lovegrass	Good stand, unmowed (average 13 in. or 330 mm)
	Kudzu	Dense growth, uncut
	Blue gamma	Good stand, uncut (average 13 in. or 330 mm)
C	Crabgrass	Fair stand, uncut (10-to-48 in. or 55-to-1220 mm)
	Bermuda grass	Good stand, mowed (average 6 in. or 150 mm)
	Common lespedeza	Good stand, uncut (average 11 in. or 280 mm)
	Grass-legume mixture: summer (orchard grass redtop, Italian ryegrass, and common lespedeza)	Good stand, uncut (6-8 in. or 150-200 mm)
	Centipedegrass	Very dense cover (average 6 in. or 150 mm)
	Kentucky bluegrass	Good stand, headed (6-12 in. or 150-305 mm)
D	Bermuda grass	Good stand, cut to 2.5 in. or 65 mm
	Common lespedeza	Excellent stand, uncut (average 4.5 in. or 115 mm)
	Buffalo grass	Good stand, uncut (3-6 in. or 75-150 mm)
	Grass-legume mixture: fall, spring (orchard grass Italian ryegrass, and common lespedeza)	Good Stand, uncut (4-5 in. or 100-125 mm)
	Lespedeza sericea	After cutting to 2 in. or 50 mm (very good before cutting)
E	Bermuda grass	Good stand, cut to 1.5 in. or 40 mm
	Bermuda grass	Burned stubble

Table 2E-4. Permissible Shear Stress for Various Linings (from TxDOT, 2009)

Protective Cover	(lb./sq.ft.)	tp (N/m^2)
Retardance Class A Vegetation (See the "Retardation Class for Lining Materials" table above)	3.70	177
Retardance Class B Vegetation (See the "Retardation Class for Lining Materials" table above)	2.10	101
Retardance Class C Vegetation (See the "Retardation Class for Lining Materials" table above)	1.00	48
Retardance Class D Vegetation (See the "Retardation Class for Lining Materials" table above)	0.60	29
Retardance Class E Vegetation (See the "Retardation Class for Lining Materials" table above)	0.35	17
Woven Paper	0.15	7
Jute Net	0.45	22
Single Fiberglass	0.60	29
Double Fiberglass	0.85	41
Straw W/Net	1.45	69
Curled Wood Mat	1.55	74
Synthetic Mat	2.00	96
Gravel. D_{50} = 1 in. or 25 mm	0.40	19
Gravel. D_{50} = 2 in. or 50 mm	0.80	38

Table 2E-5. Manning's n Values

(from HCFCD, 2010)

Description	Manning's "n" Value
Channel	
Grass-Lined	0.040[1]
Riprap-Lined	0.040[1]
Articulated Concrete Block - Grassed	0.040[1]
Articulated Concrete Block - Bare	0.030
Concrete-Lined	0.015
Natural or Overgrown Channels	Usually 0.050 – 0.080
Overbanks	
Some flow	Usually 0.080 – 0.150
Ineffective flow areas	0.99[2]
Conduit[3]	
Concrete Pipe	0.013
Concrete Box	0.013
Corrugated Metal Pipe	0.024

[1] For design flows larger than 10,000 cfs, an "n" value of 0.035 may be used.

[2] Use the ineffective flow area option in HEC-RAS

[3] If the conduit is maintained by another jurisdiction, the "n" value specified by that jurisdiction can be used.

Table 2E-6. Channel Capacity Calculation Results

Perimeter Channel	25-yr, 24-hr Peak Flow, Q (cfs)	Peak Depth of Flow (ft)	Hydraulic Radius (ft)	Peak Channel Velocity (ft/s)	Peak Tractive Stress (psf)	Freeboard (ft)	100-yr, 24-hr Peak Flow, Q (cfs)	Peak Depth of Flow (ft)	Hydraulic Radius (ft)	Peak Channel Velocity (ft/s)	Peak Channel Tractive Stress (psf)
R1	160.8	3.79	2.20	2.44	0.21	1.21	209.2	4.27	2.43	2.61	0.23
R2	160.8	3.79	2.20	2.44	0.21	1.21	209.2	4.27	2.43	2.61	0.23
R3	323.9	4.67	2.83	2.89	0.27	1.33	436.3	5.36	3.18	3.12	0.30
R4	146.5	3.90	2.14	2.39	0.20	1.10	190.0	4.36	2.36	2.56	0.22
R5	146.5	3.90	2.14	2.39	0.20	1.10	190.0	4.36	2.36	2.56	0.22
R6	262.9	4.02	2.58	2.72	0.24	1.23	343.9	4.58	2.88	2.92	0.27

Table 2E-7. Culvert C1 Capacity Analysis Results

Design Case	Design Rainfall Event	Peak Flow into Culvert (cfs)	Coincident Tailwater Elevation (ft MSL)[1]	Peak Headwater Elevation (ft MSL)[2]	Peak Outlet Velocity (ft/s)
Case I	25-year, 24-hour	258.2	104.10	110.71	13.80
Case II	100-year, 24-hour	333.8	105.70	111.66	14.93

Notes:

1. The coincident tailwater elevation was extracted from surface water pond model described in Attachment 2B of this Drainage Report at the time the peak flow into the Culvert.
2. The elevation of the top of the channel is 112.00 ft MSL. Based on the computed peak headwater elevation during the Case I, 1-ft of freeboard is provided for the 25-year, 24-hour design rainfall event. Likewise, the peak headwater elevation was computed to be below elevation at the top of the channel, and overtopping will not occur.

FIGURES

- Figure 2E-1. TxDOT Standard Detail FW-0 for Concrete Wingwalls
- Figure 2E-2. TxDOT Standard Detail SCP-10 for Precast Single Box Culverts
- Figure 2E-3. HY-8 Modeling Output for Culvert C1 (Case I)
- Figure 2E-4. HY-8 Modeling Output for Culvert C1 (Case II)

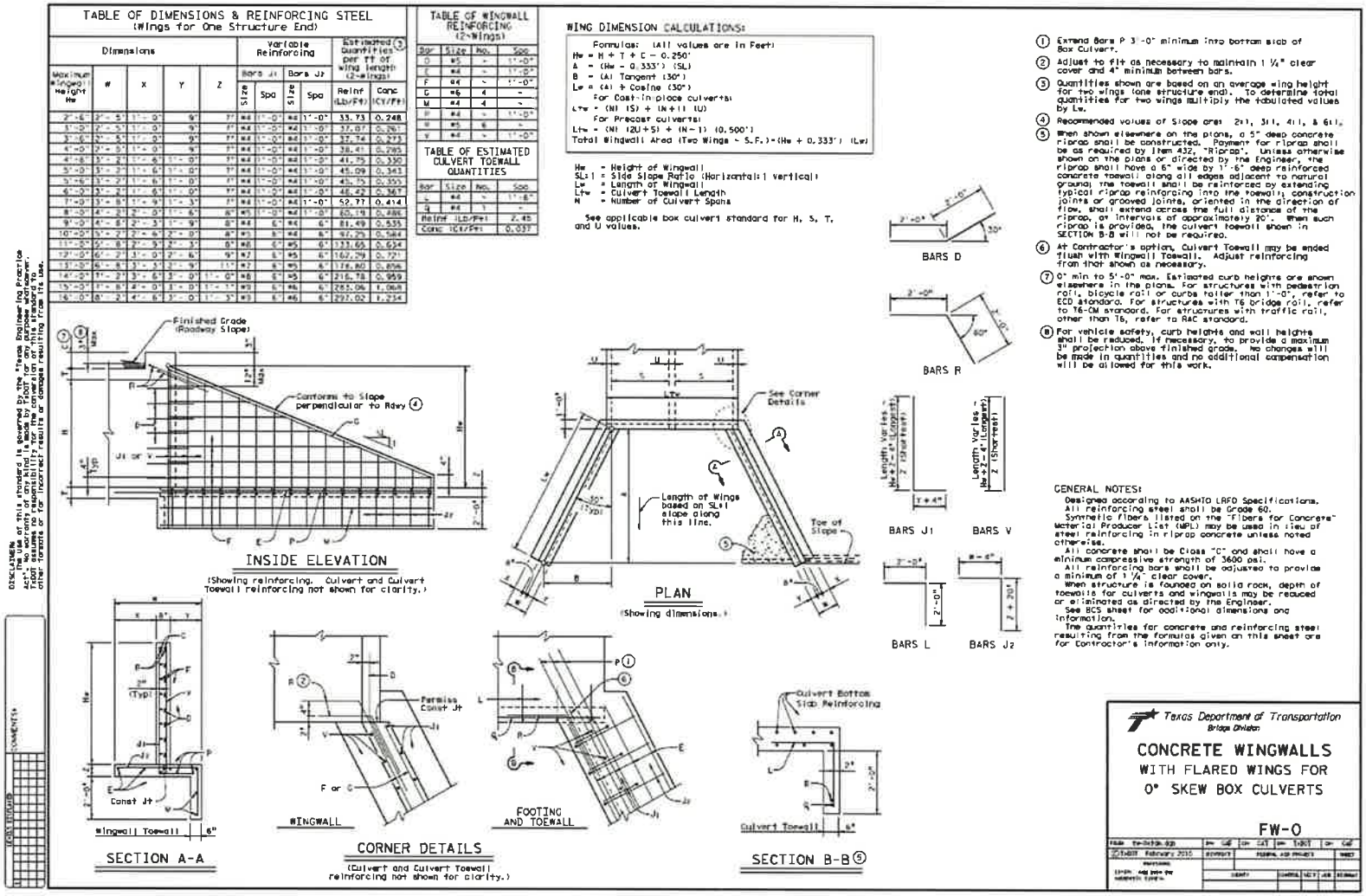

Figure 2E-1. TxDOT Standard Detail FW-0 for Concrete Wingwalls

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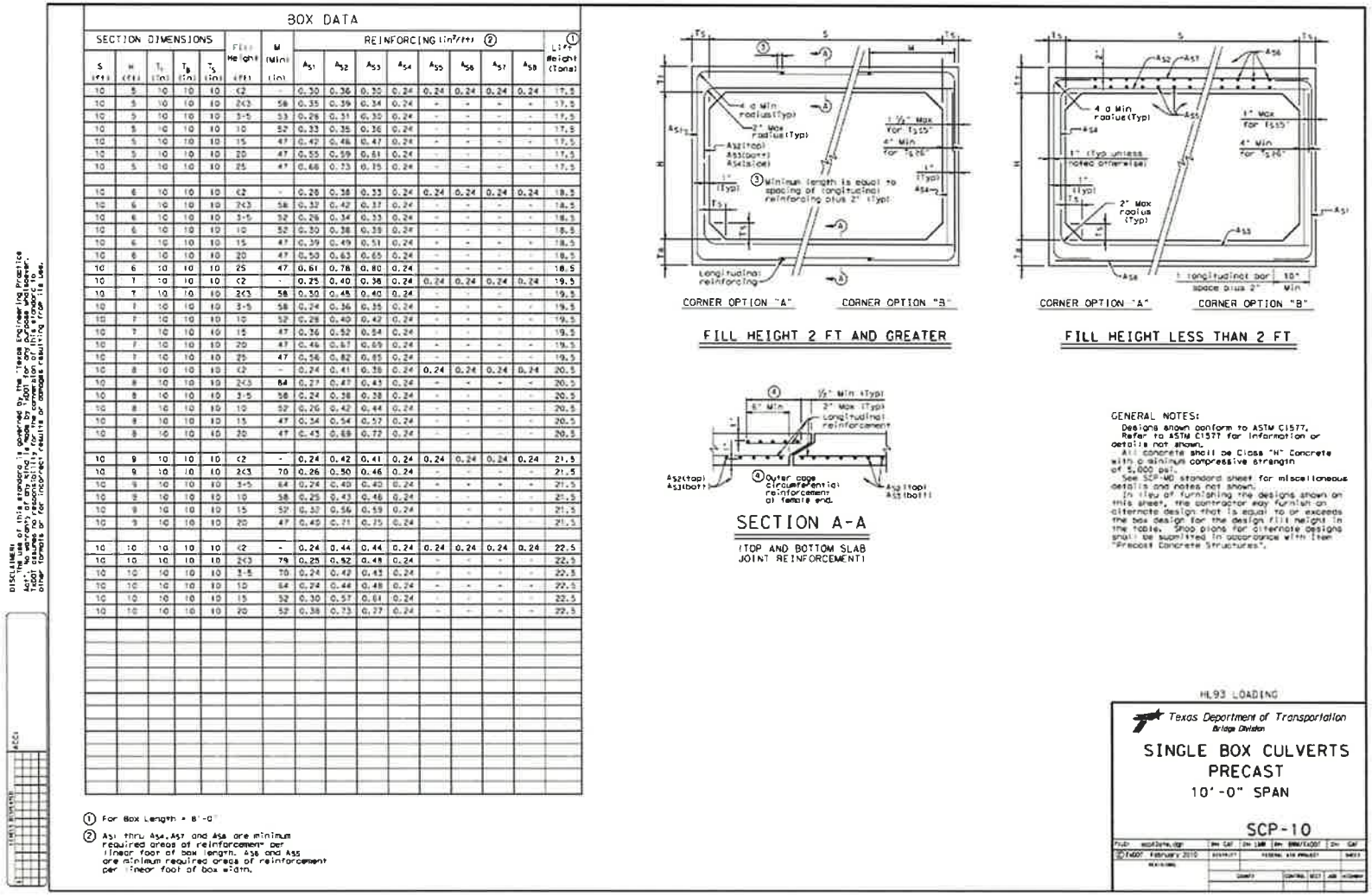

Figure 2E-2. TxDOT Standard Detail SCP-10 for Precast Single Box Culverts

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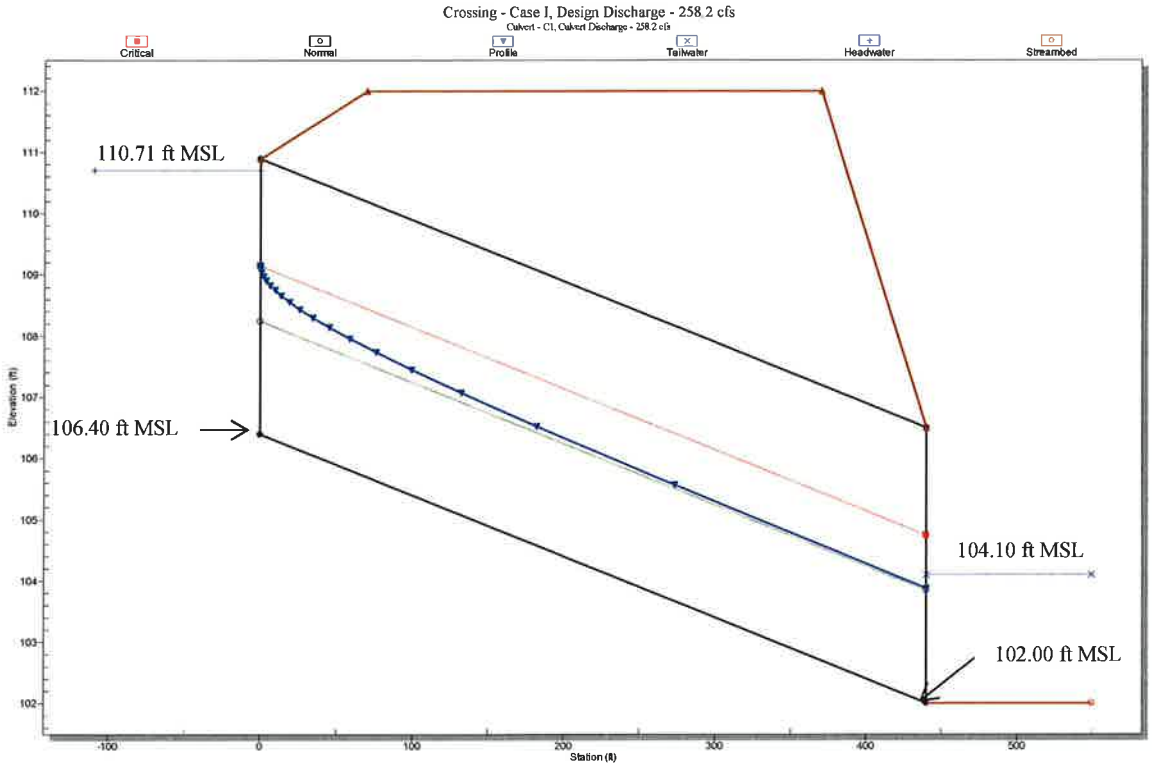


Figure 2E-3. HY-8 Modeling Output for Culvert C1 (Case I)

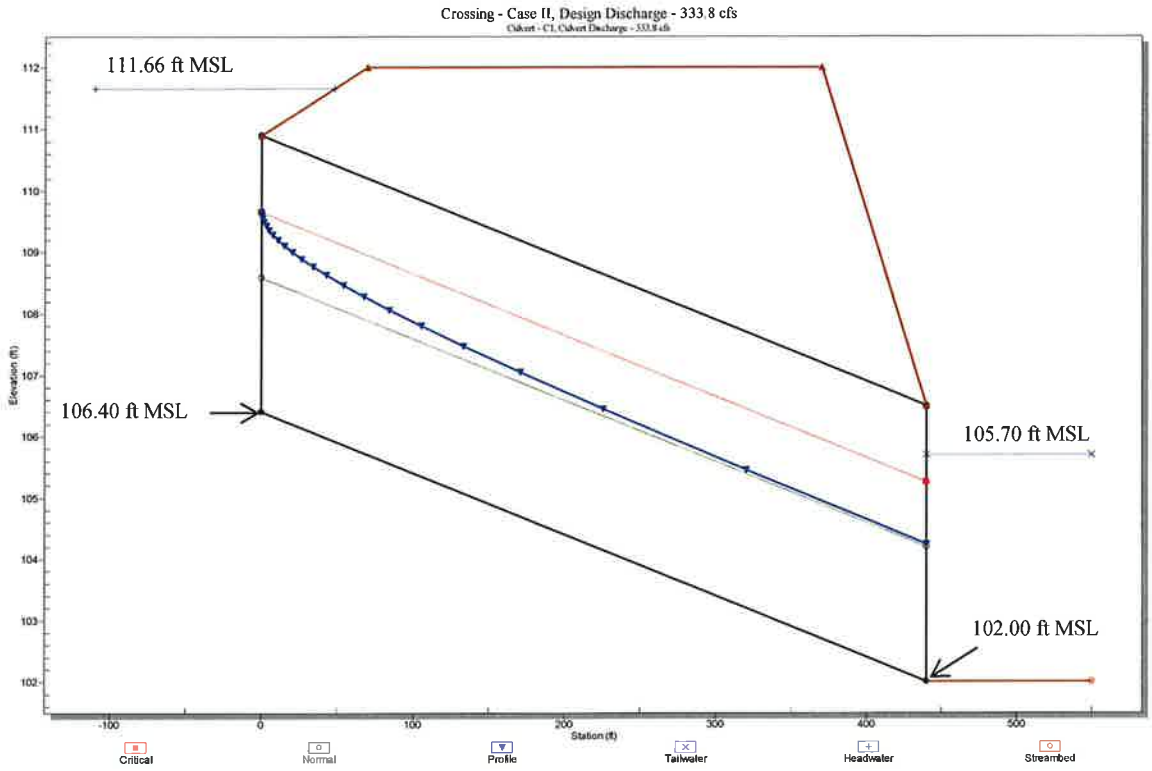


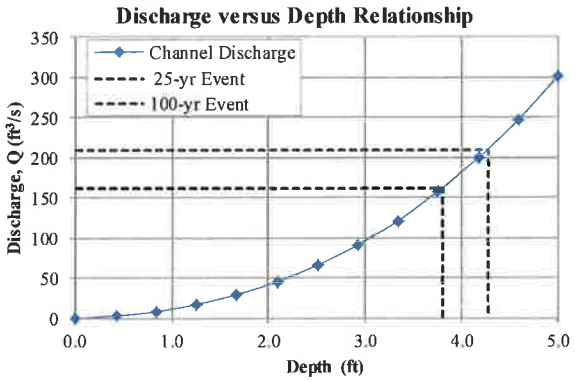
Figure 2E-4. HY-8 Modeling Output for Culvert C1 (Case II)

Appendix 2E-1
Perimeter Channel Calculations

Design/Check: Trapezoidal/Triangular Channel
Methodology: Manning's Equation
Project: Fairbanks Landfill Expansion
Ditch ID: **Reach, R1 (North Perimeter Drainage Channel)**

Peak Discharge, Q_{max}=	160.80	cfs (25-yr Event)
Peak Discharge, Q_{max}=	209.20	cfs (100-yr Event)
Bottom Width, B =	6.00	ft
Left Side Slope, Z_1 =	3.00	horizontal :1 vertical
Right Side Slope, Z_2 =	3.00	horizontal :1 vertical
Manning's Roughness Coeff., n =	0.040	
Longitudinal Channel Slope, S_o =	0.0015	ft/ft

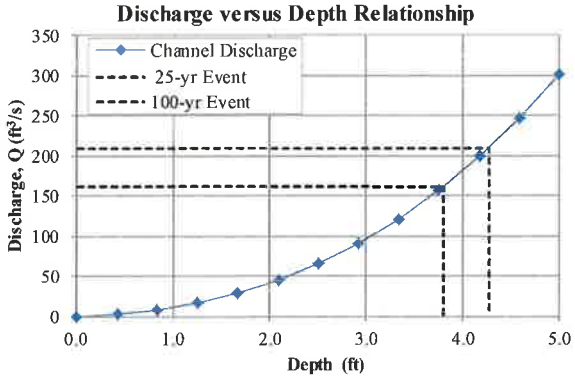
Depth of Flow Y ft	Area of Flow A ft^2	Wetted Perimeter P ft	Hydraulic Radius R=A/P ft	Average Velocity V ft/s	Discharge (Flow Rate) Q=AV ft^3/s	Avg. Tractive Stress τ_o lb/ft^2	Comments
0.01	0.06	6.06	0.01	0.07	0.0	0.00	
0.43	3.10	8.69	0.36	0.73	2.2	0.03	
0.84	7.18	11.32	0.63	1.06	7.6	0.06	
1.26	12.29	13.95	0.88	1.33	16.3	0.08	
1.67	18.44	16.58	1.11	1.55	28.6	0.10	
2.09	25.63	19.21	1.33	1.75	44.8	0.12	
2.51	33.86	21.84	1.55	1.93	65.4	0.15	
2.92	43.12	24.47	1.76	2.10	90.8	0.16	
3.34	53.42	27.10	1.97	2.27	121.2	0.18	
3.75	64.76	29.73	2.18	2.42	157.0	0.20	
4.17	77.14	32.36	2.38	2.57	198.6	0.22	
4.58	90.55	34.99	2.59	2.72	246.3	0.24	
5.00	105.00	37.62	2.79	2.86	300.4	0.26	
3.79	65.91	29.99	2.20	2.44	160.80	0.21	Q (25-yr Event)
4.27	80.18	32.98	2.43	2.61	209.20	0.23	Q (100-yr Event)



Design/Check: Trapezoidal/Triangular Channel
Methodology: Manning's Equation
Project: Fairbanks Landfill Expansion
Ditch ID: **Reach, R2 (North Perimeter Drainage Channel)**

Peak Discharge, Q_{max} =	160.80	cfs (25-yr Event)
Peak Discharge, Q_{max} =	209.20	cfs (100-yr Event)
Bottom Width, B =	6.00	ft
Left Side Slope, Z_1 =	3.00	horizontal :1 vertical
Right Side Slope, Z_2 =	3.00	horizontal :1 vertical
Manning's Roughness Coeff., n =	0.040	
Longitudinal Channel Slope, S_o =	0.0015	ft/ft

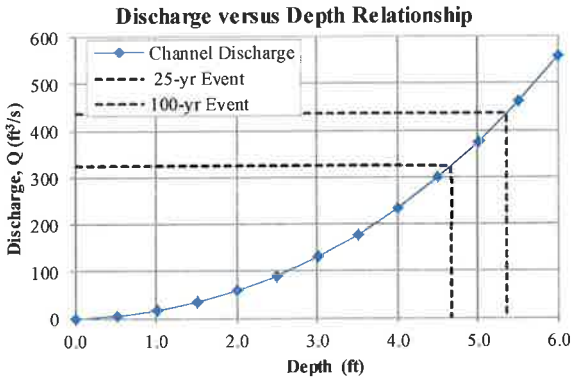
Depth of Flow Y ft	Area of Flow A ft^2	Wetted Perimeter P ft	Hydraulic Radius R=A/P ft	Average Velocity V ft/s	Discharge (Flow Rate) Q=AV ft^3/s	Avg. Tractive Stress τ_o lb/ft^2	Comments
0.01	0.06	6.06	0.01	0.07	0.0	0.00	
0.43	3.10	8.69	0.36	0.73	2.2	0.03	
0.84	7.18	11.32	0.63	1.06	7.6	0.06	
1.26	12.29	13.95	0.88	1.33	16.3	0.08	
1.67	18.44	16.58	1.11	1.55	28.6	0.10	
2.09	25.63	19.21	1.33	1.75	44.8	0.12	
2.51	33.86	21.84	1.55	1.93	65.4	0.15	
2.92	43.12	24.47	1.76	2.10	90.8	0.16	
3.34	53.42	27.10	1.97	2.27	121.2	0.18	
3.75	64.76	29.73	2.18	2.42	157.0	0.20	
4.17	77.14	32.36	2.38	2.57	198.6	0.22	
4.58	90.55	34.99	2.59	2.72	246.3	0.24	
5.00	105.00	37.62	2.79	2.86	300.4	0.26	
3.79	65.91	29.99	2.20	2.44	160.80	0.21	Q (25-yr Event)
4.27	80.18	32.98	2.43	2.61	209.20	0.23	Q (100-yr Event)



Design/Check: Trapezoidal/Triangular Channel
Methodology: Manning's Equation
Project: Fairbanks Landfill Expansion
Ditch ID: **Reach, R3 (North Perimeter Drainage Channel)**

Peak Discharge, Q_{max}=	323.90	cfs (25-yr Event)
Peak Discharge, Q_{max}=	436.30	cfs (100-yr Event)
Bottom Width, B =	10.00	ft
Left Side Slope, Z_1 =	3.00	horizontal :1 vertical
Right Side Slope, Z_2 =	3.00	horizontal :1 vertical
Manning's Roughness Coeff., n =	0.040	
Longitudinal Channel Slope, S_o =	0.0015	ft/ft

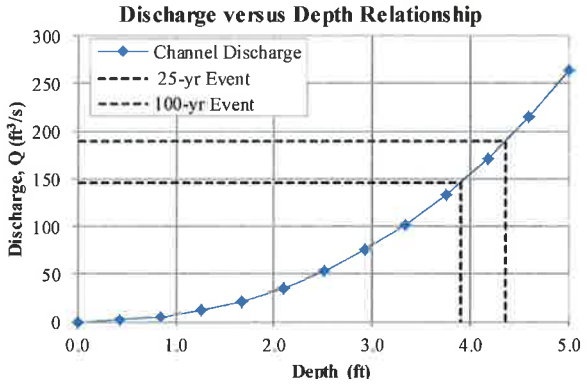
Depth of Flow Y ft	Area of Flow A ft^2	Wetted Perimeter P ft	Hydraulic Radius R=A/P ft	Average Velocity V ft/s	Discharge (Flow Rate) Q=AV ft^3/s	Avg. Tractive Stress τ_o lb/ft^2	Comments
0.01	0.10	10.06	0.01	0.07	0.0	0.00	
0.51	5.87	13.22	0.44	0.84	4.9	0.04	
1.01	13.13	16.38	0.80	1.25	16.4	0.08	
1.51	21.89	19.53	1.12	1.56	34.1	0.10	
2.01	32.15	22.69	1.42	1.82	58.5	0.13	
2.51	43.90	25.85	1.70	2.05	90.2	0.16	
3.01	57.14	29.01	1.97	2.27	129.6	0.18	
3.50	71.88	32.16	2.23	2.47	177.3	0.21	
4.00	88.11	35.32	2.49	2.65	233.9	0.23	
4.50	105.84	38.48	2.75	2.83	299.9	0.26	
5.00	125.07	41.63	3.00	3.00	375.8	0.28	
5.50	145.79	44.79	3.25	3.17	462.1	0.30	
6.00	168.00	47.95	3.50	3.33	559.4	0.33	
4.67	112.04	39.52	2.83	2.89	323.90	0.27	Q (25-yr Event)
5.36	139.70	43.89	3.18	3.12	436.30	0.30	Q (100-yr Event)



Design/Check: Trapezoidal/Triangular Channel
Methodology: Manning's Equation
Project: Fairbanks Landfill Expansion
Ditch ID: **Reach, R4 (West Perimeter Drainage Channel)**

Peak Discharge, Q_{max} =	146.50	cfs (25-yr Event)
Peak Discharge, Q_{max} =	190.00	cfs (100-yr Event)
Bottom Width, B =	4.00	ft
Left Side Slope, Z_1 =	3.00	horizontal :1 vertical
Right Side Slope, Z_2 =	3.00	horizontal :1 vertical
Manning's Roughness Coeff., n =	0.040	
Longitudinal Channel Slope, S_o =	0.0015	ft/ft

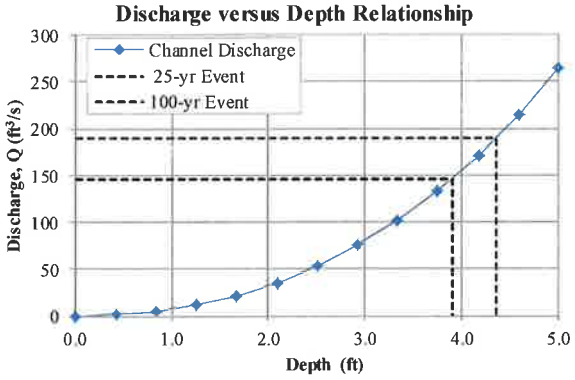
Depth of Flow Y ft	Area of Flow A ft^2	Wetted Perimeter P ft	Hydraulic Radius R=A/P ft	Average Velocity V ft/s	Discharge (Flow Rate) Q=AV ft^3/s	Avg. Tractive Stress τ_o lb/ft^2	Comments
0.01	0.04	4.06	0.01	0.07	0.0	0.00	
0.43	2.25	6.69	0.34	0.70	1.6	0.04	
0.84	5.49	9.32	0.59	1.01	5.6	0.08	
1.26	9.77	11.95	0.82	1.26	12.3	0.12	
1.67	15.09	14.58	1.03	1.48	22.3	0.16	
2.09	21.45	17.21	1.25	1.67	35.8	0.20	
2.51	28.85	19.84	1.45	1.85	53.4	0.23	
2.92	37.28	22.47	1.66	2.02	75.4	0.27	
3.34	46.75	25.10	1.86	2.18	102.1	0.31	
3.75	57.25	27.73	2.06	2.34	134.0	0.35	
4.17	68.80	30.36	2.27	2.49	171.3	0.39	
4.58	81.38	32.99	2.47	2.63	214.4	0.43	
5.00	95.00	35.62	2.67	2.78	263.7	0.47	
3.90	61.22	28.66	2.14	2.39	146.50	0.20	Q (25-yr Event)
4.36	74.35	31.55	2.36	2.56	190.00	0.22	Q (100-yr Event)



Design/Check: Trapezoidal/Triangular Channel
Methodology: Manning's Equation
Project: Fairbanks Landfill Expansion
Ditch ID: **Reach, R5 (West Perimeter Drainage Channel)**

Peak Discharge, Q_{max}=	146.50	cfs (25-yr Event)
Peak Discharge, Q_{max}=	190.00	cfs (100-yr Event)
Bottom Width, B =	4.00	ft
Left Side Slope, Z_1 =	3.00	horizontal :1 vertical
Right Side Slope, Z_2 =	3.00	horizontal :1 vertical
Manning's Roughness Coeff., n =	0.040	
Longitudinal Channel Slope, S_o =	0.0015	ft/ft

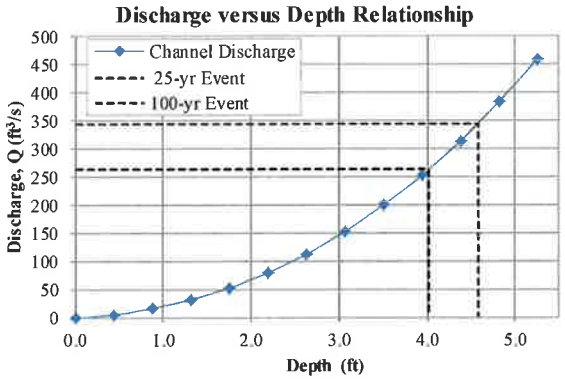
Depth of Flow Y ft	Area of Flow A ft^2	Wetted Perimeter P ft	Hydraulic Radius R=A/P ft	Average Velocity V ft/s	Discharge (Flow Rate) Q=AV ft^3/s	Avg. Tractive Stress τ_o lb/ft^2	Comments
0.01	0.04	4.06	0.01	0.07	0.0	0.00	
0.43	2.25	6.69	0.34	0.70	1.6	0.03	
0.84	5.49	9.32	0.59	1.01	5.6	0.06	
1.26	9.77	11.95	0.82	1.26	12.3	0.08	
1.67	15.09	14.58	1.03	1.48	22.3	0.10	
2.09	21.45	17.21	1.25	1.67	35.8	0.12	
2.51	28.85	19.84	1.45	1.85	53.4	0.14	
2.92	37.28	22.47	1.66	2.02	75.4	0.16	
3.34	46.75	25.10	1.86	2.18	102.1	0.17	
3.75	57.25	27.73	2.06	2.34	134.0	0.19	
4.17	68.80	30.36	2.27	2.49	171.3	0.21	
4.58	81.38	32.99	2.47	2.63	214.4	0.23	
5.00	95.00	35.62	2.67	2.78	263.7	0.25	
3.90	61.22	28.66	2.14	2.39	146.50	0.20	Q (25-yr Event)
4.36	74.35	31.55	2.36	2.56	190.00	0.22	Q (100-yr Event)



Design/Check: Trapezoidal/Triangular Channel
Methodology: Manning's Equation
Project: Fairbanks Landfill Expansion
Ditch ID: **Reach, R6 (West Perimeter Drainage Channel)**

Peak Discharge, Q_{max} =	262.90	cfs (25-yr Event)
Peak Discharge, Q_{max} =	343.90	cfs (100-yr Event)
Bottom Width, B =	12.00	ft
Left Side Slope, Z_1 =	3.00	horizontal :1 vertical
Right Side Slope, Z_2 =	3.00	horizontal :1 vertical
Manning's Roughness Coeff., n =	0.040	
Longitudinal Channel Slope, S_o =	0.0015	ft/ft

Depth of Flow Y ft	Area of Flow A ft^2	Wetted Perimeter P ft	Hydraulic Radius R=A/P ft	Average Velocity V ft/s	Discharge (Flow Rate) Q=AV ft^3/s	Avg. Tractive Stress τ_o lb/ft^2	Comments
0.01	0.12	12.06	0.01	0.07	0.0	0.00	
0.45	5.96	14.82	0.40	0.79	4.7	0.04	
0.88	12.94	17.59	0.74	1.18	15.2	0.07	
1.32	21.07	20.35	1.04	1.48	31.1	0.10	
1.76	30.34	23.11	1.31	1.73	52.5	0.12	
2.19	40.75	25.87	1.58	1.95	79.6	0.15	
2.63	52.31	28.63	1.83	2.16	112.8	0.17	
3.07	65.01	31.40	2.07	2.34	152.4	0.19	
3.50	78.86	34.16	2.31	2.52	198.8	0.22	
3.94	93.85	36.92	2.54	2.69	252.3	0.24	
4.38	109.99	39.68	2.77	2.85	313.2	0.26	
4.81	127.26	42.44	3.00	3.00	381.9	0.28	
5.25	145.69	45.20	3.22	3.15	458.8	0.30	
4.02	96.73	37.43	2.58	2.72	262.90	0.24	Q (25-yr Event)
4.58	117.81	40.95	2.88	2.92	343.90	0.27	Q (100-yr Event)



ATTACHMENT 2F

ON-SITE DESIGN-ACTIVE FACE SURFACE WATER CONTROLS

Written by: J. McNash Date: 11/5/2012 Reviewed & Revised by: S. Graves Date: 2/25/2014

Client: USAWTXL Project: Fairbanks Landfill Expansion Project No.: TXL0263 Phase No.: 05

ON-SITE DESIGN – ACTIVE FACE SURFACE WATER CONTROLS FAIRBANKS LANDFILL EXPANSION



3/3/2014

SEALED FOR PERMITTING PURPOSES, CALCULATION PAGES 1 TO 22

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

1 INTRODUCTION

The purpose of this calculation package is to present the analysis for the sizing of the diversion, containment, and run-on berms to be utilized at the active face (i.e., areas of exposed waste) during development of the Fairbanks Landfill (Figure 2F-1). The diversion containment, and run-on berms will be utilized to keep clean surface water separate from potentially contaminated water, to minimize the generation of contaminated water, prevent runoff/discharge of contaminated water, and prevent migration of contaminated water to the surface run-on water. Contaminated water will be managed in a timely manner and accordance with the Contaminated Water Management Plan presented in Appendix IV-A of the Site Operating Plan (SOP).

Diversion berms are temporary soil berms constructed up-gradient from the active working face, to intercept flow before it comes in contact with waste. These temporary diversion berms will be used to route the clean runoff around active areas into the surface water management system and away from the active face. Meanwhile, temporary containment and run-on berms (down-gradient from, and generally at the base of the active working face), constructed with soil, will be used to contain contaminated water and prevent the migration of contaminated water from the active face, as well as to prevent the run-on of clean surface water draining from adjacent areas onto the active face. The specific objectives of the analysis include (i) calculating the maximum up-gradient drainage area which can be managed by each diversion berm for the 25-year, 24-hour rainfall event; and (ii) calculating the required height of each temporary containment and run-on berm to contain the contaminated runoff and prevent surface run-on resulting from the 25-year, 24-

hour rainfall event.

2 ASSUMPTIONS AND PROCEDURES

The following sections discuss the assumptions and procedures for the design of the temporary diversion berms and temporary containment and run-on berms.

2.1 Diversion Berm

It is assumed that temporary diversion berms will be installed with flow line (longitudinal) slope ranging from 0.5% to 2%. Temporary diversion berms will be placed up-gradient from the active working face. The temporary diversion berms are assumed to be "tack-on" berms (see Figure 2F-1 of this calculation package) to form a v-shaped channel. A channel depth of 2.5 feet was assumed (i.e., this is a fixed parameter of these calculations). The Rational Method described in the *Hydraulic Design Manual* (TxDOT, 2009) is used to calculate the peak surface water discharge (since the drainage area will be less than 200 acres). A given diversion berm is anticipated to temporarily manage drainage areas of less than 20 acres and designed accordingly as presented herein. The channels were sized assuming they are flowing full, since they are interior and temporary site features. The following steps were utilized to calculate the drainage areas that each diversion berm can accommodate.

1. Compute the discharge capacity of diversion berms with 0.5%, 1%, 1.5%, and 2% slopes using Manning's Equation for open channel flow.

2. Apply the Rational Method to compute the up-gradient drainage area that would produce the discharge capacity calculated in Step 1.

Manning's equation was used to estimate the peak discharge capacity of the v-shaped channel created by a temporary diversion berm. Manning's equation (Chow, 1959) is expressed as:

$$Q = \frac{1.49}{n} A R^{2/3} S^{1/2} \quad (1)$$

where:

Q = discharge (cubic feet per second [cfs]),

n = Manning's roughness coefficient,

A = area of cross-section of flow (square feet [ft^2]),

P = wetted perimeter (ft),

R = hydraulic radius = A/P (ft), and

S = longitudinal slope (ft/ft).

The peak discharge from the contributing drainage area by the Rational Method can be computed by:

$$Q = C \times I \times A \quad (2)$$

where:

Q = peak design discharge (cfs),

C = runoff coefficient (dimensionless),

I = design rainfall intensity (inches per hour [in/hr]), and

A = drainage area (acres).

The design rainfall intensity in Equation (2) is calculated by:

$$I = \frac{b}{(t_c + d)^e} \quad (3)$$

where:

I = design rainfall intensity (in/hr),

t_c = time of concentration (minutes [min]), and

b, d, e = coefficients for specific frequencies listed by Texas county.

Equation (2) is rearranged, and the watershed drainage area was back-calculated for each potential flow line slope of a temporary diversion berm. Calculations for each flow line slope are presented in Appendix 2F-1.

2.2 Containment and Run-On Berms

It is assumed that temporary containment and run-on berms (which may be a shared berm,

provided that the berm height is the larger of the two required heights) will be constructed with 3H:1V side slopes and will be constructed to varying heights, depending on the geometry of the working face, storage area, and resulting calculated volume of contaminated water and surface run-on water to be stored on each respective side of the berm(s). These containment and run-on berms are designed to have one foot (1-ft) of freeboard The required height of the containment berms is calculated for drainage areas ranging from 0.5 to 4.0 acres (to encompass a range of potential active area sizes in and around the working face itself) and contaminated water storage areas ranging from 0.1 to 1.0 acres. The required height of the run-on berms is calculated for drainage areas ranging from 2.0 to 30.0 acres (to account for a range of potential up-gradient excavation area sizes adjacent to an active Sector/working face) and surface run-on water storage areas ranging from 0.25 to 5.0 acres. The following steps were utilized to calculate the height required for each of the containment and run-on berm scenarios.

1. Calculate the 25-year, 24-hour rainfall volume to be captured behind the containment berm.

2. Calculate the height of the containment and run-on berm required to hold the volume of water calculated in Step 1, and then add 1-ft of freeboard to calculate the resulting total berm height (i.e., the required minimum berm height).

The total required storage volume of surface water is calculated by:

$$V = A_D \times R \quad (4)$$

where:

V = total storage volume (ft^3),

A_D = drainage area (ft^2), and

R = 25-year, 24-hour rainfall depth (ft).

For these calculations, 100% of the precipitation over the drainage area is considered surface water runoff that requires containment (i.e., no infiltration). This is a conservative assumption for sizing of these berms, because it is likely that some infiltration will in fact occur.

The required height for each of the containment and run-on berm scenarios is computed by Equation (5):

$$H = V/A_S + 1.0 \text{ ft freeboard} \quad (5)$$

where:

V = total storage volume (ft^3),

H = total height of containment or run-on berm (ft), and

A_S = storage area (ft^2).

Calculations for each scenario are presented in Appendix 2F-2 and Appendix 2F-3.

3 DESIGN PARAMETERS

The following sections discuss the justification behind the selected design parameters for the temporary diversion berms and temporary containment berms.

3.1 Diversion Berm

The Manning's Roughness Coefficient (n) for the diversion berm was selected as 0.04 (HCFCD, 2010). The peak discharge flowing to the channel is calculated using the Rational Method. The runoff coefficient (C) was selected as 0.7, as these berms will be placed on relatively steeper slopes (TxDOT, 2009). For a conservative design approach, a minimum time of concentration of 10 minutes was used to calculate the rainfall intensity by Equation (3). TxDOT (2009) recommends 10 minutes for the minimum time of concentration because small areas with exceedingly short times of concentration could result in design rainfall intensities that are unrealistically high. The coefficients b, d, and e in Equation (3) were selected as 81, 7.7, 0.724, respectively, for a 25-year rainfall event in Harris County (TxDOT, 2009). The rainfall intensity was then calculated as follows:

$$I = \frac{b}{(t_c + d)^e} = \frac{81}{(10 + 7.7)^{0.724}} = 10.1 \; in/hr$$

3.2 Containment and Run-On Berm

The temporary containment and run-on berms were sized by calculating the rainfall depth

during the 25-year, 24-hour rainfall event. The Harris County Flood Control District (HCFCD) provides rainfall frequency and duration depths for the Harris County Hydrologic Regions. Table 2B-1 in Attachment 2B, to the Site Development Plan, provides a summary of the rainfall depths for various durations and return periods for Harris County Hydrologic Region 2. Based on this table, the 25-year, 24-hour rainfall depth of 9.6 inches (0.80 ft) was selected to represent the Fairbanks Landfill site in Harris County.

4 RESULTS

The results of the temporary diversion berms calculation are summarized in Table 2F-1 for each assumed flow line slope. The drainage areas calculated represent the maximum drainage area that each temporary diversion berm configuration can accommodate for the 25-year, 24-hour design rainfall event. It should be noted that multiple diversion berms may be constructed if, during operations, a larger area than those calculated in Table 2F-1 will be draining towards the active face, in order to comply with the drainage area requirements presented herein for the given berm height and the selected flow line slope.

The results of the temporary containment and run-on berms calculation are summarized in Table 2F-2 and 2F-3 respectively. It is noted that the results presented in Table 2F-2 and 2F-3 cover various combinations of drainage areas and water storage areas, to allow for flexibility of site operations. The facility will use this information to select the required berm height based on the corresponding dimensions of the drainage area and storage area. As mentioned, for most cases, it is expected that a temporary berm will act as both containment and run-on berm, provided that it must have the larger of the two required heights in order to serve the dual-purpose of acting as a containment berm and a run-on berm. However, it should be noted that separate containment and run-on berms meeting the requirements presented herein for a given drainage situation may be constructed at the facility's discretion.

Additionally, if the working face is built directly on top of the protective cover of the liner system (i.e., for the first lift of waste placed in a newly lined sector), the containment and run-on berm shall be installed within the lined area of the cell or phase.

5 REFERENCES

Chow, V.T. (1959), *Open Channel-Hydraulics,* McGraw-Hill.

HCFCD (2009). *Hydrology and Hydraulics Guidance Manual*. Harris County Flood Control District, December 2009.

HCFCD (2010). *Policy, Criteria, and Procedure Manual*. Harris County Flood Control District, December 2010.

TxDOT (2009). *Hydraulic Design Manual*, Texas Department of Transportation, revised March 2009.

TABLES

- Table 2F-1. Diversion Berm Drainage Area Sizing
- Table 2F-2. Containment Berm Heights for Various Drainage and Storage Areas
- Table 2F-3. Run-on Berm Heights for Various Drainage and Storage Areas

Table 2F-1. Diversion Berm Drainage Area Sizing

Depth of Channel (ft)	Diversion Berm Flow Line Slope (%)	Maximum Drainage Area (AC)	Maximum Predicted Flow Velocity (ft/s)
2.5	0.5	9.2	3.0
	1.0	13.0	4.2
	1.5	16.0	5.2
	2.0	18.4	6.0

Note:

1. The back-calculated maximum allowable drainage area for the channel dimensions (geometry and slope) given above, as calculated by the Rational Method, assumes that the channel created by the diversion berm is flowing full when conveying the peak discharge during the 25-year rainfall event and to the maximum contributing drainage area..

Table 2F-2. Containment Berm Heights for Various Drainage and Storage Areas

Containment Berm Drainage Area	Contaminated Water Storage Area	Minimum Required Berm Height
(AC)	(AC)	(ft)
0.50	0.10	5.0
	0.25	2.6
	0.50	1.8
1.0	0.10	9.0
	0.25	4.2
	0.50	2.6
1.5	0.25	5.8
	0.50	3.4
	0.75	2.6
2.0	0.25	7.4
	0.50	4.2
	0.75	3.1
3.0	0.40	7.0
	0.75	4.2
	1.00	3.4
4.0	0.50	7.4
	0.75	5.3
	1.00	4.2

Notes:

1. The calculated required berm height includes 1-ft of freeboard for the containment berm.
2. Table 2F-2 is intended as a guide for the landfill operator, as during operation, the active working face location will change as filling progresses, and new containment berms will be constructed accordingly.

Table 2F-3. Run-On Berm Heights for Various Drainage and Storage Areas

Run-On Berm Drainage Area	Run-On Water Storage Area	Minimum Required Berm Height
(AC)	(AC)	(ft)
2.00	0.25	7.4
	0.50	4.2
	0.75	3.1
4.0	0.50	7.4
	0.75	5.3
	1.0	4.2
10.0	1.0	9.0
	2.0	5.0
	3.0	3.7
15.0	2.0	7.0
	3.0	5.0
	4.0	4.0
20.0	2.0	9.0
	3.0	6.3
	4.0	5.0
25.0	3.0	7.7
	4.0	6.0
	5.0	5.0
30.0	3.0	9.0
	4.0	7.0
	5.0	5.8

Notes:

1. The calculated required berm height includes 1-ft of freeboard for the containment berm.
2. Table 2F-3 is intended as a guide for the landfill operator, as during operation, the excavation areas contributing run-on towards the berm next to the active area will change as filling progresses, and new run-on berms will be constructed accordingly.

FIGURES

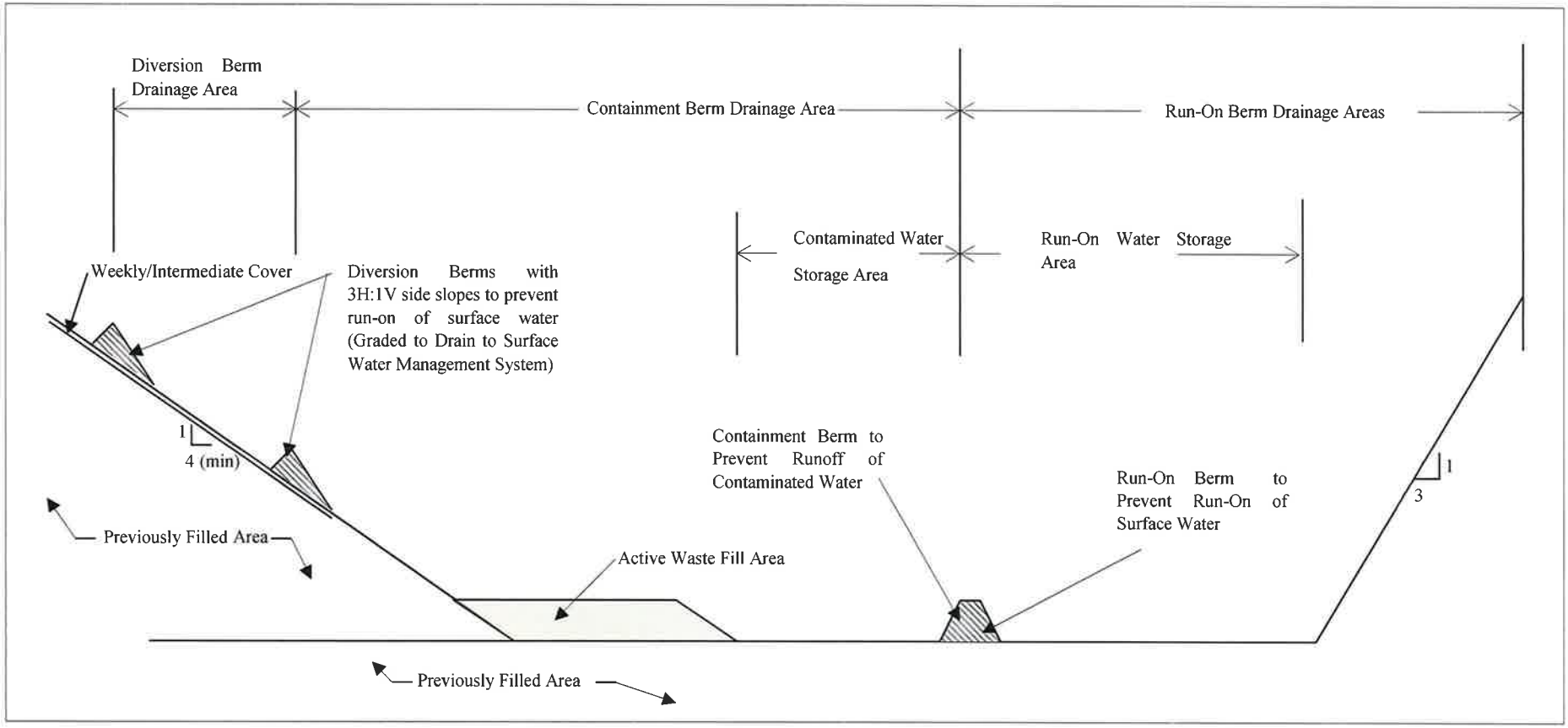


Figure 2F-1. Typical/Schematic of Active Fill Area Section (Not to Scale (NTS))

Note:

If the working face is built directly on top of the protective cover of the liner system (i.e., during the first waste lift in a new lined sector, the containment and run-on berm shall be constructed within the lined area.

APPENDIX 2F-1
DIVERSION BERM CALCULATIONS

Written by: J. McNash Date: 11/5/2012 Reviewed & Revised by: S. Graves Date: 2/25/2014

Client: USAWTXL Project: Fairbanks Landfill Expansion Project No.: TXL0263 Phase No.: 05

Design/Check: Trapezoidal/Triangular Channel

Methodology: Manning's Equation

Project: Fairbanks Landfill Expansion

Ditch ID: **Diversion Berm, 0.5% Flow Line Slope**

Peak Discharge, Q_{max} =	-	cfs
Bottom Width, B =	0.00	ft
Left Side Slope, Z_1 =	3.00	horizontal :1 vertical
Right Side Slope, Z_2 =	4.00	horizontal :1 vertical
Manning's Roughness Coeff., n =	0.040	
Longitudinal Channel Slope, S_o =	0.0050	ft/ft

Depth of Flow Y ft	Area of Flow A ft^2	Wetted Perimeter P ft	Hydraulic Radius R=A/P ft	Average Velocity V ft/s	Discharge (Flow Rate) Q=AV ft^3/s	Avg. Tractive Stress τ_o lb/ft^2	Comments
0.01	0.00	0.07	0.00	0.07	0.0	0.00	
0.22	0.17	1.58	0.10	0.58	0.1	0.03	
0.43	0.63	3.10	0.20	0.91	0.6	0.06	
0.63	1.40	4.61	0.30	1.19	1.7	0.09	
0.84	2.47	6.12	0.40	1.44	3.6	0.13	
1.05	3.84	7.63	0.50	1.67	6.4	0.16	
1.26	5.51	9.14	0.60	1.88	10.4	0.19	
1.46	7.49	10.65	0.70	2.08	15.6	0.22	
1.67	9.76	12.17	0.80	2.27	22.2	0.25	
1.88	12.34	13.68	0.90	2.46	30.3	0.28	
2.09	15.22	15.19	1.00	2.64	40.1	0.31	
2.29	18.39	16.70	1.10	2.81	51.7	0.34	
2.50	21.88	18.21	1.20	2.98	65.1	0.37	
2.50	21.88	18.21	1.20	2.98	65.11	0.37	DESIGN Q

Area Sizing

	Q =	CiA	cfs
	C =	0.7	
	I =	10.10	in/hr
	Q =	65.11	cfs
Therefore,	**A =**	**9.2**	**Acres**

Written by: J. McNash Date: 11/5/2012 Reviewed & Revised by: S. Graves Date: 2/25/2014

Client: USAWTXL Project: Fairbanks Landfill Expansion Project No.: TXL0263 Phase No.: 05

Design/Check: Trapezoidal/Triangular Channel

Methodology: Manning's Equation

Project: Fairbanks Landfill Expansion

Ditch ID: **Diversion Berm, 1% Flow Line Slope**

Peak Discharge, Q_{max} =	-	cfs
Bottom Width, B =	0.00	ft
Left Side Slope, Z_1 =	3.00	horizontal :1 vertical
Right Side Slope, Z_2 =	4.00	horizontal :1 vertical
Manning's Roughness Coeff., n =	0.040	
Longitudinal Channel Slope, S_o =	0.0100	ft/ft

Depth of Flow Y ft	Area of Flow A ft^2	Wetted Perimeter P ft	Hydraulic Radius R=A/P ft	Average Velocity V ft/s	Discharge (Flow Rate) Q=AV ft^3/s	Avg. Tractive Stress τ_o lb/ft^2	Comments
0.01	0.00	0.07	0.00	0.11	0.0	0.00	
0.22	0.17	1.58	0.10	0.83	0.1	0.07	
0.43	0.63	3.10	0.20	1.29	0.8	0.13	
0.63	1.40	4.61	0.30	1.68	2.4	0.19	
0.84	2.47	6.12	0.40	2.03	5.0	0.25	
1.05	3.84	7.63	0.50	2.36	9.0	0.31	
1.26	5.51	9.14	0.60	2.66	14.7	0.38	
1.46	7.49	10.65	0.70	2.94	22.0	0.44	
1.67	9.76	12.17	0.80	3.22	31.4	0.50	
1.88	12.34	13.68	0.90	3.48	42.9	0.56	
2.09	15.22	15.19	1.00	3.73	56.7	0.63	
2.29	18.39	16.70	1.10	3.97	73.1	0.69	
2.50	21.88	18.21	1.20	4.21	92.1	0.75	
2.50	21.88	18.21	1.20	4.21	92.07	0.75	DESIGN Q

Area Sizing

	Q =	CiA	cfs
	C =	0.7	
	I =	10.10	in/hr
	Q =	92.07	cfs
Therefore,	**A =**	**13.0**	**Acres**

Written by: J. McNash Date: 11/5/2012 Reviewed & Revised by: S. Graves Date: 2/25/2014

Client: USAWTXL Project: Fairbanks Landfill Expansion Project No.: TXL0263 Phase No.: 05

Design/Check: Trapezoidal/Triangular Channel

Methodology: Manning's Equation

Project: Fairbanks Landfill Expansion

Ditch ID: **Diversion Berm, 1.5% Flow Line Slope**

Peak Discharge, Q_{max}=	-	cfs
Bottom Width, B =	0.00	ft
Left Side Slope, Z_1 =	3.00	horizontal :1 vertical
Right Side Slope, Z_2 =	4.00	horizontal :1 vertical
Manning's Roughness Coeff., n =	0.040	
Longitudinal Channel Slope, S_o =	0.0150	ft/ft

Depth of Flow Y ft	Area of Flow A ft^2	Wetted Perimeter P ft	Hydraulic Radius R=A/P ft	Average Velocity V ft/s	Discharge (Flow Rate) Q=AV ft^3/s	Avg. Tractive Stress τ_o lb/ft^2	Comments
0.01	0.00	0.07	0.00	0.13	0.0	0.00	
0.22	0.17	1.58	0.10	1.01	0.2	0.10	
0.43	0.63	3.10	0.20	1.58	1.0	0.19	
0.63	1.40	4.61	0.30	2.06	2.9	0.28	
0.84	2.47	6.12	0.40	2.49	6.2	0.38	
1.05	3.84	7.63	0.50	2.89	11.1	0.47	
1.26	5.51	9.14	0.60	3.26	17.9	0.56	
1.46	7.49	10.65	0.70	3.61	27.0	0.66	
1.67	9.76	12.17	0.80	3.94	38.4	0.75	
1.88	12.34	13.68	0.90	4.26	52.5	0.84	
2.09	15.22	15.19	1.00	4.57	69.5	0.94	
2.29	18.39	16.70	1.10	4.87	89.5	1.03	
2.50	21.88	18.21	1.20	5.16	112.8	1.12	
2.50	21.88	18.21	1.20	5.16	112.77	1.12	DESIGN Q

Area Sizing

	Q =	CiA	cfs
	C =	0.7	
	I =	10.10	in/hr
	Q =	112.77	cfs
Therefore,	**A =**	**16.0**	**Acres**

Written by: J. McNash Date: 11/5/2012 Reviewed & Revised by: S. Graves Date: 2/25/2014

Client: USAWTXL Project: Fairbanks Landfill Expansion Project No.: TXL0263 Phase No.: 05

Design/Check: Trapezoidal/Triangular Channel
Methodology: Manning's Equation
Project: Fairbanks Landfill Expansion
Ditch ID: **Diversion Berm, 2% Flow Line Slope**

Peak Discharge, Q_{max} =	-	cfs
Bottom Width, B =	0.00	ft
Left Side Slope, Z_1 =	3.00	horizontal :1 vertical
Right Side Slope, Z_2 =	4.00	horizontal :1 vertical
Manning's Roughness Coeff., n =	0.040	
Longitudinal Channel Slope, S_o =	0.0200	ft/ft

Depth of Flow Y ft	Area of Flow A ft^2	Wetted Perimeter P ft	Hydraulic Radius R=A/P ft	Average Velocity V ft/s	Discharge (Flow Rate) Q=AV ft^3/s	Avg. Tractive Stress τ_o lb/ft^2	Comments
0.01	0.00	0.07	0.00	0.15	0.0	0.01	
0.22	0.17	1.58	0.10	1.17	0.2	0.13	
0.43	0.63	3.10	0.20	1.83	1.2	0.25	
0.63	1.40	4.61	0.30	2.38	3.3	0.38	
0.84	2.47	6.12	0.40	2.88	7.1	0.50	
1.05	3.84	7.63	0.50	3.33	12.8	0.63	
1.26	5.51	9.14	0.60	3.76	20.7	0.75	
1.46	7.49	10.65	0.70	4.16	31.2	0.88	
1.67	9.76	12.17	0.80	4.55	44.4	1.00	
1.88	12.34	13.68	0.90	4.92	60.7	1.13	
2.09	15.22	15.19	1.00	5.27	80.2	1.25	
2.29	18.39	16.70	1.10	5.62	103.3	1.37	
2.50	21.88	18.21	1.20	5.95	130.2	1.50	
2.50	21.88	18.21	1.20	5.95	130.21	1.50	DESIGN Q

Area Sizing

	Q =	CiA	cfs
	C =	0.7	
	I =	10.10	in/hr
	Q =	130.21	cfs
Therefore,	**A =**	**18.4**	**Acres**

APPENDIX 2F-2
CONTAINMENT BERM CALCULATIONS

Written by: J. McNash Date: 11/5/2012 Reviewed & Revised by: S. Graves Date: 2/25/2014

Client: USAWTXL Project: Fairbanks Landfill Expansion Project No.: TXL0263 Phase No.: 05

FAIRBANKS LANDFILL EXPANSION
CONTAINMENT BERM SIZING CALCULATIONS

25-yr / 24-hr rainfall depth = 9.6 in

Required Freeboard = 1 ft

Drainage Area, A_D (AC)	Storage Volume, A_s (CF)	Storage Area (AC)	Minimum Required Berm Height (FT)
0.50	17,424	0.10	5.0
		0.25	2.6
		0.50	1.8
1.00	34,848	0.10	9.0
		0.25	4.2
		0.50	2.6
1.50	52,272	0.25	5.8
		0.50	3.4
		0.75	2.6
2.00	69,696	0.25	7.4
		0.50	4.2
		0.75	3.1
3.00	104,544	0.40	7.0
		0.75	4.2
		1.00	3.4
4.00	139,392	0.50	7.4
		0.75	5.3
		1.00	4.2

APPENDIX 2F-3
RUN-ON BERM CALCULATIONS

Written by: J. McNash Date: 11/5/2012 Reviewed & Revised by: S. Graves Date: 2/25/2014

Client: USAWTXL Project: Fairbanks Landfill Expansion Project No.: TXL0263 Phase No.: 05

FAIRBANKS LANDFILL EXPANSION
RUN ON BERM SIZING CALCULATIONS

25-yr / 24-hr rainfall depth = 9.6 in

Required Freeboard = 1 ft

Drainage Area, A_D (AC)	Storage Volume, A_s (CF)	Storage Area (AC)	Minimum Required Berm Height (FT)
2.00	69,696	0.25	7.4
		0.50	4.2
		0.75	3.1
4.00	139,392	0.50	7.4
		0.75	5.3
		1.00	4.2
10.00	348,480	1.00	9.0
		2.00	5.0
		3.00	3.7
15.00	522,720	2.00	7.0
		3.00	5.0
		4.00	4.0
20.00	696,960	2.00	9.0
		3.00	6.3
		4.00	5.0
25.00	871,200	3.00	7.7
		4.00	6.0
		5.00	5.0
30.00	1,045,440	3.00	9.0
		4.00	7.0
		5.00	5.8

Prepared for:

USA Waste of Texas Landfills, Inc.

PERMIT AMENDMENT APPLICATION
PART III – SITE DEVELOPMENT PLAN
ATTACHMENT 2H

INTERMEDIATE COVER EROSION AND SEDIMENT CONTROL PLAN

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

Prepared by:

Geosyntec consultants

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3/3/2014

FOR PERMIT PURPOSES ONLY

Submitted August 2013
Revised March 2014

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3/3/2014
STATE OF TEXAS
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FOR PERMIT PURPOSES ONLY

DRAWINGS

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APPENDICES

Appendix 2H-1 Intermediate Cover Erosion Analysis
Appendix 2H-2 Hydraulic Design of Intermediate Cover Diversion Structures

1. INTRODUCTION

The purpose of this document is to provide a plan for controlling erosion and sediment on intermediate cover for the Fairbanks Landfill Expansion. Erosion control is necessary to maintain the integrity of the intermediate cover and to prevent off-site discharge of sediments. This Intermediate Cover Erosion and Sediment Control Plan (ICESCP) has been developed to address the requirements identified in Title 30 Texas Administrative Code (30 TAC) §330.305.

As required by 30 TAC §330.305(d), the Fairbanks Landfill Expansion has been designed to provide effective erosional stability to top deck surfaces and external side slopes during all phases of landfill operation, closure, and post-closure care. Top deck surfaces and external side slopes are:

- those above grade slopes that directly drain to the facility surface water management system (i.e., areas where the surface water directly flows to a perimeter channel or surface water pond);
- those slopes that have received intermediate or final cover; and
- those surfaces that have either reached their permitted elevation, or will subsequently remain inactive for longer than 180 days.

Slopes that drain to areas of ongoing waste placement, pre-excavated areas, areas that have received only weekly cover, or areas under construction which have not received waste are not considered external side slopes.

The top deck surfaces and external side slopes will be covered with weekly cover, intermediate cover, or final cover. The definitions of each of these cover systems and their respective erosion and sediment control practices are provided below.

1.1 Weekly Cover

Weekly cover is defined in 30 TAC §330.165(b) for Type IV landfills. Weekly cover consists of six inches of well-compacted earthen material (or approved alternative) not previously mixed with garbage, rubbish, or other solid waste. The rate of cover must be no less than weekly, unless the Texas Commission on Environmental Quality (TCEQ) Executive Director approves another schedule. The placement and erosion control practices for weekly cover areas are addressed in the Site Operating Plan (SOP).

1.2 Intermediate Cover

Intermediate cover is defined in 30 TAC §330.165(c). Intermediate cover consists of at least 12 inches of suitable earthen material and is graded and maintained to prevent erosion and ponding of water. All areas that have received waste but will be inactive for longer than 180 days will be provided with intermediate cover. Information regarding the erosion and sediment control practices for intermediate cover is provided in Section 3 of this ICESCP. Additional information

regarding placement, maintenance, and repair of intermediate cover is located in Section 5 of this ICESCP and Section 24 of the SOP.

1.3 Final Cover

1.3.1 Reference to Closure Plan

Final cover is defined in 30 TAC §330, Subchapter K. The final cover system for the Fairbanks Landfill is described in the Closure Plan located in Attachment 7 of the Site Development Plan (SDP). As areas of the landfill reach final grade, the final cover system and the permanent surface water management system will be installed, which includes vegetated top deck and side slopes, drainage terraces, and downchute channels.

1.3.2 Erosional Stability of the Final Cover

The long-term erosional stability of the final cover slopes is demonstrated using the Revised Universal Soil Loss Equation (RUSLE) and is presented in Attachment 3E of the SDP. As shown in Attachment 3E and further described in the Closure Plan (Attachment 7), the calculated long-term annual soil loss is less than the long-term permissible value, indicating that the final cover system is designed with adequate resistance to erosion. Refer to these aforementioned attachments for additional discussion to clarify the ground coverage percentage and other assumptions that factor in to the calculated long-term annual soil loss. In particular, the "Conclusions and Recommendations" section of Attachment 3E discusses usage of soil loss results including how they relate to ground coverage. Additionally, the erosional stability of the side slope drainage terraces, top deck drainage terraces, and downchutes is demonstrated based on calculated flow velocity and is presented in Attachment 2D, as well.

1.3.3 Final Cover Maintenance

Maintenance requirements for areas with final cover during operations and after closure are addressed, respectively, in Section 24 of the SOP and Section 3 of the Post-Closure Plan Attachment 8 of the SDP).

1.4 Landfill Perimeter Areas

The permanent surface water management system design includes features in the landfill perimeter areas outside the footprint of the disposal area. Runoff will be conveyed from the landfill to perimeter drainage channels and culverts and ultimately routed to the two on-site surface water ponds. These features provide for positive, non-erosive drainage of runoff from the landfill and surrounding site areas. Perimeter drainage channels will be utilized during development and operation of the Fairbanks Landfill, and will ultimately convey surface water runoff from the final cover or intermediate cover slopes. The erosional stability of the permanent drainage channels is demonstrated based on calculated flow velocity and is presented in Attachment 2E. Maintenance requirements for perimeter drainage features are addressed in Section 3 in the Post-Closure Plan located in Attachment 8 of the SDP.

2. INTERMEDIATE COVER EROSION AND SEDIMENT CONTROL DESIGN

As required by 30 TAC §330.305(d), the landfill design must provide effective erosional stability to top deck surfaces and external side slopes. An Intermediate Cover Erosion Analysis was performed and is included in Appendix 2H-1 of this ICESCP.

2.1 Permissible Soil Loss and Non-Erodible Velocity

A permissible soil loss of 50 tons/acre/year is used as the design criteria to which the calculated soil loss for intermediate cover is compared. This is based on previously-issued draft guidance from TCEQ [*Guidance for Addressing Erosional Stability During All Phases of Landfill Operation (Draft)* (TCEQ, 2007)]. It is noted that this draft guidance was never finalized by TCEQ and is currently not available on TCEQ's website or in print. Thus, it is not believed to be a formal regulatory requirement – but nevertheless is used for this plan. Also, for the purposes of the site-specific erosion and sediment control design, the permissible soil loss is the "permissible soil loss for comparable soil-slope lengths and soil-cover conditions" referred to by 30 TAC §330.305(d)(2). For comparison purposes, 50 tons/acre is equivalent to a soil thickness of 0.25 in. (six mm) for a soil with a typical bulk density of 110 pcf.

The permissible non-erodible velocity of five (5) ft/sec is used as the design criteria to which the estimated flow velocities are compared. *Storm Water Management Guidelines for Construction Activities* (TxDOT, 2002) indicates that flow velocities should not exceed four (4) ft/sec in sandy soils or five (5) ft/sec in more cohesive soils. Five (5) ft/sec is appropriate for this facility because it is anticipated that intermediate cover will be constructed of cohesive soils that are readily available at the site.

2.2 Intermediate Cover Erosion Analysis Results

The Intermediate Cover Erosion Analysis is presented in Appendix 2H-1 of this ICESCP. The Revised Universal Soil-Loss Equation (RUSLE) is used in the Intermediate Cover Erosion Analysis to calculate the annual soil loss. Results from the Intermediate Cover Erosion Analysis indicate that adequate erosional stability of the intermediate cover on the top deck and side slopes can be achieved with stabilized soil surfaces and surface water diversions. To achieve effective erosional stability, the maximum parallel offset (horizontal) of the temporary diversion structures is 600-ft on the top deck. The maximum parallel offset for the external 4H:1V side slopes is dependent on the ground cover attained on the interim cover. For 60%, 70%, and 80% ground cover on the interim cover system, the maximum parallel offset of terraces on the external 4H:1V side slopes is 175-ft, 300-ft, and 750-ft, respectively. These distances are based on a soil stabilization practice method that provides a cropping management factor (C) of 0.042 or less on the top deck and external side slopes. These C values correspond to ground cover consisting of grass, grass-like plants, mulch, or organic matter at least two inches deep covering 60% or greater of the surface of the intermediate cover.

3. EROSION AND SEDIMENT CONTROL BEST MANAGEMENT PRACTICES (BMPS)

Based on the Intermediate Cover Erosion Analysis presented in Appendix 2H-1 of this ICESCP, soil stabilization and surface water diversion BMPs are required for erosional stability of the intermediate cover on the top deck surface and external side slopes during landfill operations. Drawing 2H-1 depicts a plan view of the site to show an example configuration of a landfill development phase, showing the areas requiring erosion and sediment controls addressed in this plan. Descriptions of the required soil stabilization and drainage controls are provided below. Optional BMPs that may be used in addition to the required BMPs at the landfill operator's discretion are also described.

3.1 Soil Stabilization

The purpose of soil stabilization is to provide a ground cover that limits the rainfall impact energy, provides a limited amount of water storage through rainfall interception, and limits sheet flow runoff velocity by increasing surface roughness. In the natural condition, soil is stabilized by native vegetation. As previously described, the temporary soil stabilization practice must provide a maximum C value of 0.042 for intermediate cover. These C values correspond to ground cover consisting of grass, grass-like plants, mulch, or organic matter at least two inches deep covering at least 60% of the surface of the intermediate cover. Intermediate cover will be installed in accordance with the requirements of the SOP, will be stabilized with at least 60% ground cover within 180 days following installation, and will be maintained until final cover is installed or waste filling operations resume. Placement of intermediate cover and stabilization activities will be documented in the Site Operating Record. Details of the soil stabilization BMPs that will be implemented are listed below.

- Vegetation – Vegetation, as a BMP, is the sowing or sodding of fast-germinating annual or perennial grasses, grains, or legumes to provide a vegetative stabilization for disturbed areas. With leaves and stems above ground and fibrous roots below ground, vegetation can provide an effective and long-lasting ground cover. Lack of water and lack of or improper use of soil amendments will usually result in poor vegetation establishment. Seed may be applied to the landfill surface by broadcasting, drilling, hydraulic methods such as hydroseeding or hydromulching, or other methods. Vegetation types, rates of application, and other specifications for establishing vegetation are left to the discretion of the landfill operator, but should be in accordance with temporary vegetation BMP standards or guidelines published by relevant State or local agencies, appropriate for the area. An example of a standard vegetation specification is published in TxDOT (2004), the *Texas Department of Transportation (TxDOT) Standard Specification for Construction and Maintenance of Highways, Streets, and Bridges*, Item 162 (sodding) and Item 164 (seeding). Use of this particular

standard specification is not required but is provided as an example of a common and widely-used specification that provides vegetation-related BMPs. Intermediate cover must achieve a relatively uniform ground cover of at least 60% within 180 days following placement. If vegetation establishment at the minimum density specified above cannot be achieved (due to drought, temperatures, or other unforeseen conditions), then additional soil stabilization BMPs (e.g., mulch) will be implemented until the required vegetation density is achieved.

- Mulch – Mulching is the application of a layer of organic, biodegradable material which is spread over areas where vegetation is not yet established. Types of mulch include compost, shredded wood, straw, or manufactured products. Mulch may be distributed over the ground surface dry or hydraulically applied as slurry. If applied dry, the mulch must be tracked into the surface to prevent the mulch from being washed away. If mulch is to be used as the only soil stabilization feature (i.e., without vegetation), a two-inch (minimum) thick layer of "primary grind" mulch is required. Note that "primary grind" mulch is mulch obtained from the primary run from an industrial tub grinder. Primary grind mulch is very coarse mulch that mats together and resists washing away. It is noted that this technique has been used successfully in stabilizing intermediate cover side slopes at similar landfill projects within Texas. Types of mulch slurries include hydromulch, bonded fiber matrix (BFM), flexible growth medium (FGM), as well as other commercially available products. Slurry mixtures typically include a tackifier or binder which increases the strength and durability of the mulch. Seed can also be added to the slurry, in which case the ground surface would be stabilized with a mulch/vegetation composite. If mulch is used in lieu of vegetation for intermediate cover, then the mulch will be applied to cover all of the area requiring stabilization within 180 days of intermediate cover installation. If mulch is used in conjunction with vegetation, then the mulch will be applied to areas where the vegetation fails to establish, or the mulch will be used as a supplemental layer to encourage vegetative growth while providing some degree of soil stabilization until vegetation becomes established.

3.2 Surface Water Diversions

The purpose of a surface water diversion structure is to limit the length of slope over which surface water runoff can travel as sheet flow or shallow concentrated flow. The diversion concentrates and laterally conveys surface water in a non-erosive manner to the perimeter ditch or downchute. Surface water diversion BMPs that will be implemented are listed below.

- Side Slope Drainage Terraces – The proposed final grading plan includes tack-on terraces on the external 4H:1V side slopes of the landfill. These terraces will be constructed of intermediate cover overlying waste and will have a flow line (or

longitudinal) slope of approximately 3%. The surface of the intermediate cover within the terrace will be stabilized with vegetation or mulch. Rolled erosion control products may also be used for stabilization of the drainage terraces. Details showing the required dimensions and spacing of the built-in terraces are provided on Drawing 2H-2. Design calculations for these side slope drainage terraces on the intermediate cover surface are provided in Appendix 2H-2.

- Top Deck Drainage Terraces – Top deck drainage terraces are open channels used to collect flow from top deck surfaces and convey it to the temporary downchute channels along the side slopes in a non-erosive manner. Top deck drainage channels are designed as v-shaped channels with 3H:1V and 3% side slopes and a flowline slope of approximately 0.15%. Details showing the required dimensions and layout of the drainage features are provided on Drawing 2H-2. Design calculations for the top deck drainage terraces on the intermediate cover surface are provided in Appendix 2H-2.

- Temporary Downchutes – Temporary downchutes (also known as downdrains or let-downs) are open channels used to collect flow from surface water diversion structures and convey it down the side slope in a non-erosive manner. Downchutes will be constructed using soil berms to create an above-grade channel, or will be excavated to create a depressed channel (in which case a minimum of one foot of intermediate cover will be maintained beneath the downchute). The bottom and side slopes of the temporary downchute channel will be lined with turf reinforcement mat, geomembrane, reno mattress/articulated block, or other alternative lining material to prevent erosion. If an alternative lining material is used, the lining material must have a Manning's n equal to or less than 0.04. The lining material must be able to tolerate the anticipated velocity and tractive stress at the design flow rate and corresponding calculated depth of flow. All equivalency evaluations performed pursuant to these criteria will be placed in the Site Operating Record. A rip rap apron will be installed at the downstream end of the downchutes to provide erosion protection. Details showing the required dimensions and information on these structures are provided on Drawing 2H-2. Design calculations for these temporary structures are provided in Appendix 2H-2.

3.3 Optional Erosion and Sediment Control BMPs

As demonstrated in the Intermediate Cover Erosion Analysis included in Appendix 2H-1, the soil stabilization and surface water diversion BMPs specified above in Sections 3.1 and 3.2 are the only BMPs required to limit soil loss in accordance with 30 TAC §330.305(d). No other BMPs are required. However, other erosion and sediment control BMPs may be implemented during landfill operations at the operator's discretion in order to reduce soil losses even further than required or to provide temporary erosion and sediment controls during the period between

installation of intermediate cover and establishment of vegetation or mulch on the top deck and external side slopes. Examples of optional BMPs that may be implemented are listed below.

- Silt Fence – Silt fence consists of filter fabric supported by wire mesh netting or other backing stretched between either wooden or metal posts with the lower edge of the fabric securely embedded in the soil. Silt fence may be located as needed to intercept and filter sheet flow. Typical locations of silt fence include along the toe or crest of external side slopes and should be installed at a fairly level grade. Silt fence may not be used in areas of concentrated flow (e.g., channels and diversions). The maximum drainage area to the silt fence should not exceed the manufacturer's specification, but in no case shall the drainage area be greater than 0.5 acre per 100 ft of fence. A typical silt fence detail is provided on Drawing 2H-3.

- Biodegradable Logs – Biodegradable logs (or filter socks) consist of a biodegradable core material contained in a synthetic mesh sock or tube and are installed above, across, or below slopes to intercept and filter sheet flow. The logs are anchored to the surface using stakes or other methods and should be installed at a fairly level grade. Biodegradable logs may not be used in areas of concentrated flow (e.g., channels and diversions). The maximum drainage area to the biodegradable logs should not exceed 0.5 acre per 100 ft of log. A typical biodegradable log detail is provided on Drawing 2H-3.

- Organic Berms – Organic berms (or organic filter berms) are linear berms constructed of mulch or a mix of mulch and compost. Organic berms may be located as needed to intercept and filter sheet flow. Typical locations of organic berms include along the toe or crest of external side slopes. Organic berms may not be used in areas of concentrated flow (e.g., channels, terraces, and diversions). The maximum drainage area to the organic berms should not exceed 0.5 acre per 100 ft of berm. A typical organic berm detail is provided on Drawing 2H-3.

4. INTERMEDIATE COVER INSTALLATION AND STABILIZATION SCHEDULE

The schedule for installation of intermediate cover and associated erosion and sediment control BMPs is as follows:

- Areas with weekly cover that remain inactive for periods greater than 180 days will receive intermediate cover.
- Intermediate cover diversion structures and downchutes will be installed as soon as practical following placement of intermediate cover, but in no case more than 180 days from when intermediate cover is installed.
- Intermediate cover will be stabilized with vegetation or mulch as soon as practical following placement of intermediate cover. A minimum of 60% land cover (corresponding to cropping management factor of at least 0.042) will be established over the intermediate cover areas within 180 days from intermediate cover construction.
- The intermediate cover and temporary erosion control structures will be maintained as detailed in Section 5 below (the Intermediate Cover Erosion and Sediment Control Maintenance Plan).
- Final cover will be constructed incrementally as the site develops. Temporary erosion control features will be removed as permanent erosion control structures are constructed.

5. INTERMEDIATE COVER EROSION AND SEDIMENT CONTROL MAINTENANCE PLAN

The landfill operator will restore and repair the intermediate cover areas and their erosion and sediment control features in the event of washout or failure. Excess silt buildup, weeds and other debris that are adversely affecting flow in diversion structures will be removed to restore their design configuration, followed by re-stabilizing the disturbed areas as appropriate. Site inspections by landfill personnel will be performed weekly in accordance with the facility's Texas Pollutant Discharge Elimination System (TPDES) Multi-Sector General Permit. Written records of these inspections and maintenance activities will be maintained in the Site Operating Record, as further discussed in the Site Operating Plan (SOP).

The following items will be evaluated during the inspections:

- presence of adequate vegetation coverage (grass and/or mulch) to meet the applicable minimum ground cover percentages specified herein;
- adequacy of the spacing between interim diversion structures on side slopes in accordance with the table on Drawing 2H-2;
- erosion of intermediate cover areas, perimeter ditches, diversion channels, downchutes, and other drainage features;
- settlement of intermediate cover areas, diversion channels, downchutes, and other drainage features;
- silt and sediment build-up in diversion channels, perimeter ditches, downchutes, and surface water ponds;
- presence of ponded water on intermediate cover or behind diversion structures;
- obstructions in drainage features;
- presence of erosion or sediment discharge at off-site surface water discharge locations; and
- functionality of temporary erosion and sediment control features.

Maintenance activities will be performed to correct damaged or deficient items noted during the site inspections. These activities will be performed as soon as possible after the inspection. Damaged or deficient items will be corrected within seven days of detection unless access is restricted due to weather, ground conditions, and other site-specific conditions.

Maintenance activities will consist of the following, as needed:

- placement of additional vegetation or mulch on areas with deficient coverage;
- adjustments to, or installation of, interim diversion structures that are found to be spaced inadequately;
- placement, grading, and stabilization of additional soils in eroded areas or in areas which have settled;
- replacement of riprap or other structural armoring;
- removal of obstructions from drainage features;
- removal of silt and sediment build-up from the erosion and sediment controls;
- removal of ponded water on the intermediate cover or behind diversion structures;
- repairs to erosion and sedimentation controls; and
- installation of additional erosion and sedimentation controls, as needed.

Inspection, maintenance, and recordkeeping frequencies and techniques are discussed below.

- Site inspections by landfill personnel will be performed weekly.
- Documentation of the inspection will be included in the Site Operating Record.
- Documentation of maintenance activities that were performed to correct damaged or deficient items noted during the site inspections will be included in the Site Operating Record.
- Landfill personnel will be trained to perform inspections, install, and maintain erosion and sediment control features.

6. REFERENCES

TCEQ (2007). *Guidance for Addressing Erosional Stability During All Phases of Landfill Operation (Draft)*, Texas Commission on Environmental Quality, 14 February 2007.

TxDOT (2002). *Storm Water Management Guidelines for Construction*, Texas Department of Transportation.

TxDOT (2004). Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges, Texas Department of Transportation, 1 June 2004.

APPENDIX 2H-1

INTERMEDIATE COVER EROSION ANALYSIS

Written by: J. McNash Date: 10/19/2012 Reviewed & Revised by: S. Graves Date: 2/25/2014

Client: USAWTXL Project: Fairbanks Landfill Expansion Project No.: TXL0263 Phase No.: 05

INTERMEDIATE COVER EROSION ANALYSIS



3/3/2014

SEALED FOR PERMITTING PURPOSES,
CALCULATION PAGES 1 TO 21

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

1 INTRODUCTION

The purpose of this calculation package is to present the intermediate cover erosion analysis for the Fairbanks Landfill. This package provides calculations for the annual soil loss from the external-facing intermediate cover top deck and side slope surfaces under potential interim conditions during operations. In addition, estimates of overland flow velocities on the previously mentioned slopes are provided for the purpose of assessing whether the surface water velocities will remain below permissible non-erodible velocities.

2 PROJECT BACKGROUND

The landfill intermediate cover system includes a surface water management system. Intermediate cover placement of the landfill is expected to be completed as areas reach final elevations and await the construction of the final cover system. The intermediate cover system is comprised of a top deck surface and side slopes designed with temporary drainage features until the final cover system is constructed. The top deck of the landfill will have a surface slope of approximately 3%, and flow into top deck drainage terraces. The side slopes of the intermediate cover on external-facing slopes will be constructed with a grade of 4 horizontal to 1 vertical (4H:1V) (i.e., 25%). The landfill's surface water management system includes the following permanent and temporary drainage features: top deck drainage terraces, downchute channels, side slope drainage terraces, perimeter drainage channels, and surface water ponds. The proposed surface water diversion structures will convey flow from the top deck to the downchute

applicable for grass and grass-like plants. For ground cover consisting of decaying compacted duff or litter (e.g., mulch), the most applicable representative surface condition for velocity calculation purposes is "forest with heavy ground litter and meadow". While the mulch-covered slopes of the landfill are not situated in a forest, the mulched surface will have a surface condition (or "roughness") that is best compared to "heavy ground litter" found in a forest (i.e., decaying duff and litter, twigs, etc.).

For estimating shallow concentrated flow velocities for flow distances more than 300 ft using USDA(2010), a velocity factor (K_v) of 9.965 is selected from Table 2H-1-1 for a "Nearly Bare & Untilled" surface. The velocity factor is applied with the slope to estimate the velocity of the interim cover condition for shallow concentrated flow (after 300-ft of sheet flow).

6 RESULTS

6.1 RUSLE

Applying the RUSLE with the parameters defined above, the computed soil loss in tons/acre/year is calculated as follows:

$$A = R \times K \times LS \times C \times P$$

Top Deck Slopes, 60% ground cover:

$$A = 450 \times 0.37 \times 0.96 \times 0.042 \times 1 = 6.71 \text{ tons/acre/year}$$

Side Slopes, 60% ground cover, 175-ft slope length between terraces:

$$A = 450 \times 0.37 \times 7.09 \times 0.042 \times 1 = 49.58 \text{ tons/acre/year}$$

Top Deck Slopes, 70% ground cover:

$$A = 450 \times 0.37 \times 0.96 \times 0.0275 \times 1 = 4.40 \text{ tons/acre/year}$$

Side Slopes, 70% ground cover, 300-ft slope length between terraces:

$$A = 450 \times 0.37 \times 10.81 \times 0.0275 \times 1 = 49.50 \text{ tons/acre/year}$$

Top Deck Slopes, 80% ground cover:

$$A = 450 \times 0.37 \times 0.96 \times 0.013 \times 1 = 2.08 \text{ tons/acre/year}$$

Side Slopes, 80% ground cover, 750-ft slope length between terraces:

$$A = 450 \times 0.37 \times 10.81 \times 0.013 \times 1 = 47.77 \text{ tons/acre/year}$$

As shown above, the calculated annual soil loss from the intermediate cover on the top deck and side slope surfaces are less than the 50 tons/acre/year permissible rate of soil loss for interim conditions. These results show that if 60% ground cover is present, the side slope terraces should be placed no greater than 175-ft apart. If 70% ground cover is present, the side slope terraces may be placed up to 300-ft apart. If 80% ground cover is present during interim conditions, the side slope terraces may be placed up to 750-ft apart. It is expected that 60%, 70%, and 80% ground cover can be achieved with grassing, a combination of grassing and mulching, and mulching, respectively. Table 2H-1-5 summarizes allowable side slope terrace spacing under each ground cover option.

6.2 Erodible Velocity

As mentioned previously, sheet flow velocity estimates using Figure 2H-1-1 are performed only for the more conservative condition of having only 60% ground cover. The estimated velocities are as follows:

Top Deck Slopes (3%): For overland flow (length up to 300 ft) – 1.8 ft/s (for bare ground) and 1.3 ft/s (for grass).

The weighted average value for the overland flow velocity for 60% ground cover is calculated as:

$$\text{Top Deck Overland Flow Velocity} = 1.8 \times 0.40 + 1.3 \times 0.60 = 1.5 \text{ ft/s}$$

For distances greater than 300-ft on the top deck, where flow becomes shallow concentrated flow, the velocity estimates using the previously mentioned equation (and shown in Figure 2H-1-2) is calculated as:

$$\text{Top Deck Shallow Concentrated Flow Velocity, } V = 9.965 \times 0.03^{1/2} = 1.73 \text{ ft/s}$$

Side Slopes (25%): 5.0 ft/sec (for bare ground) and 3.5 ft/sec (for grass).

The weighted average value for the overland flow velocity for 60% ground cover is calculated as:

$$\text{Side Slope Overland Flow Velocity} = 5.0 \times 0.40 + 3.5 \times 0.60 = 4.1 \text{ ft/s}$$

For distances greater than 300-ft on the side slopes, where flow becomes shallow concentrated flow, the velocity estimates using the previously mentioned equation (and shown in Figure 2H-1-2) is calculated as:

$$\text{Side Slope Shallow Concentrated Flow Velocity, } V = 9.965 \times 0.25^{1/2} = 4.98 \text{ ft/s}$$

As shown above, the estimated flow velocities are less than 5.0 ft/s.

7 CONCLUSIONS

The ground surface cover condition and maximum terrace spacing requirements are computed above and summarized in Table 2H-1-5. Based on the calculations presented herein, the following conclusions are drawn:

- For the conditions analyzed herein, the calculated soil loss from the intermediate cover is less than the permissible soil loss of 50 tons/acre/year, which is acceptable.
- For the conditions analyzed herein, the estimated velocities for the top deck and side slope surfaces were calculated to be less than the permissible non-erosive velocity of five (5) ft/sec, which is acceptable.
- To provide effective erosional stability on the external facing 3% top deck slope surfaces, a horizontal spacing of 600-ft between temporary diversion structures is acceptable for a 60% or greater ground cover of grass/mulch or the like.
- To provide effective erosional stability on the external facing 25% side slopes when there is a 60% ground cover of grass/mulch or the like, the maximum horizontal spacing between terraces should be 175-ft.
- To provide effective erosional stability on the external facing 25% slopes when there is a 70% or greater ground cover of grass/mulch or the like, the maximum horizontal spacing between terraces should be 300-ft.
- To provide effective erosional stability on the external facing 25% slopes when there is a 80% or greater ground cover of grass/mulch or the like, the maximum horizontal spacing between terraces should be 750-ft.

8 REFERENCES

NRCS (2012). Soil Data Mart, Natural Resources Conservation Service, United States Department of Agriculture, Soil Survey Geographic (SSURGO) Database, accessed 4 January 2012, http://soildatamart.nrcs.usda.gov.

TxDOT (2002). *Storm Water Management Guidelines for Construction Activities*, Texas Department of Transportation, revised 2002.

TxDOT (2009). *Hydraulic Design Manual*, Texas Department of Transportation, revised March 2009.

USDA (1977). Procedure for Computing Sheet and Rill Erosion on Project Areas, United States Department of Agriculture, Soil Conservation Services, Engineering Division and Ecological Sciences and Technology Division, Technical Release No. 51, Revision 2.

USDA (1986). *Urban Hydrology for Small Watersheds*, Technical Release 55 (TR-55), United States Department of Agriculture, Science and Education Administration, Agriculture Handbook Number 537.

USDA (1978). Predicting Rainfall Erosion Losses: A Guide to Conservation Planning, United States Department of Agriculture, Science and Education Administration, Agriculture Handbook Number 537.

USDA (1996). Predicting Soil Erosion by Water: A Guide to Conservation Planning with the Revised Universal Soil Loss Equation (RUSLE), United States Department of Agriculture, Agricultural Research Service, Agriculture Handbook Number 703.

USDA (2010), *National Engineering Handbook*, United States Department of Agriculture, National Resources Conservation Service, Ch. 15, 2010.

ATTACHMENT 3

WASTE MANAGEMENT UNIT DESIGN

ATTACHMENT 3 TABLE OF CONTENTS

WITHIN ATTACHMENT 3, EACH INDIVIDUAL ENGINEERING REPORT, PLAN, OR CALCULATION, AND EACH ENGINEERING DRAWING IS SIGNED, SEALED, AND DATED BY THE RESPONSIBLE ENGINEER AS REQUIRED BY THE TEXAS ENGINEERING PRACTICE ACT.

ATTACHMENT 3 WASTE MANAGEMENT UNIT DESIGN
- ATT. 3A Landfill Design Drawings
- ATT. 3B Volume and Site Life Estimate
- ATT. 3C Liner Quality Control Plan (LQCP)
- ATT. 3D Geotechnical Report and Analyses of Landfill Design
  - 3D.1 Geotechnical Report
  - 3D.2 Slope Stability
  - 3D.3 Settlement
  - 3D.4 Liner Uplift, Dewatering System, and Ballast Evaluation
- ATT. 3E Final Cover Soil Erosion Loss Calculations

ATTACHMENT 3A

LANDFILL DESIGN DRAWINGS

LIST OF DRAWINGS		
Drawing No.	Title	Drawing Date (latest revision)
3-1	Facility Layout Plan	August 2013
3-2	Overall Base Grading Plan	August 2013
3-3	Overall Final Cover Grading Plan	March 2014
3-4	Landfill Entrance Plan	August 2013
3-5	Landfill Cross-Section Location Map	August 2013
3-6	Landfill Cross-Section A-A'	March 2014
3-7	Landfill Cross-Section B-B'	March 2014
3-8	Landfill Cross-Section C-C'	March 2014
3-9	Landfill Cross-Section D-D'	March 2014
3-10	Landfill Cross-Section E-E'	March 2014
3-11	General Landfill Construction Design Details I	March 2014
3-12	General Landfill Construction Design Details II	March 2014



N

0 200' 400'
SCALE IN FEET

LEGEND

- 100 — EXISTING GROUND ELEVATION (FT, MSL) (NOTES 1,2)
- EXISTING ROAD
- EXISTING WATER LINE
- N 13893000 E 3069000 — STATE PLANE COORDINATES (NOTE 2)
- 44 — SITE GRID
- PROPERTY BOUNDARY
- PROPOSED PERMIT BOUNDARY
- OVERALL LIMIT OF FINAL COVER
- FINAL COVER DRAINAGE TERRACE
- FINAL COVER DOWNCHUTE
- 200 — PROPOSED GROUND ELEVATION (FT, MSL) (NOTE 3)

NOTES:

1. THE EXISTING TOPOGRAPHIC BASE MAP SHOWN ON THIS DRAWING WAS COMPILED USING PHOTOGRAMMETRIC METHODS BASED ON AERIAL PHOTOGRAPHY PERFORMED ON 26 MARCH 2012 AND PREPARED BY DALLAS AERIAL SURVEYS (DAS), INC.
2. ELEVATIONS ARE IN FEET ABOVE MEAN SEA LEVEL (FT, MSL), AS DEFINED THE USGS NATIONAL GEODETIC VERTICAL DATUM (NAVD) OF 1988. STATE PLANE COORDINATE GRID CORRESPONDS TO THE TEXAS STATE PLANE COORDINATE SYSTEM, TEXAS SOUTH CENTRAL ZONE (4204), NORTH AMERICAN DATUM OF 1983 (NAD 83).
3. TOP OF FINAL COVER SYSTEM REFERS TO THE PROPOSED FINISHED GRADE (TOP OF THE TOPSOIL COMPONENT OF THE FINAL COVER SYSTEM). LIMIT OF FINAL COVER SYSTEM REFERS TO THE TOE OF SLOPE OF THE TOPSOIL LAYER.
4. OUTSIDE OF THE LIMIT OF FINAL COVER, THE PROPOSED CONTOURS REFER TO FINISHED GRADE.
5. REFER TO PART III, ATTACHMENT 2, DRAWING 2-1 FOR ADDITIONAL SURFACE WATER MANAGEMENT FEATURES ON THE FINAL COVER SYSTEM (NOT SHOWN ON THIS DRAWING FOR CLARITY).
6. TOP OF FINAL COVER ELEVATIONS ARE FOR THE 2-FT THICK FINAL COVER SYSTEM SHOWN ON DETAIL 2 ON DRAWING 3-11. AS INDICATED ON NOTE 4 OF DRAWING 3-11, A TOPSOIL LAYER THAT IS AN ADDITIONAL 6-INCHES THICKER (I.E., 1-FT THICK INSTEAD OF 0.5-FT THICK) MAY BE REQUIRED, DEPENDING ON THE ACTUAL SOIL CLASSIFICATION OF THE COMPACTED SOIL INFILTRATION LAYER AT THE TIME OF FINAL COVER CONSTRUCTION OF A GIVEN AREA, RESULTING IN A 2.5-FT THICK FINAL COVER. IF THIS OCCURS ALONG THE PEAK RIDGELINE OF THE LANDFILL, THE MAXIMUM FINAL COVER ELEVATION WOULD BE ELEVATION 250.5 FT, MSL INSTEAD OF THE 250.0 FT, MSL SHOWN.

STATE OF TEXAS
SCOTT M. GRAVES
86557
LICENSED
PROFESSIONAL ENGINEER
3/3/2014

FOR PERMIT PURPOSES ONLY

REV	DATE	DESCRIPTION	DRN	APP
1	MAR. 2014	REVISED, RESPONSE TO NOD 1	JJV/KH	SMG
-	AUG. 2013	INITIAL SUBMITTAL TO TCEQ	JJV	SMG

USA WASTE OF TEXAS LANDFILLS, INC.

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8217 SHOAL CREEK BLVD, SUITE 200
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PHONE: 512.451.4003

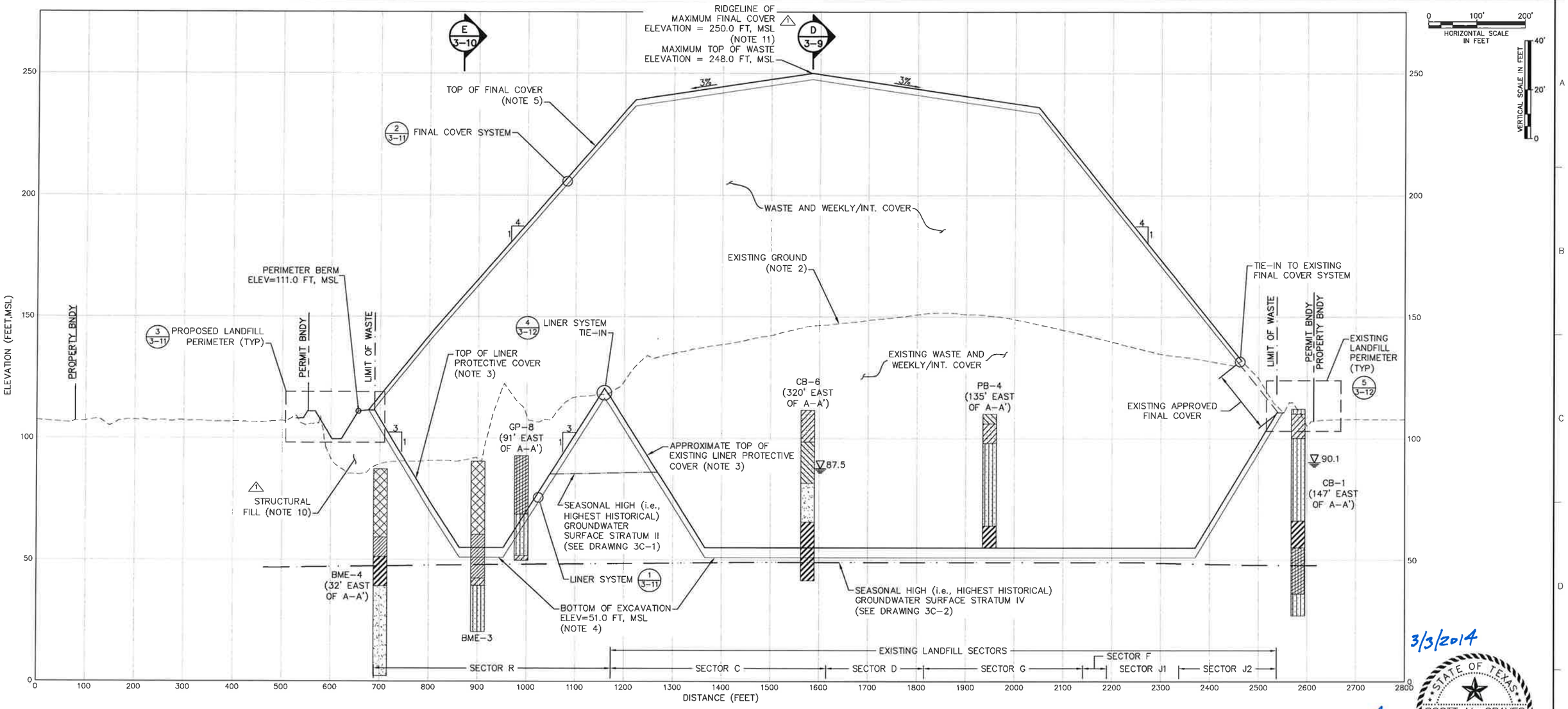
TITLE:
OVERALL FINAL COVER GRADING PLAN

PROJECT:
FAIRBANKS LANDFILL
PERMIT AMENDMENT APPLICATION – PERMIT NO. MSW-1565B

PROJECT NO.: TXL0263	DESIGN BY: SMG	REVIEWED BY: SMG	PART NO.: III	DRAWING: 3-3
FILE: 0263P3-3	DRAWN BY: JJV	APPROVED BY: SMG		

PERMIT DRAWING

DRAWING: Austin P:\CADD\Projects\F\Fairbanks Landfill\Permit\Expansion (TXL0263)\Drawings\Dwgs-Rev0\0263P3-3.dwg PLOTTED: Feb 26, 2014 - 11:14am

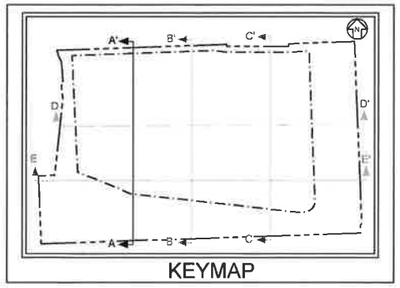


NOTES:

1. ELEVATIONS ARE IN FEET ABOVE MEAN SEA LEVEL (FT, MSL).
2. EXISTING GROUND SHOWN ON THIS DRAWING IS TAKEN FROM THE TOPOGRAPHIC BASE MAP SHOWN ON DRAWING 3-5.
3. TOP OF LINER PROTECTIVE COVER SHOWN ON THIS DRAWING IS TAKEN FROM THE OVERALL BASE GRADING PLAN ON DRAWING 3-2.
4. BOTTOM OF EXCAVATION SHOWN ON THIS DRAWING REFERS TO THE BOTTOM OF CLAY LINER, BASED ON THE BASE GRADING PLAN ON DRAWING 3-2. THE ELEVATION OF DEEPEST EXCAVATION (EDE) FOR THE FACILITY IS 51.0 FT, MSL.
5. TOP OF FINAL COVER TAKEN FROM OVERALL FINAL COVER GRADING PLAN ON DRAWING 3-3.
6. GROUNDWATER INITIAL AND/OR STATIC WATER LEVELS ARE PROVIDED FOR THOSE LOCATIONS WHERE THE INFORMATION IS AVAILABLE ON BORING LOGS AND WELL INSTALLATION REPORTS/ONGOING MONITORING, AS APPROPRIATE. REFER TO PART III, ATTACHMENTS 4 AND 5 FOR GEOLOGY AND GROUNDWATER INFORMATION, RESPECTIVELY, INCLUDING BORING AND WELL INSTALLATION LOGS, HYDROGEOLOGIC INTERPRETATIONS, AND POTENTIOMETRIC SURFACE(S).
7. PROPOSED TOP OF FINAL COVER IS SLOPED AT 4H:1V ON THE LANDFILL SIDESLOPES AND THREE PERCENT ON THE LANDFILL TOP AREAS. SLOPES AND FINAL COVER SYSTEM LAYER THICKNESS MAY APPEAR DISTORTED ON THESE CROSS SECTIONS DUE TO THE EXAGGERATED VERTICAL SCALE AND THE SKEWED ANGLE AT WHICH THE SECTIONS WERE CUT COMPARED TO THE THREE-DIMENSIONAL SLOPE DIRECTIONS.
8. LINER SYSTEM IS SLOPED AT 3H:1V ON THE LANDFILL BASE SIDESLOPES. SLOPES AND LINER SYSTEM THICKNESS MAY APPEAR DISTORTED ON THESE CROSS SECTIONS DUE TO THE EXAGGERATED VERTICAL SCALE AND THE SKEWED ANGLE AT WHICH THE SECTIONS WERE CUT COMPARED TO THE THREE-DIMENSIONAL SLOPE DIRECTIONS.
9. THIS CROSS-SECTION SHOWS THE SOIL PROFILE (BORING LOG) TAKEN FROM PREVIOUSLY DRILLED BORINGS AND/OR PREVIOUSLY-INSTALLED GROUNDWATER MONITORING WELLS AND LANDFILL GAS PROBES THAT THE CROSS-SECTION PASSES THROUGH OR NEAR. REFER TO PART III, ATTACHMENTS 5 AND 6 FOR THE PROPOSED GROUNDWATER MONITORING WELL LAYOUT AND PROPOSED LANDFILL GAS PROBE LAYOUT, RESPECTIVELY.
10. ⚠1 AREAS WHERE EXISTING GROUND ELEVATIONS ARE BELOW THE LINER SYSTEM SUBGRADE, OR BELOW FINISHED GRADE OF PERIMETER LANDFILL FEATURES (PERIMETER BERM/ROAD, STORMWATER CONVEYANCES, STORMWATER PONDS) SHALL BE FILLED WITH COMPACTED FILL SOIL, IN ACCORDANCE WITH SECTION 5 OF THE LINER QUALITY CONTROL PLAN (LQCP-ATTACHMENT 3C).
11. ⚠1 TOP OF FINAL COVER ELEVATIONS ARE FOR THE 2-FT THICK FINAL COVER SYSTEM SHOWN ON DETAIL 2 ON DRAWING 3-11. AS INDICATED ON NOTE 4 OF DRAWING 3-11, A TOPSOIL LAYER THAT IS AN ADDITIONAL 6-INCHES THICKER (I.E., 1-FT THICK INSTEAD OF 0.5-FT THICK) MAY BE REQUIRED, DEPENDING ON THE ACTUAL SOIL CLASSIFICATION OF THE COMPACTED SOIL INFILTRATION LAYER AT THE TIME OF FINAL COVER CONSTRUCTION OF A GIVEN AREA, RESULTING IN A 2.5-FT THICK FINAL COVER. IF THIS OCCURS ALONG THE PEAK RIDGELINE OF THE LANDFILL, THE MAXIMUM FINAL COVER ELEVATION WOULD BE ELEVATION 250.5 FT, MSL INSTEAD OF THE 250.0 FT, MSL SHOWN.

LEGEND OF SOIL/ROCK CLASSIFICATIONS AND GROUNDWATER

- FILL
- SAND
- CLAY (CL)
- CLAY (CH)
- CLAYEY SAND
- SILTY SAND
- SANDY CLAY
- SILTY CLAY
- INITIAL GROUNDWATER ELEVATION (NOTE 6)



KEYMAP

PERMIT DRAWING

3/3/2014

STATE OF TEXAS
SCOTT M. GRAVES
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1	MAR. 2014	REVISED, RESPONSE TO NOD 1	JJV/KH	SMG
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REV	DATE	DESCRIPTION	DRN	APP

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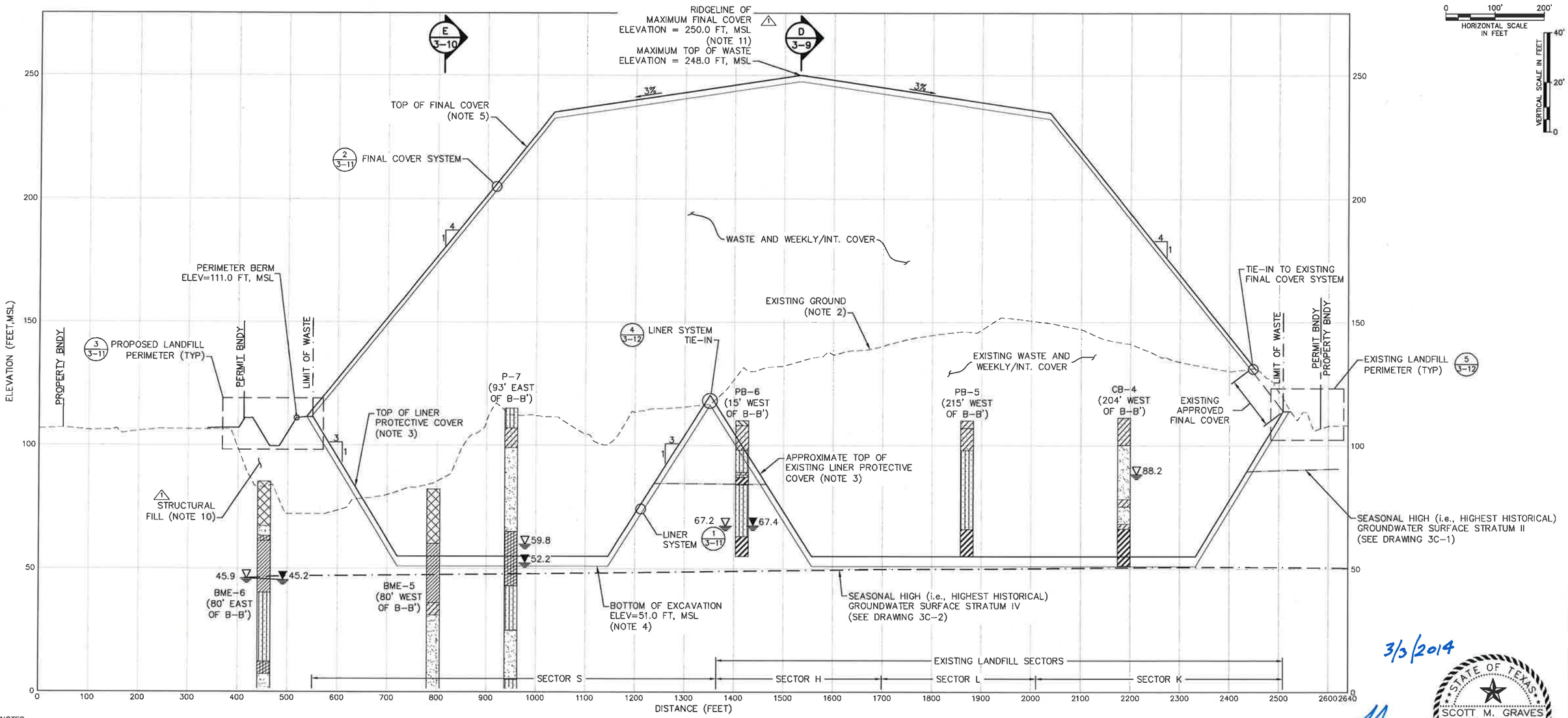
AUSTIN, TEXAS 78757
PHONE: 512.451.4003

TITLE:
LANDFILL CROSS-SECTION A-A'

PROJECT:
FAIRBANKS LANDFILL
PERMIT AMENDMENT APPLICATION – PERMIT NO. MSW-1565B

PROJECT NO.: TXL0263	DESIGN BY: SMG	REVIEWED BY: SMG	PART NO.: III	DRAWING: 3-6
FILE: 0263P3-6	DRAWN BY: JJV	APPROVED BY: SMG		

DRAWING: Austin P:\CADD\Projects\Fairbanks Landfill\Permit\Expansion (TXL0263)\Drawings\Dwgs-RevO\0263P3-6.dwg PLOTTED: Feb 28, 2014 - 1:52pm



NOTES:

1. ELEVATIONS ARE IN FEET ABOVE MEAN SEA LEVEL (FT, MSL).
2. EXISTING GROUND SHOWN ON THIS DRAWING IS TAKEN FROM THE TOPOGRAPHIC BASE MAP SHOWN ON DRAWING 3-5.
3. TOP OF LINER PROTECTIVE COVER SHOWN ON THIS DRAWING IS TAKEN FROM THE OVERALL BASE GRADING PLAN ON DRAWING 3-2.
4. BOTTOM OF EXCAVATION SHOWN ON THIS DRAWING REFERS TO THE BOTTOM OF CLAY LINER, BASED ON THE BASE GRADING PLAN ON DRAWING 3-2. THE ELEVATION OF DEEPEST EXCAVATION (EDE) FOR THE FACILITY IS 51.0 FT, MSL.
5. TOP OF FINAL COVER TAKEN FROM OVERALL FINAL COVER GRADING PLAN ON DRAWING 3-3.
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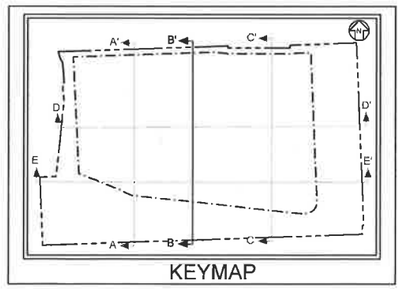
- CLAY (CH)
- CLAYEY SAND
- SILTY SAND
- SANDY CLAY
- SILTY CLAY
- INITIAL GROUNDWATER ELEVATION (NOTE 6)
- STATIC MEASUREMENT OF GROUNDWATER ELEVATION (NOTE 6)



KEYMAP

PERMIT DRAWING

3/3/2014

STATE OF TEXAS
SCOTT M. GRAVES
86557
LICENSED PROFESSIONAL ENGINEER

FOR PERMIT PURPOSES ONLY

REV	DATE	DESCRIPTION	DRN	APP
1	MAR. 2014	REVISED, RESPONSE TO NOD 1	JJV/KH	SMG
–	AUG. 2013	INITIAL SUBMITTAL TO TCEQ	JJV	SMG

USA WASTE OF TEXAS LANDFILLS, INC.

LANDFILL SITE ADDRESS:
8205 FAIRBANKS N HOUSTON RD
HOUSTON, TEXAS 77064
PHONE: 713.824.6867

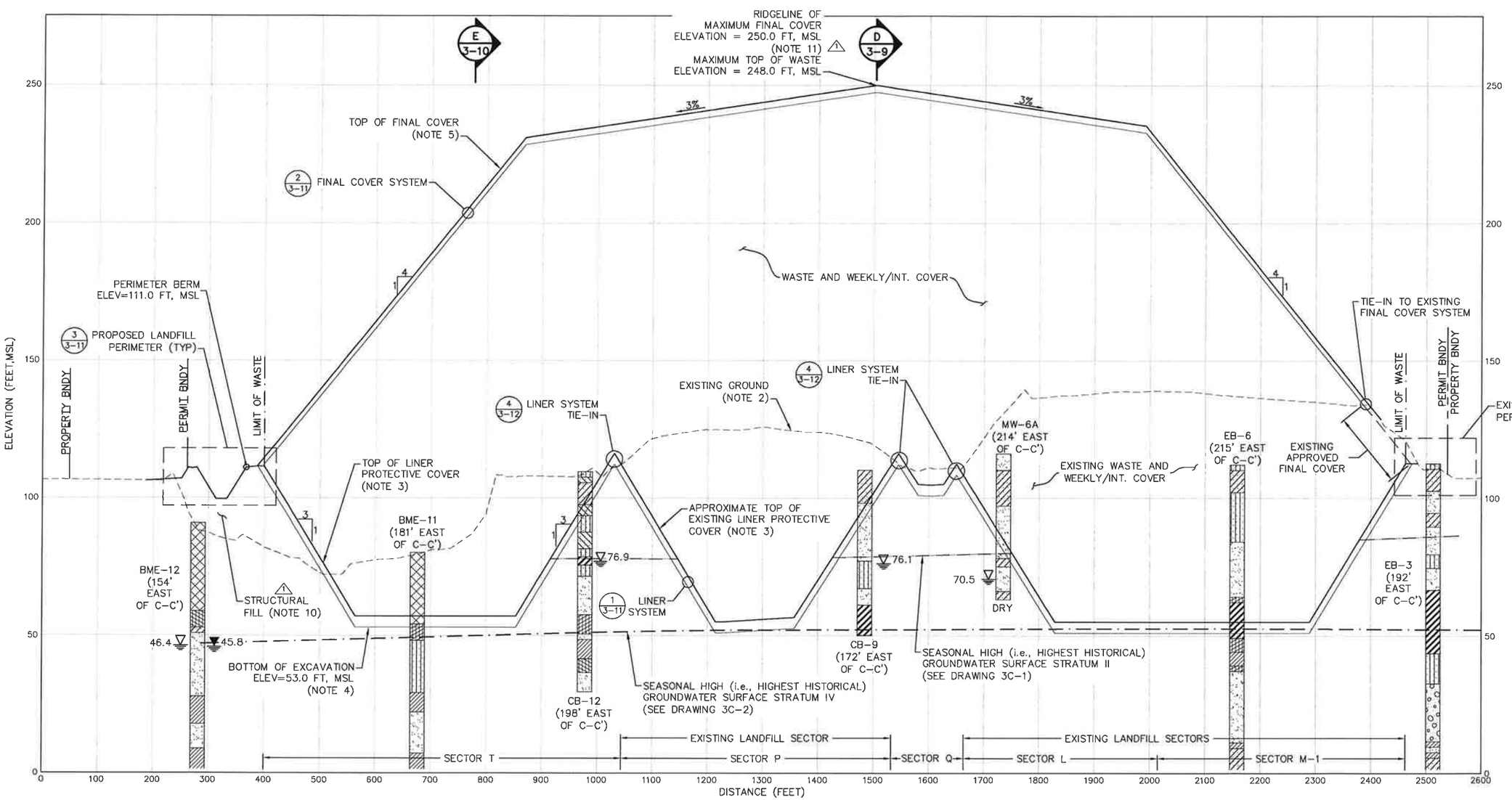
Geosyntec consultants
GEOSYNTEC CONSULTANTS, INC.
TEXAS ENG. FIRM REGISTRATION NO. 1182
8217 SHOAL CREEK BLVD, SUITE 200
AUSTIN, TEXAS 78757
PHONE: 512.451.4003

TITLE: LANDFILL CROSS-SECTION B-B'

PROJECT: FAIRBANKS LANDFILL
PERMIT AMENDMENT APPLICATION – PERMIT NO. MSW-1565B

PROJECT NO.: TXL0263	DESIGN BY: SMG	REVIEWED BY: SMG	PART NO.: III	DRAWING: 3-7
FILE: 0263P3-7	DRAWN BY: JJV	APPROVED BY: SMG		

DRAWING: Austin P:\CADD\Projects\F\Fairbanks Landfill\Permit\Expansion (TXL0263)\Drawings\Dwgs-RevO\0263P3-7.dwg PLOTTED: Feb 28, 2014 - 1:52pm



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- GRAVELLY SAND
- CLAYEY SILT
- INITIAL GROUNDWATER ELEVATION (NOTE 6)
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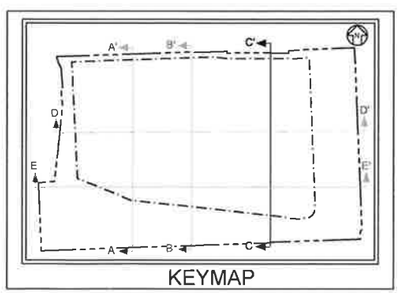

KEYMAP

PERMIT DRAWING

3/3/2014

STATE OF TEXAS
SCOTT M. GRAVES
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REV	DATE	DESCRIPTION	DRN	APP
1	MAR. 2014	REVISED, RESPONSE TO NOD 1	JJV/KH	SMG
-	AUG. 2013	INITIAL SUBMITTAL TO TCEQ	JJV	SMG

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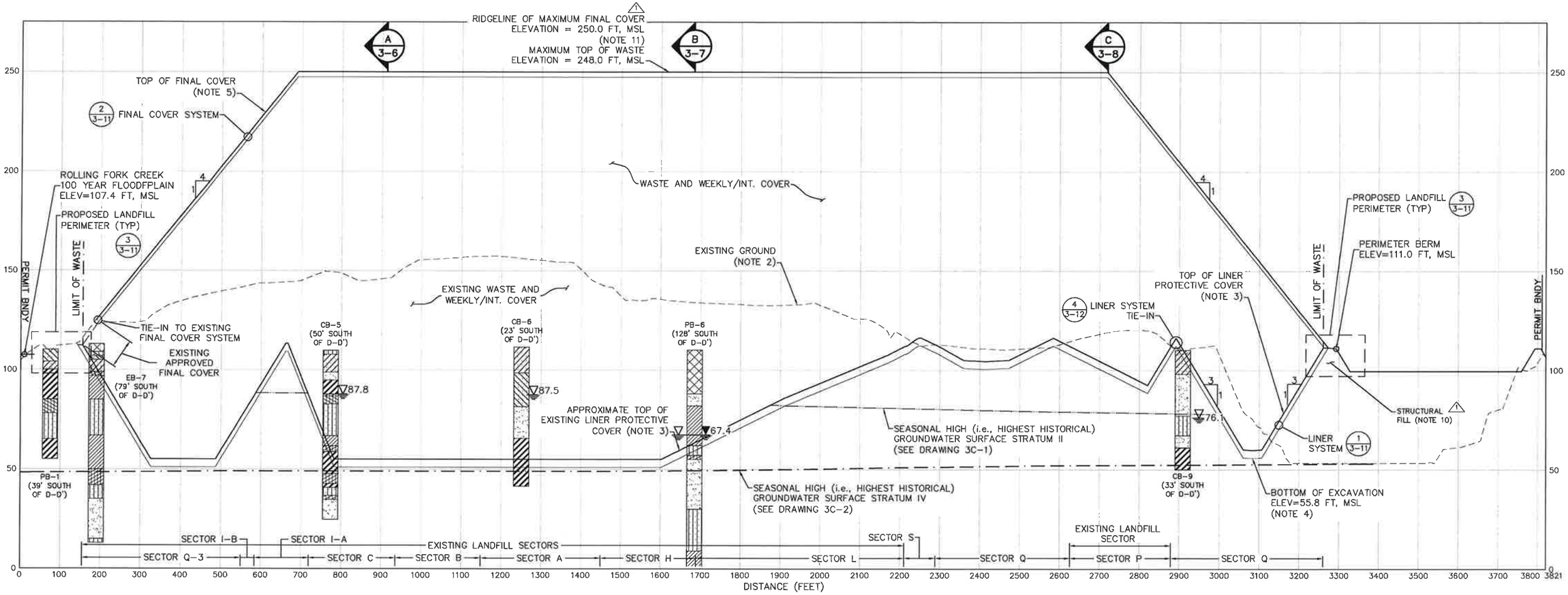
8217 SHOAL CREEK BLVD, SUITE 200
AUSTIN, TEXAS 78757
PHONE: 512.451.4003

TITLE: LANDFILL CROSS-SECTION C-C'

PROJECT: FAIRBANKS LANDFILL
PERMIT AMENDMENT APPLICATION – PERMIT NO. MSW-1565B

PROJECT NO.: TXL0263	DESIGN BY: SMG	REVIEWED BY: SMG	PART NO.: III	DRAWING: 3-8
FILE: 0263P3-8	DRAWN BY: JJV	APPROVED BY: SMG		

DRAWING: Austin P:\CAD\Projects\FV\Fairbanks Landfill\Permit\Expansion (TXL0263)\Drawings\Dwgs-Rev0\0263P3-8.dwg PLOTTED: Feb 28, 2014 - 1:33pm



0 130' 260'
HORIZONTAL SCALE IN FEET

VERTICAL SCALE IN FEET 0 26' 52'

NOTES:

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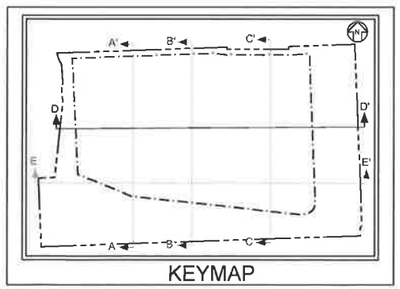

KEYMAP

PERMIT DRAWING

STATE OF TEXAS
SCOTT M. GRAVES
86557
LICENSED
PROFESSIONAL ENGINEER
3/3/2014

FOR PERMIT PURPOSES ONLY

1	MAR. 2014	REVISED, RESPONSE TO NOD 1	JJV/KH	SMG
–	AUG. 2013	INITIAL SUBMITTAL TO TCEQ	JJV	SMG
REV	DATE	DESCRIPTION	DRN	APP

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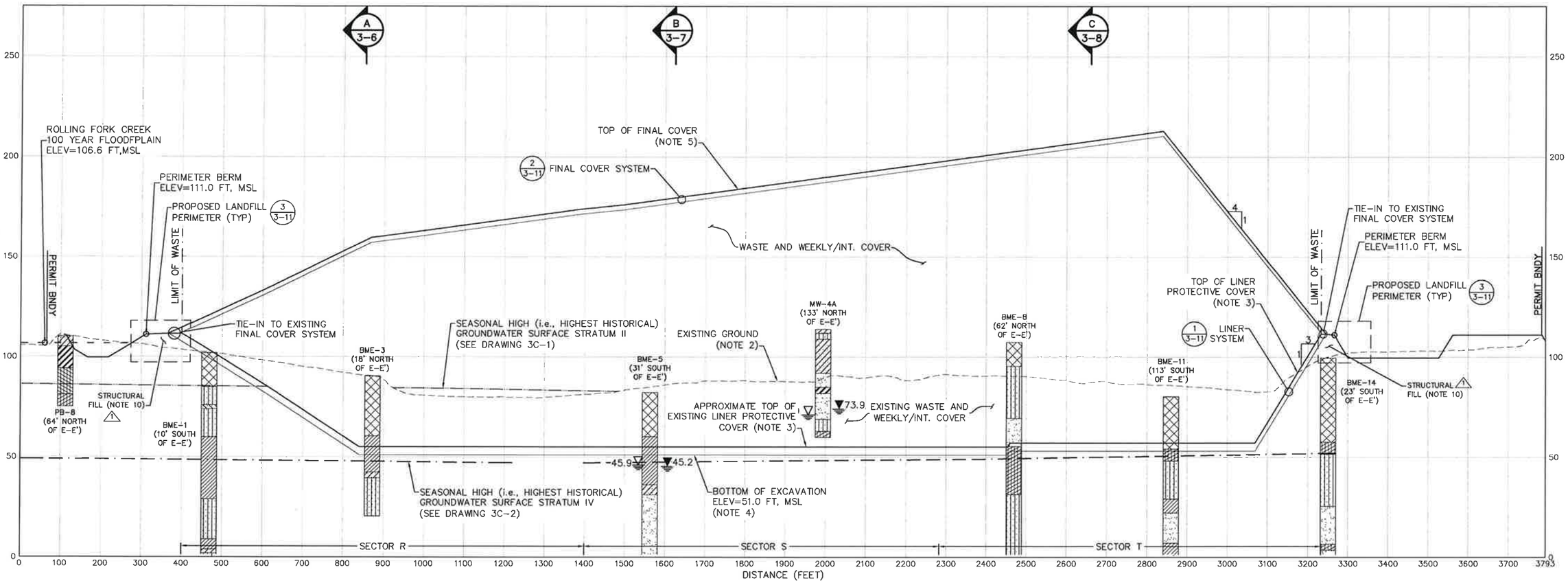
TEXAS ENG. FIRM REGISTRATION NO. 1182
8217 SHOAL CREEK BLVD, SUITE 200
AUSTIN, TEXAS 78757
PHONE: 512.451.4003

TITLE:
LANDFILL CROSS-SECTION D-D'

PROJECT:
FAIRBANKS LANDFILL
PERMIT AMENDMENT APPLICATION – PERMIT NO. MSW-1565B

PROJECT NO.: TXL0263	DESIGN BY: SMG	REVIEWED BY: SMG	PART NO.: III	DRAWING: 3-9
FILE: 0263P3-9	DRAWN BY: JJV	APPROVED BY: SMG		

DRAWING: Austin P:\CADD\Projects\FY\Fairbanks Landfill\Permit\Expansion (TXL0263)\Drawings\Dwgs-Rev0\0263P3-9.dwg PLOTTED: Feb 28, 2014 - 1:53pm



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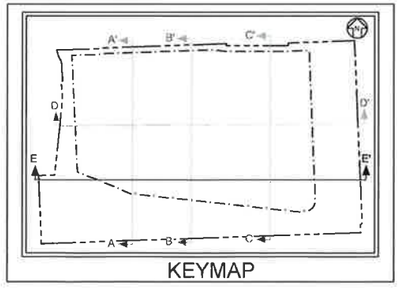

KEYMAP

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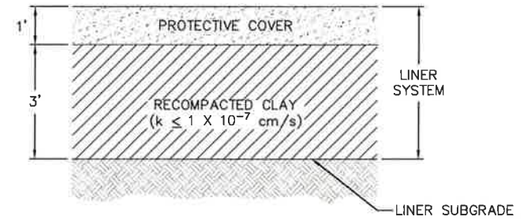
TITLE:
LANDFILL CROSS-SECTION E-E'

PROJECT:
FAIRBANKS LANDFILL
PERMIT AMENDMENT APPLICATION – PERMIT NO. MSW-1565B

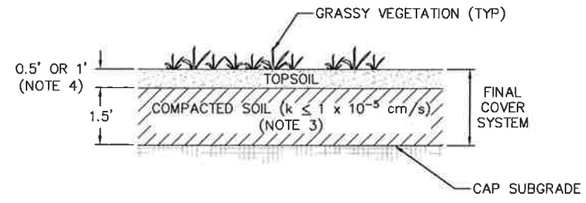
PROJECT NO.: TXL0263	DESIGN BY: SMG	REVIEWED BY: SMG	PART NO.: III	DRAWING: 3-10
FILE: 0263P3-10	DRAWN BY: JJV	APPROVED BY: SMG		

DRAWING: Austin P:\CADD\Projects\Fairbanks Landfill\Permit\Expansion (TXL0263)\Drawings\Dwgs-RevO\0263P3-10.dwg PLOTTED: Feb 28, 2014 - 1:54pm

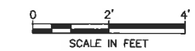


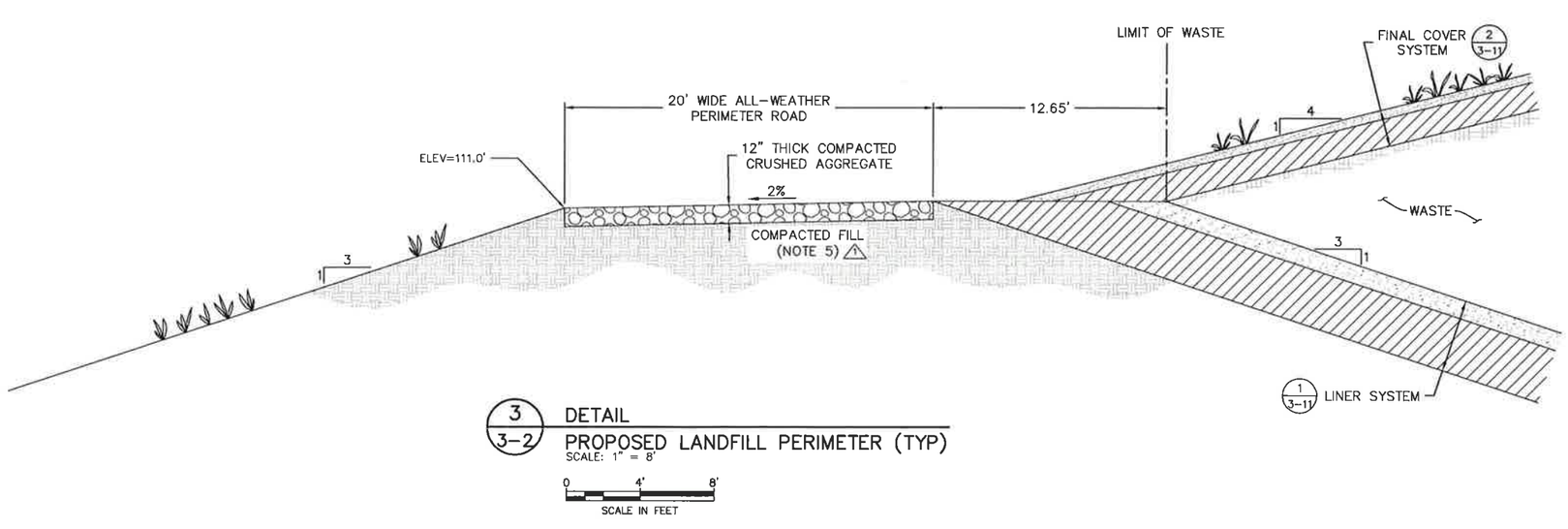
1 / 3-6 DETAIL
LINER SYSTEM
SCALE: 1" = 4'





2 / 3-6 DETAIL
FINAL COVER SYSTEM ⚠1
SCALE: 1" = 4'





3 / 3-2 DETAIL
PROPOSED LANDFILL PERIMETER (TYP)
SCALE: 1" = 8'

NOTES:

1. THE REQUIRED LINER SYSTEM MATERIAL PROPERTIES AND SPECIFICATIONS ARE GIVEN IN THE LINER QUALITY CONTROL PLAN (LQCP) IN ATTACHMENT 3C OF THE SITE DEVELOPMENT PLAN.
2. THE REQUIRED FINAL COVER SYSTEM MATERIAL PROPERTIES AND SPECIFICATIONS ARE GIVEN IN THE FINAL COVER QUALITY CONTROL PLAN (FCQCP) IN ATTACHMENT 7 OF THE SITE DEVELOPMENT PLAN.
3. THE COMPACTED SOIL LAYER SHALL BE CLAYEY SOIL CLASSIFIED BY THE UNIFIED SOILS CLASSIFICATION SYSTEM (USCS) AS "SC" (SANDY CLAY), "CL" (LEAN CLAY), OR "CH" (FAT CLAY).
4. IF THE COMPACTED SOIL LAYER IS CLASSIFIED AS "SL" OR "CL" MATERIAL, THE TOPSOIL SHALL BE 0.5' (MIN) THICK. IF THE COMPACTED SOIL LAYER IS CLASSIFIED AS "CH", THE TOPSOIL SHALL BE 1.0' (MIN) THICK.

⚠1
5. AREAS WHERE EXISTING GROUND ELEVATIONS ARE BELOW THE LINER SYSTEM SUBGRADE, OR BELOW FINISHED GRADE OF PERIMETER LANDFILL FEATURES (PERIMETER BERM/ROAD, STORMWATER CONVEYANCES, STORMWATER PONDS) SHALL BE FILLED WITH COMPACTED FILL SOIL, IN ACCORDANCE WITH SECTION 5 OF THE LINER QUALITY CONTROL PLAN (LQCP–ATTACHMENT 3C).

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LICENSED
PROFESSIONAL ENGINEER
3/3/2014

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REV	DATE	DESCRIPTION	DRN	APP
⚠1	MAR. 2014	REVISED, RESPONSE TO NOD 1	JJV/KH	SMG
–	AUG. 2013	INITIAL SUBMITTAL TO TCEQ	JJV	SMG

USA WASTE OF TEXAS LANDFILLS, INC.

LANDFILL SITE ADDRESS:
8205 FAIRBANKS N HOUSTON RD
HOUSTON, TEXAS 77064
PHONE: 713.824.6867

Geosyntec consultants
GEOSYNTEC CONSULTANTS, INC.
TEXAS ENG. FIRM REGISTRATION NO. 1182
8217 SHOAL CREEK BLVD, SUITE 200
AUSTIN, TEXAS 78757
PHONE: 512.451.4003

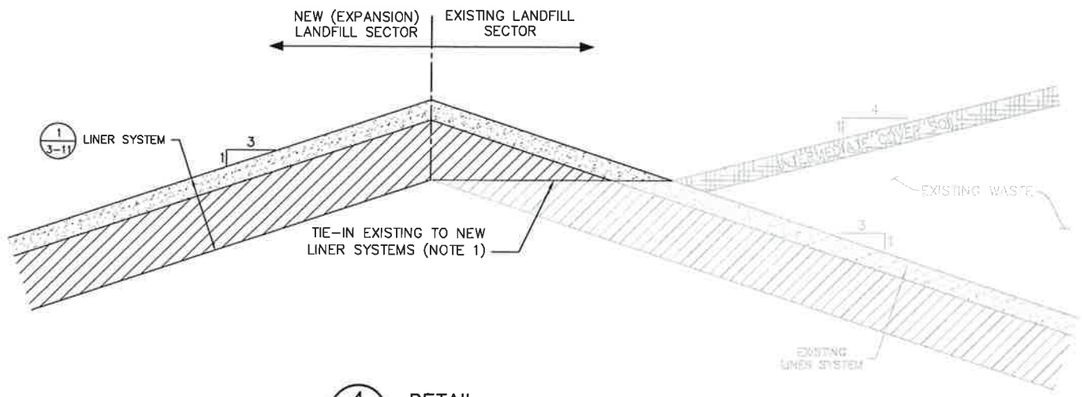
TITLE:
GENERAL LANDFILL CONSTRUCTION DESIGN DETAILS I

PROJECT:
FAIRBANKS LANDFILL
PERMIT AMENDMENT APPLICATION – PERMIT NO. MSW–1565B

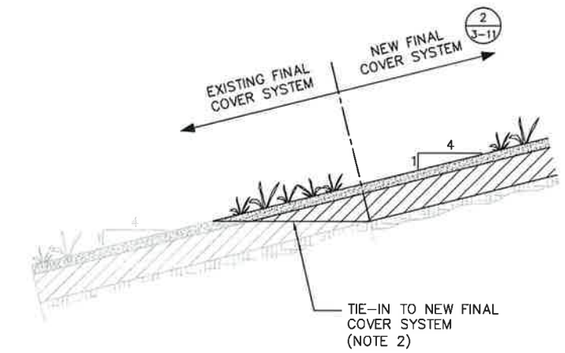
PROJECT NO.: TXL0263	DESIGN BY: SMG	REVIEWED BY: SMG	PART NO.: III	DRAWING: 3–11
FILE: 0263P3–11	DRAWN BY: JJV	APPROVED BY: SMG		

PERMIT DRAWING

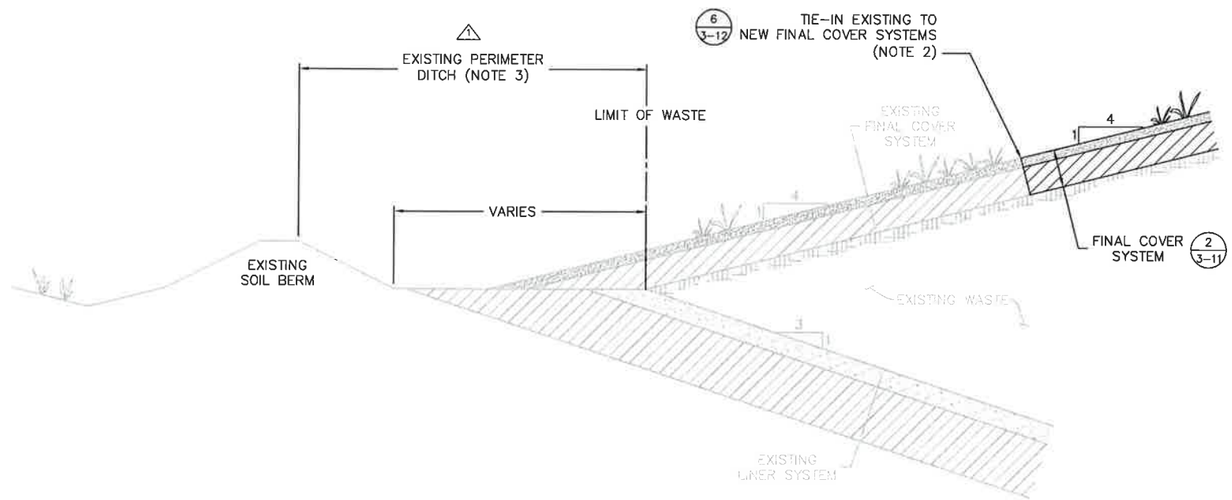
DRAWING: Austin P:\CADD\Projects\F\Fairbanks Landfill\Permit\Expansion (TXL0263)\Drawings\Dwgs-Rev0\0263P3-11.dwg PLOTTED: Feb 28, 2014 - 1:54pm



4 / 3-2 DETAIL
NEW LINER SYSTEM TIE-IN AT EXISTING LANDFILL SECTORS
SCALE: N.T.S.



⚠1 6 / 3-3 DETAIL
TIE-IN OF NEW FINAL COVER SYSTEM TO EXISTING FINAL COVER SYSTEM
SCALE: N.T.S.



5 / 3-2 DETAIL
EXISTING LANDFILL PERIMETER (TYP)
SCALE: N.T.S.

NOTES:

1. REFER TO THE LINER QUALITY CONTROL PLAN (LQCP) FOR LINER TIE-IN REQUIREMENTS.
2. REFER TO THE FINAL COVER QUALITY CONTROL PLAN (FCQCP) FOR FINAL COVER TIE-IN REQUIREMENTS.

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3/3/2014

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REV	DATE	DESCRIPTION	DRN	APP
⚠1	MAR. 2014	REVISED, RESPONSE TO NOD 1	JJV/KH	SMG
–	AUG. 2013	INITIAL SUBMITTAL TO TCEQ	JJV	SMG

USA WASTE OF TEXAS LANDFILLS, INC.

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TITLE:
GENERAL LANDFILL CONSTRUCTION DESIGN DETAILS II

PROJECT:
FAIRBANKS LANDFILL
PERMIT AMENDMENT APPLICATION – PERMIT NO. MSW-1565B

PROJECT NO.: TXL0263	DESIGN BY: SMG	REVIEWED BY: SMG	PART NO.: III	DRAWING: 3-12
FILE: 0263P3-12	DRAWN BY: JJV	APPROVED BY: SMG		

PERMIT DRAWING

DRAWING: Austin P:\CADD\Projects\TX\Fairbanks Landfill\Permit\Expansion (TXL0263)\Drawings\Dwgs-Rev0\0263P3-12.dwg PLOTTED: Feb 28, 2014 - 12:01pm

ATTACHMENT 3B

VOLUME AND SITE LIFE ESTIMATE

Written by: Y. Bholat Date: 12/3/2012 Reviewed & Revised by: S. Graves Date: 2/25/2014

Client: WM TX Project: Fairbanks Landfill Expansion Project No.: TXL0263 Phase No.: 05

VOLUME AND SITE LIFE ESTIMATE
FAIRBANKS LANDFILL



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

1 INTRODUCTION

The purpose of this calculation package is to estimate waste disposal volumes of the Fairbanks Landfill. The relevant volumes evaluated herein are as follows:

- the waste disposal volume (i.e. "airspace") gained by the expansion;
- the remaining airspace at the currently-permitted, and proposed expanded facility; and
- the total maximum volume of waste at the facility.

Additionally, the life of the site is estimated herein based on the calculated remaining airspace, the in-place density of waste, and the projected rate of waste acceptance over time.

2 LANDFILL VOLUMES

2.1 Method

In general, the waste volume at the landfill is defined as the volume available for the deposition of waste, intermediate cover, and weekly cover. Overall, this is represented as the volume between the three-dimensional (3-D) surface of the top of protective cover component of the liner system and the 3-D surface of the bottom of the final cover system. However, to obtain the other relevant volumes identified above, it was also necessary to

Table 1
LANDFILL VOLUME CALCULATION SUMMARY

Waste Disposal Volume Gained by Expansion (Permit MSW-1565B)		
(A)	Top of Protective Cover (in new areas) and Existing Ground (in existing areas) vs. Top of Final Cover (AutoCAD computation)	18,326,500 cubic yards
(B)	3-D Area of Overall Final Cover (AutoCAD computation)	661,200 square yards
(C)	Volume of Final Cover (using two feet thick final cover)	440,800 cubic yards
(D)	Airspace Added Due to Expansion: **(A)** – **(C)** [rounded to nearest 1000]	17,886,000 cubic yards
Remaining Airspace of Existing Landfill (Permit MSW-1565A)		
(E)	Top of Existing Ground to Top of Final Cover in Areas Not Yet Final Capped (AutoCAD computation)	279,500 cubic yards
(F)	3-D Area of Existing Landfill Not Yet Final Capped (AutoCAD computation)	272,400 square yards
(G)	Volume of Final Cover of Existing Landfill (using two feet thick final cover):	181,600 cubic yards
(H)	Remaining Airspace of Existing Landfill: **(E)** – **(G)** [rounded to nearest 1000]	98,000 cubic yards
Remaining Airspace (Permit MSW-1565B): Existing Landfill + Proposed Expansion		
(I)	Net Capacity of Landfill (Existing + Expansion): **(D)** + **(H)**	17,984,000 cubic yards
Maximum Volume of Waste at the Facility		
(J)	Current-Permitted (MSW-1565A) Volume	8,326,000 cubic yards
(D)	Airspace Added Due to Expansion	17,886,000 cubic yard
(K)	Maximum Volume of Waste: **(J)** + **(D)**	26,212,000 cubic yards

3 SITE LIFE CALCULATIONS

A detailed discussion of the waste acceptance rate, and rationale for the assumed growth rate over time, is discussed in Part II, Section 2.2 of the Permit Amendment Application. In summary, it is assumed that waste receipts will increase from 275,000 tons per year to 425,000 tons per year over the first five years. Beyond the fifth year, a 2.17% linear (non-compounded) growth rate was assumed.

To calculate the site life, the annual waste receipt at the gate (in tons) is converted to the airspace consumed (in cubic yards) by dividing by the assumed in-place density (tons per cubic yard). The in-place density was assumed to be 0.75 tons per cubic yard, a value consistent with site-specific data for the Fairbanks facility as listed in TCEQ's annual summary for MSW for fiscal year 2012, as well as consistent with values commonly used in industry practice. Then, starting with the calculated remaining airspace (existing landfill

+ proposed expansion) presented in Table 1, the calculated airspace consumed on a year by year basis is applied to the remaining airspace, until the volume is depleted. These calculations are presented below in Table 2. As shown, the site life is calculated to be essentially depleted at the end of Year 27.

Table 2
SITE LIFE CALCULATIONS

Year Number	Assumed Calendar Year	Waste Receipts at Gate	Average Daily Tonnage (using 284 normal working days/yr)	Airspace Consumed	Total Airspace Remaining at End of Year
		tons	tons/day	cubic yards	cubic yards
1	2014	275,000	968	366,667	17,617,333
2	2015	325,000	1,144	433,333	17,184,000
3	2016	375,000	1,320	500,000	16,684,000
4	2017	400,000	1,408	533,333	16,150,667
5	2018	425,000	1,496	566,667	15,584,000
6	2019	434,223	1,529	578,963	15,005,037
7	2020	443,445	1,561	591,260	14,413,777
8	2021	452,668	1,594	603,557	13,810,220
9	2022	461,890	1,626	615,853	13,194,367
10	2023	471,113	1,659	628,150	12,566,217
11	2024	480,335	1,691	640,447	11,925,770
12	2025	489,558	1,724	652,743	11,273,027
13	2026	498,780	1,756	665,040	10,607,987
14	2027	508,003	1,789	677,337	9,930,650
15	2028	517,225	1,821	689,633	9,241,017
16	2029	526,448	1,854	701,930	8,539,087
17	2030	535,670	1,886	714,227	7,824,860
18	2031	544,893	1,919	726,523	7,098,337
19	2032	554,115	1,951	738,820	6,359,517
20	2033	563,338	1,984	751,117	5,608,400
21	2034	572,560	2,016	763,413	4,844,987
22	2035	581,783	2,049	775,710	4,069,277
23	2036	591,005	2,081	788,007	3,281,270
24	2037	600,228	2,113	800,303	2,480,967
25	2038	609,450	2,146	812,600	1,668,367
26	2039	618,673	2,178	824,897	843,470
27	2040	627,895	2,211	837,193	6,277
28	2041	637,118	2,243	Landfill capacity essentially depleted at end of Year 27.	

Prepared for:
USA Waste of Texas Landfills, Inc.

PERMIT AMENDMENT APPLICATION

PART III – SITE DEVELOPMENT PLAN
SUB-ATTACHMENT 3C

LINER QUALITY CONTROL PLAN

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

Prepared by:

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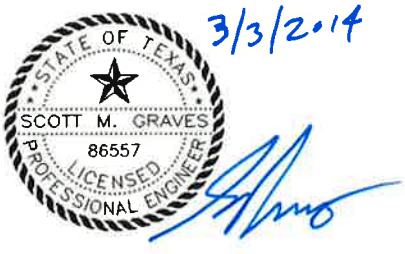
(512) 451-4003



3/3/2014

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Submitted August 2013
Revised March 2014

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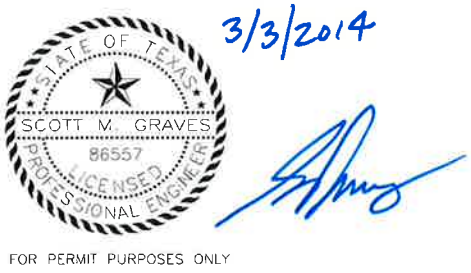
FIGURE

Figure 3C-1 Procedure for Developing Alternate Acceptable Permeability Zone (APZ)

APPENDICES

Appendix 3C-1 Seasonal High Groundwater Elevation Information
Appendix 3C-2 Sector Layout Plan



1. INTRODUCTION

1.1 Purpose

This Liner Quality Control Plan (LQCP) for the Fairbanks Landfill was prepared to meet the requirements of 30 TAC §330.63(d)(4)(G) and 30 TAC §330.339. The LQCP establishes the material requirements; construction installation requirements; quality control program; and quality assurance monitoring, testing, documentation, and reporting procedures that shall be used during construction of the soils for the liner system at the Fairbanks Landfill (the facility), and related compacted fill soil construction of the perimeter berm/road that will form the sidewall for the liner. This LQCP shall be followed during construction of the disposal units to verify that the liner system is constructed in accordance with the site-specific permitted design and with the applicable state regulations for liners and ground-water protection.

A copy of the current version of this LQCP must be maintained on site at all times. The LQCP shall also be made available to facility employees, construction personnel, and testing personnel at the outset of each liner system project, and at any time upon request by Texas Commission on Environmental Quality's (TCEQ's) inspectors. Revisions to this LQCP shall receive written approval from TCEQ before implementation.

1.2 Liner System Cross Section

The proposed liner system for the facility is shown on an engineering detail on Drawing 3-11 in Attachment 3A (Landfill Design Drawings) of this permit amendment application, and is described as follows (from bottom to top):

- 3-foot thick recompacted clay liner having a coefficient of permeability no greater than 1×10^{-7} cm/sec (i.e., $k \leq 1 \times 10^{-7}$ cm/sec); and
- 1-ft thick protective cover layer.

The existing landfill sectors have already been constructed and approved with either the above type of liner system with recompacted clay, or for older sectors, 3-ft (min) of in-situ liner meeting the above permeability requirement on base (floor) areas. More specifically, the initial permit (1565) allowed the option of use in-situ material as the low permeability liner component, while Permit 1565A specified only the use of recompacted clay liner (floor and sidewalls). In all cases, the sidewall liner type was 3-ft thick recompacted clay for every sector. A sector layout plan, identifying the sector designations, locations, and dates of their Soil and Liner Evaluation

Reports (SLERs) as of March 2014 (the date of this revised LQCP submittal), is provided in Appendix 3C-2 of this LQCP. A review of available SLER information has revealed that Sectors A through H (all of which were developed as part of Permit 1565) were constructed using in-situ liner on the floor areas and recompacted soil liner on the sidewalls. The available SLER information suggests that the remaining sectors were constructed using recompacted clay liner on both the floors and the sidewalls. Since all of the sectors developed to-date have sidewall liner composed of 3-ft thick (min) recompacted clay liner, this information will help clarify the tie-in of new liner to existing liner.

1.3 Definitions of Quality Assurance and Quality Control

In the context of this document, it is important to distinguish between construction quality assurance and construction quality control. These terms are defined as follows:

- Construction Quality Assurance (CQA) refers to means and actions employed by the CQA personnel to assure conformity of liner system construction with the requirements of the permitted design, as shown on project-specific Construction Documents including this LQCP. CQA is provided by a third-party consultant who is independent from production and installation (i.e., independent of the Contractor and any other material suppliers).

- Construction Quality Control (CQC) refers to those actions taken by the Contractor to ensure that the materials and the workmanship meet the requirements of the permitted design, as shown on project-specific Construction Documents including this LQCP.

1.4 Contractor Responsibilities

In this document, the term Contractor refers to those parties who are constructing and installing the liner system components. It is the responsibility of the Contractor to provide materials meeting the physical specifications provided herein, to construct the liner system in accordance with the installation specifications provided herein, and to follow at least the minimum QC requirements set forth in this document.

1.5 CQA Personnel Roles and Responsibilities

1.5.1 CQA Professional of Record (POR)

Each phase of the liner system installation evaluation shall be conducted by the CQA POR (hereafter referred to simply as "POR") or by a qualified representative (described subsequently)

under the direct supervision of the POR. It is the responsibility of the POR to oversee implementation of the LQCP during construction of the disposal units to verify that the liner system (materials, construction activities, and QA/QC activities) is constructed in accordance with the site-specific permitted design and with the applicable state regulations for liners and ground-water protection. The POR shall be an independent third-party professional engineer (P.E.) registered in Texas and experienced in geotechnical engineering and soils testing. In addition, the POR must also be familiar with the use of soils for landfill construction and with the applicable regulatory requirements.

1.5.2 CQA Technician

A properly qualified CQA Technician may work under the direct supervision of the POR to monitor, test, and document the liner system construction. As such, the CQA Technician's responsibility is to serve as a field representative of the POR, to monitor, test, and document that the liner system is constructed in accordance with the requirements of this LQCP and as further directed and overseen by the POR. The CQA Technician shall have one of the following minimum levels of experience: (i) a minimum of two years of directly related landfill construction experience (or experience with similar low permeability compacted soil layers used in other containment applications); or (ii) for an engineer or geologist with a bachelor of science degree, a minimum of six months of directly related experience. If there is more than one CQA Technician on-site at the same time on a project, a Lead CQA Technician shall be designated, who shall meet the above CQA Technician requirements.

Note – the above CQA Technician experience requirement intentionally excludes references to National Institute for Certification in Engineering Technologies (NICET) certification. A previously-published TCEQ guidance document known as the "1994 Liner Construction and Testing Handbook" (currently out-of-print), suggested the technician should have NICET Level 2 certification in soils testing. NICET Level 2 for soils construction requires two years of experience and passing a written examination, but this examination is not specific to landfills or construction of low permeability soil layers. As a suitable alternative since NICET is no longer the landfill industry standard, this LQCP requires a minimum of two years of landfill construction experience or equivalent for a non-graduate engineer or geologist level, instead of the two years of general soils experience plus examination required by NICET for Level 2.

1.6 Construction Timing and Full-Time CQA

Liner system components shall be constructed in a systematic and timely manner. Once construction is started, delays should be avoided unless adverse weather conditions prevent

construction progress. Work areas for liner construction should be selected, sized, and sequenced so that each day's work can be protected from adverse weather conditions. Furthermore, the selection of size and shape of work areas shall be consistent, so that uniform construction/installation techniques and equipment can be selected.

Full-time CQA shall be provided during construction and installation of the liner system by the POR or his/her qualified representative(s) serving as CQA Technicians as described above. In the remainder of this document, the term "CQA personnel" refers collectively to either the POR or the CQA Technician(s) working on-site under direct supervision of the POR.

2. RECOMPACTED CLAY LINER

2.1 Introduction

This section addresses the specifications and CQA requirements for the proposed recompacted clay liner.

2.2 Recompacted Clay Liner Specifications

2.2.1 Recompacted Clay Liner Material Requirements

Material requirements for the physical properties of the recompacted clay liner are presented in Table 3C-1.

2.2.2 Recompacted Clay Liner Moisture-Density Target Compaction Requirements

Each lift of the recompacted clay liner shall be compacted to within the required range of moisture content and density defined by the pre-construction CQA testing program as described subsequently in Section 2.3 of this LQCP. The pre-construction CQA testing program will establish the target compaction criteria (i.e., Acceptable Permeability Zone (APZ)) for construction of the recompacted clay liner. The APZ, developed in the laboratory, represents a range of moisture contents and dry unit weights that yields the required hydraulic conductivity for the anticipated range of compactive efforts (representative of compaction equipment type) to be used during construction. The APZ shall be further defined by the following minimum standards for target compaction:

- For lifts compacted with "light" compaction equipment (representative of CAT 815 compactor or equivalent), the lifts shall be compacted to at least 95% of the standard Proctor maximum dry density and a corresponding standard Proctor moisture content between 0% to 5% wet of the optimum moisture content, as determined by standard Proctor test results (ASTM D 698) conducted on similar representative material during the pre-construction testing program.

- For lifts compacted with "heavy" compaction equipment (representative of CAT 825 compactor or equivalent), the lifts shall be compacted to at least 90% of the modified Proctor maximum dry density and a corresponding modified Proctor moisture content between 1% dry to 3% wet of the optimum moisture content, as determined by modified Proctor test results (ASTM D 1557) conducted on similar representative material during the pre-construction testing program.

The above criteria shall be used, unless the APZ developed from the pre-construction hydraulic conductivity tests revealed the need for requiring higher densities or moisture contents, in which case the higher density and moisture values will be used as field compaction minimums.

2.2.3 Recompacted Clay Liner Construction Requirements

2.2.3.1 Subgrade Preparation

A. The recompacted clay liner subgrade (i.e., surface on which the recompacted clay liner will be constructed) shall be graded to be relatively smooth, uniform, with positive drainage, and within general accordance of the lines and grades shown on the drawings. The subgrade shall be free of debris, organic matter (i.e., roots, vegetation), standing water, or excessive moisture.

B. For areas requiring fill to achieve the subgrade elevations for the recompacted clay liner, the fill shall meet the material, construction, and quality assurance/quality control requirements of Section 5 of this LQCP.

C. For areas requiring cut to achieve the subgrade elevations for the recompacted clay liner, once design elevations are reached the subgrade surface shall be proof-rolled and observed by CQA personnel for evidence that the surface provides support to adequately place and compact subsequent lifts of the overlying recompacted clay liner (e.g., lack of excessive pumping, rutting, deflection of subgrade surface, etc.).

D. Soft, excessively wet, or otherwise deleterious subgrade areas as identified by CQA personnel shall be removed (over-excavated) and replaced with compacted fill meeting the material and compaction requirements described above, to achieve the design elevations and to provide key-in to sufficient foundation support to adequately place and compact subsequent overlying lifts of the recompacted clay liner. The extent of over-excavation shall be identified by CQA personnel so that the affected area provides a firm foundation and ties in to surrounding areas with acceptable proof-roll results or properly placed compacted fill.

2.2.3.2 Groundwater and Standing Water Considerations

A. A groundwater dewatering system shall be installed beneath the recompacted clay liner along portions of the side slopes of the facility to provide protection against potential liner uplift by groundwater, as detailed in Section 4.6 of this LQCP. In addition, in all circumstances if groundwater is observed that could exhibit a hydrostatic uplift force on the liner, appropriate measures as discussed in Section 4.6 of this LQCP shall be employed.

B. Recompacted clay liner construction shall not take place in standing (ponded) water.

C. Completed recompacted clay liner areas, both during ongoing construction and after submittal of the Soil Liner Evaluation Report (SLER), shall have sufficient surface-water drainage controls to prevent the accumulation of water. Any ponded water that accumulates on newly constructed recompacted clay liner surfaces shall be promptly removed.

2.2.3.3 Placement and Compaction

A. Scarification. Prior to placing a lift, the existing surface (i.e., top of subgrade or previous lifts) shall be scarified by tracking with a dozer, making a pass with the compactor, or similar as approved by the POR to promote bonding between the top of subgrade and the first lift, and between adjacent lifts.

B. Lift Thickness. Recompacted clay liner material shall be placed in loose lifts of uniform thickness generally not exceeding 8-inches thickness after spreading and leveling, resulting in a compacted thickness of approximately 6-inches thick. In all cases, the loose lift thickness must not be greater than the pad/prong length of the compactor to promote bonding between lifts, reduce individual clods, and help blend and knead the soil matrix.

C. Soil Processing. Recompacted clay liner material shall be processed as needed either in-place on the loose lift, or in a separate processing area, to yield a relatively uniform soil matrix devoid of large clods or macrostructural features that may contribute to excessively high hydraulic conductivity. Clod size in the recompacted soil liner should not exceed approximately 1-inch diameter, and in all cases shall be reduced to the smallest size necessary to achieve acceptable hydraulic conductivity during the pre-construction CQA laboratory testing. Processing may be achieved by disking, grading, compacting, or pulverizing.

D. Moisture Conditioning. Moisture conditioning (either adding water to the soil or drying the soil) of the recompacted clay liner shall be performed as needed to adjust the in-place moisture content to within the specified APZ. If water addition is required, the water shall be as uniformly distributed over the lift using water trucks with pressure-spray capabilities or similar. Proper hydration time, as evaluated by CQA personnel, shall be allowed so the added water blends and mixes with the soil. Care shall be taken to prevent over-watering and ponding of water within the loose lift, as this excess water is difficult to redistribute. If drying is necessary, it shall be accomplished by disking or similar techniques to lower the moisture content to the required range in a relatively uniform and controlled manner.

E. Moisture Content and Density. Each lift of compacted soil liner shall be compacted to meet the required range of moisture contents and densities as described in Section 2.2.2.

F. Equipment. Compaction equipment shall meet the following requirements:

1) Must have either pad/tamping-foot rollers or prong-feet (sheepsfoot) rollers.

2) Must have operating weight and characteristics capable of kneading and compacting the soil to within the specified APZ (range of allowable moistures and densities). Use of bulldozers, pneumatic rollers, rubber-tired equipment, or flat-wheel rollers as the compaction equipment is not allowed.

G. Equipment Passes. Generally, compaction equipment should pass across a lift at least six times, regardless of equipment size and compaction performance to help ensure adequate remolding and lift bonding of each soil lift. However, the number of equipment passes to achieve the desired results may vary depending on the liner material and the field CQA test results.

H. Non-Conforming Tests. Should the CQA field tests (described subsequently in this LQCP) indicate that the moisture content or density of any layer of compacted soil liner material, or portion thereof, is not within the APZ, the representative portions of that particular layer shall be reworked and retested.

2.2.3.4 Recompacted Clay Liner Tie In

A. Tie in of a new section of recompacted clay liner to an old section of recompacted clay liner shall be accomplished by either: (i) stair-step method; or (ii) slope method.

1) For the stair-step method, the old recompacted clay liner shall be cut back at least 2.5-feet on 6-inch thick offset layers and the surface scarified so that the edge of each lift of the existing liner is tied in to new construction without superimposed construction joints.

2) For the slope method, the old section of recompacted clay liner shall be cut back at a 5H:1V (horizontal:vertical) slope and the surface scarified, so that the edge of the existing liner is tied in to new construction without superimposed construction joints.

2.2.3.5 Sideslope Construction Considerations

A. The side slopes at this site are proposed to be 3H:1V.

B. The recompacted clay liner on the side slopes may be constructed using either lifts parallel to the slope or horizontal lifts placed against the slope. However, the proposed 3H:1V side

slopes can be readily constructed using parallel lifts, which is the typical construction method for the landfill industry.

C. Requirements for Parallel Lift Side Slope Construction. The construction specifications, practices, and CQA requirements presented in this LQCP are fully applicable to side slopes constructed in lifts parallel to the slope. In addition, the following sides lope considerations shall apply:

    1) For parallel lift construction, compaction equipment shall run up and down the slope.

    2) Visual observation shall be made by construction and CQA personnel to verify that the eccentric weight of the equipment (with its tendency to slide down the slope) does not cause shearing of the upper portion of the lift.

    3) If the equipment tends to slide down the slope and adequate compaction cannot be achieved using parallel lifts on side slopes, horizontal lifts shall be employed.

D. Requirements for Horizontal Lift Side Slope Construction. Because horizontal lift construction is not anticipated for future liner system construction at this site, has not been necessary previously at this site, and is not a common landfill construction practice, requirements for horizontal lifts are not presented in this LQCP.

2.2.3.6 Top of Recompacted Clay Liner Preparation and Maintenance

A. The top surface of the recompacted clay liner shall be relatively smooth and uniform and free of irregularities, dimples, loose soil, or abrupt changes in grade.

B. The top surface of the recompacted clay liner shall not exhibit excessive desiccation prior to placement of the overlying protective cover layer and shall be maintained (e.g., kept moist) as needed to prevent formation of excessive desiccation cracks.

C. The surface of the recompacted clay liner shall also be kept free of standing water from rainfall events. Damage caused by precipitation shall be repaired, and if the lift must be reworked as determined by CQA personnel, then appropriate retesting of the lift shall be performed.

2.3 Recompacted Clay Liner CQA

2.3.1 General

This section of the LQCP addresses the CQA program to be implemented with regard to the recompacted clay liner component of the liner system. The following CQA activities are discussed in the remainder of this section:

- Pre-Construction Evaluation of Material Sources;
- Material Conformance Testing During Construction;
- Field Evaluation/Monitoring During Construction;
- Field Testing of Work Product;
- Deficiencies, Problems, and Repairs;
- Thickness Verification; and
- Recompacted Clay Liner Documentation.

2.3.2 Pre-Construction Evaluation of Material Sources

2.3.2.1 Sampling and Testing

Prior to construction of the recompacted clay liner, CQA personnel shall obtain a soil sample from the proposed source(s). Each source shall be evaluated for potential use as recompacted clay liner by performing the pre-construction laboratory tests presented in Table 3C-2.

2.3.2.2 Acceptable Permeability Zone (APZ) Procedure

The POR shall use the results of the pre-construction testing program to develop target compaction criteria (i.e., Acceptable Permeability Zone (APZ)) for construction of the recompacted clay liner. The APZ, developed in the laboratory, represents a range of moisture (i.e., water) contents and dry unit weights that yields the desired hydraulic conductivity for the anticipated range of compactive efforts used during construction.

Standard Approach. Pre-construction hydraulic conductivity samples shall be remolded to the moisture and density conditions set forth in Table 3C-2. These points should represent

reasonable "worst case" conditions for hydraulic conductivity results on appropriately compacted soils. Thus, if the results pass, the largest possible APZ is then defined to be the range of moisture contents and dry densities that are wetter and denser than the pre-construction test. If higher moisture contents or dry densities are used for the hydraulic conductivity tests, then the higher values will be used for field control during placement. However, if lower moisture or density values are used and confirmed to achieve acceptable hydraulic conductivities, the APZ shall still be based on the minimum compaction requirements in Section 2.2.2.

Alternate Approach. If requested by the Owner to further define a more detailed APZ, or if deemed necessary by the POR based on material variability or equipment variability, an alternate approach may be used to develop the APZ. This alternate approach provides a rational method for accepting or disapproving compaction results when more than one type of compactor or compaction effort is used or when variations in Proctor relationships make choosing the most appropriate curve difficult. The acceptable moisture-density range shall be determined by the POR using the steps described below, which have been developed in general accordance with the following reference:

Daniel, D.E. and Koerner, R.M., *Waste Containment Facilities: Guidance for Construction Quality Assurance and Quality Control of Liner and Cover Systems*, ASCE, New York, 1995.

The procedures for developing the Alternate APZ are as follows:

- Step 1) Prepare and compact soil in the laboratory over a range of moisture contents with modified Proctor (ASTM D 1557) and standard Proctor (ASTM D 698) procedures. Several specimens should be compacted at each compactive effort. Plot the resulting moisture-density relationships (i.e., "compaction curves"), as shown on attached Figure 3C-1(A).

- Step 2) Permeate each specimen in accordance with ASTM D 5084. Plot the measured hydraulic conductivity results as a function of molding moisture content, as shown on attached Figure 3C-1(B).

- Step 3) Replot the compaction curves using different symbols for specimens that had hydraulic conductivities greater than the maximum acceptable value and specimens with hydraulic conductivities less than or equal to the maximum acceptable value, as shown on attached Figure 3C-1(C). The APZ should then be drawn to encompass the data points representing the test results meeting or exceeding the design criteria given in the

specifications. Some judgment is usually necessary at this point to develop the APZ from the data points.

- Step 4) Modify the APZ developed in Step 3 based on other considerations such as strength requirements. For example, the APZ developed in Step 3 may be reduced by considering a minimum standard Proctor dry density, as shown in attached Figure 3C-1(D). Modifications for other factors should only be made that reduce the size of the APZ.

The moisture-density curve that shows the APZ should also include the zero air voids line.

2.3.2.3 Use of Results

The APZ is borrow-source soil specific. Thus, the APZ may be used from project-to-project when the same borrow source is used and when the borrow soil properties remain consistent with those used to develop the APZ. In some cases, soils in the borrow source may be variable. If the soils can be distinguished in the borrow source or at the construction area, separate APZs can be developed and applied in the field by CQA personnel. If the soils are not easily distinguishable, a composite APZ can be developed by overlaying the APZs.

2.3.3 Material Conformance Testing During Construction

When soil from the borrow/stockpile area is easily distinguished and consistent with the soil characterized during pre-construction testing, additional ongoing laboratory conformance testing beyond the initial pre-construction tests is not required. Any time the LL or PI changes by more than 10 points, or if the soil liner material being used becomes variable, or soils vary or appears inappropriate or questionable compared to the results from the initial pre-construction test program, additional material conformance testing of the tests and methods outlined in Table 3C-2 should be performed at a frequency of one series of tests per 20,000 cubic yards of recompacted clay liner material or until a consistent soil type is easily distinguished.

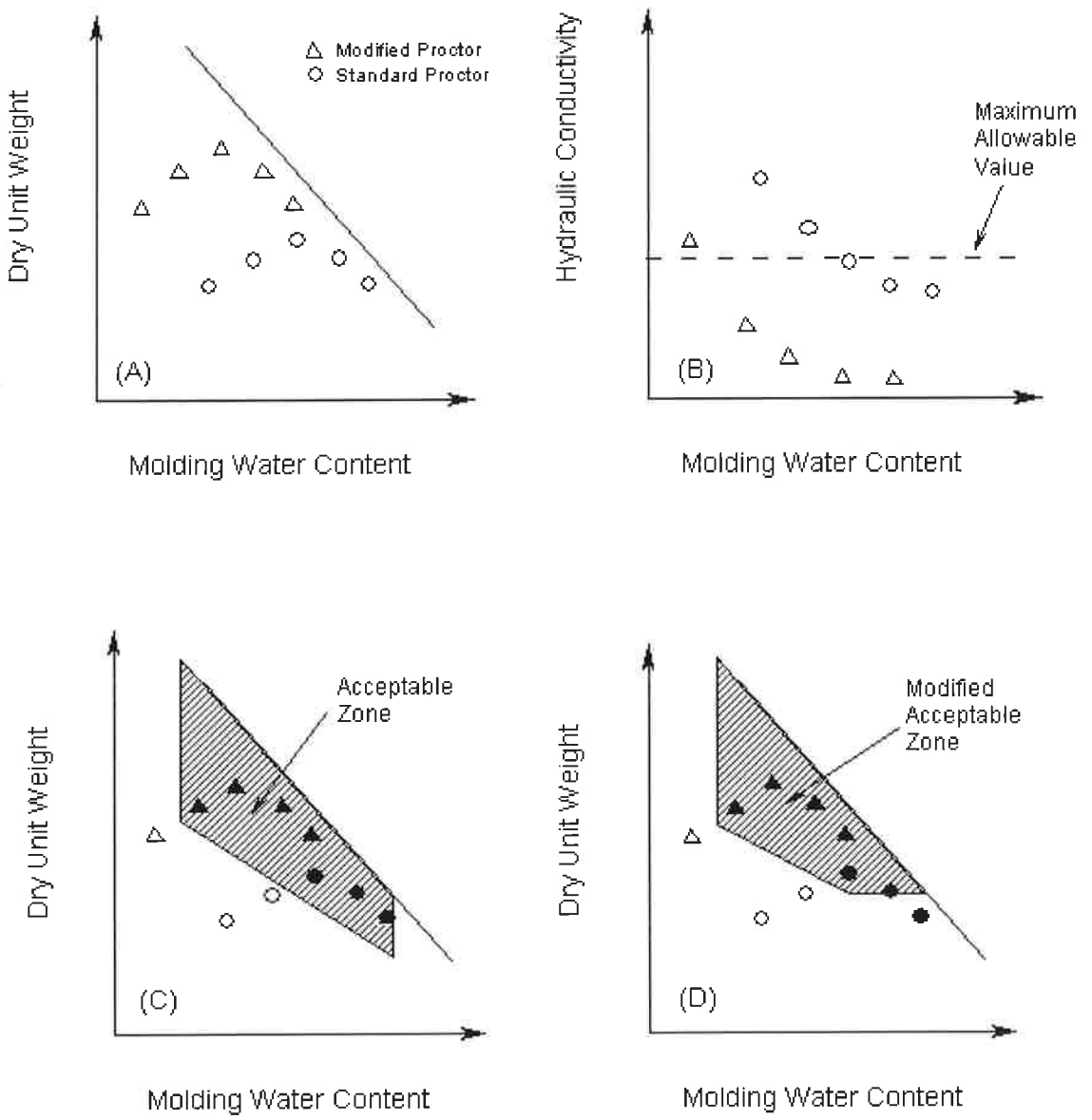


Figure 3C-1. Procedure for Developing Alternate Acceptable Permeability Zone (APZ) (adapted from Daniel and Koerner [1995]).

2.3.4 Field Evaluation/Monitoring During Construction

CQA personnel will be on-site at all times when recompacted clay liner construction is ongoing, so that all relevant activities can be observed and documented. The POR will visit the site

periodically as construction progress warrants. Such visits will be frequent enough so that the POR is fully knowledgeable of the construction methods and performance, so that the POR can determine that quality control monitoring and testing activities are adequate to meet the terms and intent of this LQCP. CQA personnel shall visually monitor and document that construction of the recompacted clay layer is in accordance with the specifications and requirements set forth previously in this LQCP. These observations shall include, but not be limited to, monitoring of:

- moisture content and distribution, particle size, and other physical properties of the soil during processing, placement, and compaction;
- type and level of compactive effort, including roller type and weight, drum size and foot length, and number of passes;
- action of compaction equipment on soil surface (i.e. foot penetration, rolling, pumping, or shearing);
- maximum clod size and breakdown of soil structure;
- method of bonding lifts together and making liner tie ins;
- stones or other inclusions which may damage adversely affect compaction, lift bonding, and in-place testing/sampling; and
- areas where damage due to excess moisture, insufficient moisture, or freezing may have occurred.

2.3.5 Field Testing of Work Product

2.3.5.1 Routine Field Testing

Field testing (e.g., density and moisture content testing and undisturbed tube sampling) of placed/recompacted clay liner materials will be performed by CQA personnel during construction to evaluate the Contractor's work product with respect to the requirements of the specifications as set forth in this LQCP. The test methods and frequencies for routine CQA field testing of the recompacted clay liner are given in Table 3C-3. Sampling and test locations shall be selected by CQA personnel.

2.3.5.2 Special Testing

A special testing frequency shall be implemented at the discretion of CQA personnel when observations indicate potential problems, or as requested by the Owner. Additional testing for suspected areas shall be considered when:

- the compactor rollers slip during rolling operations;
- the lift thickness is greater than specified;
- the material is at improper and/or highly variable moisture content;
- fewer than the anticipated number of roller passes are made;
- dirt-clogged rollers are used to compact the material;
- the fill materials differ substantially from those specified; or
- the degree of compaction is doubtful.

During construction, the frequency of testing may also be increased in the following situations:

- adverse weather conditions;
- breakdown of equipment;
- at the start and finish of grading;
- if the material fails to meet specification requirements;
- the work area is reduced; or
- as otherwise requested by the Owner.

2.3.5.3 Perforations

Perforations are holes in the recompacted clay liner that must be filled, and may include, but are limited to, the following:

- nuclear density test probe locations;
- undisturbed hydraulic conductivity test tube locations; and
- sand cone test locations or other density verification test methods.

All perforations in the recompacted clay liner created during any sampling or testing shall be backfilled using a mixture of at least 20% bentonite mixed with clay liner material and compacted in place with a tamping rod, or using an appropriate bentonite grout.

2.3.5.4 Placement of Overlying Soil Layers

All testing and evaluation of the recompacted clay liner shall be complete prior to installing the overlying protective cover layer.

2.3.6 Deficiencies, Problems, and Repairs

If a deficiency or noncompliance in the recompacted clay liner is discovered, CQA personnel shall promptly evaluate the extent and nature of the defect. The extent of the deficient area shall be evaluated by additional tests, observations, a review of records, or other means deemed appropriate.

Sections of recompacted clay liner that do not pass the required field tests (including failures due to not meeting the required hydraulic conductivity) shall be reworked as appropriate (e.g., water added, additional compaction passes, etc.) and retested until the section in question does pass. If a failure occurs, first the failing area shall be defined. This shall be accomplished performing additional tests between the failed test and the nearest adjacent passing test locations. If those additional tests pass, then the area between the failed test and the additional passing tests must be reworked and retested until passing. If the additional tests fail, then additional tests must be performed halfway between the initial additional tests and the adjacent passing tests to further define the failing area. This procedure must be repeated until the failing area is defined, reworked, and retested with passing results. All field moisture-density results shall be reported in the SLER whether they indicate passing or failing values.

2.3.7 Thickness Verification

A licensed land surveyor shall be retained to verify all lines and grades of the recompacted clay liner prior to subsequent liner system construction. Recompacted clay liner thickness verification shall be determined by instrument survey method only; no test probes that create holes will be allowed. The verification points for record purposes shall be on a grid not exceeding 5,000 square feet per grid. The selected grid shall be the same for both beginning and finished elevations of the recompacted clay liner, so that thicknesses can be calculated and verified.

2.3.8 Recompacted Clay Liner Documentation

Documentation of the recompacted clay liner shall be included in the SLER. The required SLER contents are described subsequently in Section 7.2 of this LQCP.

TABLE 3C-1
MATERIAL SPECIFICATIONS FOR RECOMPACTED CLAY LINER

PROPERTY	QUALIFIER	UNITS	SPECIFIED VALUES	TEST METHOD(1)
Maximum Particle Size(2)	Maximum	Inch	1	ASTM D 422
Percent Passing #200 Sieve	Minimum	Percent	30	ASTM D 422
Liquid Limit	Minimum	Percent	30	ASTM D 4318
Plasticity Index	Minimum	Percent	15	ASTM D 4318
Hydraulic Conductivity	Maximum	cm/s	1×10^{-7}	ASTM D 5084(3)

Notes:

(1) CQA testing frequencies are provided in Tables 3C-2 and 3C-3 of this LQCP.
(2) Recompacted clay liner material must also not contain rocks or stones that total more than 10% by weight.
(3) Refer to Table 3C-2 for additional hydraulic conductivity testing requirements.

TABLE 3C-2
PRE-CONSTRUCTION TESTING REQUIREMENTS FOR RECOMPACTED CLAY LINER

TEST	METHOD	MINIMUM FREQUENCY OF TESTING[1]	PASSING CRITERIA
Particle Size (Sieve) Analysis	ASTM D 422	1 per source	See Table 3C-1
Atterberg Limits	ASTM D 4318	1 per source	See Table 3C-1
Natural (as-received) Moisture Content	ASTM D 2216	1 per source	None
Standard Compaction	ASTM D 698, if "light" weight compactor to be used[2]	1 per source (select either Standard or Modified Compaction Test based on weight of compactor to be used)	None
Modified Compaction	ASTM D 1557, if "heavy" weight compactor to be used[2]		None
Remolded Hydraulic Conductivity	ASTM D 5084[3]	1 per moisture/density relationship	$\leq 1 \times 10^{-7}$ cm/s

Notes:

(1) The testing frequency of one per source refers to a relatively consistent and distinguishable soil type at a borrow source location based on visual observations and field classification procedures. If the same borrow source is utilized for the soil supply of more than one liner area project, results from previous pre-construction tests may continue to be used.

(2) Compaction test method shall be selected to be representative of the type of compaction equipment planned for use by the Contractor. For reference, CAT 815 series compactors or equivalent are considered "light" weight equipment, representative of Standard Compaction Tests, and CAT 825 series compactors or equivalent are considered "heavy" weight equipment, representative of Modified Compaction Tests.

(3) Hydraulic conductivity testing shall be performed using tap water or a 0.05N solution of $CaSO_4$. Use effective stress of 20 psi. Distilled or deionized water shall not be used. The permeant should be deaired. All hydraulic conductivity test data shall be submitted with the SLER.

(4) Perform remolded hydraulic conductivity tests as appropriate for the type of compaction equipment planned for use, on either: (i) a remolded sample that is compacted greater than or equal to 95% of the maximum dry density and at the optimum moisture content as determined from the Standard Proctor test; or (ii) a remolded sample that is compacted greater than or equal to 90% of the maximum dry density and at one percentage point dry of optimum as determined from the Modified Proctor test. Alternatively, a higher relative compaction or moisture content can be used in pre-construction testing; however, these higher values will then be the minimum required values for the recompacted clay liner.

(5) Additional hydraulic conductivity tests may be performed during the preconstruction testing program if authorized by the Owner, in order to develop a more detailed, alternative APZ that may broaden the range of allowable moisture-density target compaction criteria or define allowable conditions for use of soil blends. See Section 2.3.2.2 of this LQCP for a discussion of this approach.

TABLE 3C-3
FIELD TESTING REQUIREMENTS FOR RECOMPACTED CLAY LINER

TEST	METHOD	MINIMUM FREQUENCY OF TESTING – PARALLEL LIFTS	PASSING CRITERIA
In-Place Density and In-Place Moisture Content (Nuclear Gauge)	ASTM D 6938	1 per 8,000 ft^2 of surface area per lift (minimum 3 tests per lift)	Within APZ (See Section 2.2.2)
Particle Size Analysis	ASTM D 422	1 per 100,000 ft^2 of surface area per lift (minimum 1 test per lift)	See Table 3C-1
Atterberg Limits	ASTM D 4318	1 per 100,000 ft^2 of surface area per lift (minimum 1 test per lift)	See Table 3C-1
Undisturbed Hydraulic Conductivity	ASTM D 5084(2)	1 per 100,000 ft^2 of surface area per lift (minimum 1 test per lift)	$\leq 1 \times 10^{-7}$ cm/s
Oven Moisture Content	ASTM D 2216	As necessary to verify nuclear gauge density results.	None
In-Place Density (Sand Cone, Rubber Balloon, or Drive Cylinder Method)	ASTM D 1556 or ASTM D 2167 or ASTM 2937	As necessary to verify nuclear gauge density results.	None
Layer Thickness Verification	Instrument Survey Measurements by Registered Surveyor	1 per 5,000 ft^2 of surface area using uniform grid pattern	$\geq$ 3 ft thick

Notes:

(1) As described in Section 2.2.3.5, construction using parallel lifts is anticipated for all soil liner at this site, and therefore for simplicity the above table incorporates only requirements for parallel lifts. If horizontal lifts are used on sideslopes, the field testing requirements and frequencies presented in the TCEQ (formerly TNRCC) "Liner Construction and Testing Handbook", dated July 1994 shall be used.

(2) Undisturbed hydraulic conductivity tests shall be obtained using thin-walled push tube sampler (e.g., Shelby tube), and shall be tested using tap water or a 0.05N solution of $CaSO_4$. Use effective stress of 20 psi. Distilled or deionized water shall not be used. The permeant should be deaired. All hydraulic conductivity test data shall be submitted with the SLER.

(3) The undisturbed hydraulic conductivity tests on samples of constructed liner as indicated in the above table are proposed to evaluate the suitability of the as-constructed soils used for the recompacted clay liner. Field permeability testing is not proposed.

3. PROTECTIVE COVER

3.1 Introduction

This section addresses the specifications and CQA requirements for the protective cover layer proposed for placement above the recompacted clay liner component of the liner system.

3.2 Protective Cover Layer Specifications

3.2.1 Protective Cover Material Requirements

The protective cover material shall be earthen material with a 3-in. diameter maximum particle size and without deleterious materials.

3.2.2 Protective Cover Placement Requirements

A. Protective cover does not require compaction control; however, it should be stable for construction and disposal traffic.

3.3 Protective Cover Layer CQA

3.3.1 General

This section of the LQCP addresses the CQA program to be implemented with regard to the protective cover layer. The following CQA activities are discussed in the remainder of this section:

- Field Evaluation/Monitoring During Construction;
- Thickness Verification; and
- Protective Cover Layer Documentation.

Pre-construction evaluation of material sources, material conformance testing during construction, and field testing of the protective cover layer is not required.

3.3.2 Field Evaluation/Monitoring During Construction

CQA personnel will be on-site at all times when protective cover layer construction is ongoing, so that all relevant activities can be observed and documented. CQA personnel shall visually monitor and document that construction of the protective cover layer is in accordance with the specifications and requirements set forth previously in this LQCP. These observations shall include, but not be limited to visual monitoring and documentation of:

- the protective cover soil material to evaluate the visual material classification and check for the presence of deleterious materials; and

- the thickness and dimensions of the material as spread for compliance with the drawings and engineering details.

3.3.2 Thickness Verification

A licensed land surveyor shall be retained to verify protective cover thickness. Protective cover thickness verification shall be determined by instrument survey method only. The verification points for record purposes shall be on a grid not exceeding 5,000 square feet per grid. The beginning survey shall be the previously completed top of recompacted clay liner survey. The finished elevations of the protective cover layer shall be taken using the same horizontal survey locations, so that thicknesses can be calculated and verified.

3.3.3 Protective Cover Documentation

The protective cover documentation shall be included in the SLER. The required SLER contents are described subsequently in Section 7.2 of this LQCP.

4. GROUNDWATER CONTROL AND LINER SYSTEM BALLASTING

4.1 Overview

This section of the LQCP contains procedures that shall be followed when excavations extend into water bearing zones or into areas that have the potential to encounter groundwater.

4.2 Site Geology/Hydrogeology

Previous Characterizations. Based on the results of past hydrogeologic and geotechnical investigations, in the current landfill permit (MSW-1565A), the site subsurface was generally characterized into four geologic units (i.e., strata), described as follows:

- Stratum I: Firm to very stiff sandy clay (CL) and clayey sand (SC);
- Stratum II: Medium to very dense sand (SP) and silty sand (SM);
- Stratum III: Very stiff clay (CH and CL); and
- Stratum IV: Firm to very dense silty sand (SM) and sand (SP).

The above abbreviations after the soil types refer to the Unified Soil Classification System (USCS) designations in accordance with ASTM D 2487.

Updated Characterization of Stratigraphy. The site stratigraphy presented in the Geology Report (Part III, Attachment 4 of this permit amendment application) was developed in consideration of previous site investigations, along with the 2012 site investigation, to present a site-wide characterization of the subsurface. The findings are consistent with the above characterization and nomenclature, but included exploration to greater depths, and added a fifth stratum beneath the site. Also, an additional soil layer/type was encountered in portions of the site – a man-made fill layer (rather than a geologic unit). Accordingly, the subsurface strata at the site can be summarized as follows:

- Stratum I (Predominantly Clay): Surficial clay (predominantly classified as CL), with some fine-grained sand, clayey and silty sand, silty and sandy clay. The stratum consists of clay and sand zones, which are discontinuous across the site. Stratum I is, on average, approximately 14-feet thick.
- Fill Soil (Predominantly Clay): The subsurface investigation revealed that in portions of the site that are proposed for expansion, constructed (i.e., man-made) fill soil was encountered, with generally similar composition to Stratum I. The fill soil was predominantly clayey material, classified as CL.

- Stratum II (Sand): Fine grained sand and silty sand with some clayey sand. The average thickness of this layer is about 32 feet. Much of this layer has been removed from the site through either excavation to construct the existing landfill liner, or through sand pits to mine the sand material.

- Stratum III (Clay): Very stiff to hard, reddish brown and gray clay (mostly CH), silty clay, and sandy clay. This layer was interpreted to be continuous beneath the site, with an average thickness of about 25 feet.

- Stratum IV (Sand): This deep sand unit was found to consist primarily of sand, silty sand and gravelly sand. This layer was interpreted to be continuous beneath the site, with an average thickness of about 50 feet.

- Stratum V (Clay): Hard, gray and light brown clay similar to Stratum III clay. This layer is situated at an average depth of 122 feet below ground surface at the site.

Updated Characterization of Hydrogeology. The site hydrogeology presented in the Groundwater Monitoring Plan (Part III, Attachment 5 of this permit amendment application) was developed in consideration of previous site investigations, along with the 2012 site investigation. The hydrogeologic units at the site can be summarized as follows:

- Stratum II (Groundwater Zone): Based on the water levels measured in site monitoring wells and exploratory borings, the groundwater in this discontinuous upper sand layer occurs under generally unconfined, water-table conditions and generally flows to the southeast. The water table is confined or retarded at its lower limit by the underlying Stratum III clay.

- Stratum III (Confining Unit): The three piezometers installed in this layer indicate that groundwater in this clay unit is limited and the permeability of clay is low. Due to the continuity and thickness of this clay layer, it acts as a confining unit between uppermost Stratum II groundwater zone and the deeper Stratum IV sand.

- Stratum IV (Uppermost Aquifer): Based on the piezometers and wells installed in this sand layer, groundwater in Stratum IV is confined and generally flows to the northwest.

- Stratum V (Lower Confining Unit): The composition and permeability of Stratum V is similar to Stratum III, making it an effective confining unit for Stratum IV.

Effect of Site Hydrogeology on Liner System Uplift Stability. The following conclusions are drawn with regard to liner system uplift stability:

- Liner system excavations will extend through the Stratum II sand and into the underlying Stratum III clay. Because this situation may result in the landfill liner system blocking the natural groundwater flow direction in Stratum II and result in buildup of hydrostatic heads on the liner that could cause uplift, an active dewatering/pressure relief system has been designed along portions of the landfill perimeter where Stratum II is present. Due to the excavation conducted during liner construction, Stratum II is not expected to be encountered at most parts of the landfill.

- Stratum III is a low permeability clayey formation that serves as a confining layer to the underlying groundwater in Stratum IV. The liner system will be keyed-in to this clayey formation. The groundwater in Stratum IV has potentiometric levels that are below the bottom of the liner system (i.e., no uplift potential is indicated from groundwater in Stratum IV). Furthermore, evidence supports that Stratum III is so poorly permeable at the site that any underlying groundwater could not move upwards sufficiently to exert a force on the liner. Also, virtually no groundwater was reported as being observed during previous liner construction in Stratum III, nor has uplift been reported to be experienced in Stratum III. Although groundwater observations should continue to be made during future excavations as specified herein, evidence does not suggest the need for any dewatering features within Stratum III or beneath the bottom of the liner system at this time. This will continue to be evaluated during future construction, and a dewatering system will be considered if conditions warrant, as further described in Section 4.5.2.

4.3 Historical High Groundwater Elevations

Historical high groundwater elevation data and contour maps for Strata II and IV are presented in Appendix 3C-1 of this LQCP. The historical high groundwater levels in Stratum II were used to design the active dewatering/pressure relief system and calculations of ballast requirements. The historical high groundwater levels in Stratum IV are below the bottom of the liner system of the proposed landfill sectors, and is also confined by the overlying low-permeability Stratum III and therefore no uplift is expected from groundwater in Stratum IV. As additional groundwater elevation data become available for the site, the data and maps should be reviewed and updated if necessary.

4.4 Construction Stability

The bottom of the liner system for new cells at the facility will be excavated to Stratum III, thereby removing Stratum II in most parts of the landfill. The excavation process is expected to lower pore water pressures as the excavation is exposed, reducing the likelihood of seepage. However, should localized seeps or wet areas occur, the affected areas shall be evaluated in accordance with procedures set forth in Section 2.2.3 of this LQCP. Also, the surface of the Stratum III clays on the bottom of the excavation is expected to dry when exposed; therefore

little seepage, if any should occur through the foundation soils during construction. However if seepage occurs, an underdrain system may be provided below Layer III for seepage control as described in Section 4.5.2.

4.5 Short-Term Liner Stability

In terms of protection against potential liner uplift by groundwater, "short term" refers to conditions during construction and until sufficient soil and/or waste has been placed to ballast the liner from uplift and a Ballast Evaluation Report (BER) has been approved by TCEQ.

4.5.1 Stratum II Temporary Pressure Relief/Dewatering System

A groundwater control system is proposed around portions of the site perimeter that intersect the Stratum II sand. This will be composed of an active pressure relief/dewatering system to be installed during liner system construction. Groundwater will be removed from the system, as necessary, by the facility during ongoing operations to prevent buildup of hydrostatic pressures on the liner. The system will be operated by the facility until sufficient soil and/or waste ballast has been placed to achieve stability against uplift under historical high groundwater conditions. This ballast will be documented in a BER, which will be submitted to TCEQ as described subsequently. After the BER is approved by TCEQ, pumping from the pressure relief/dewatering system will be discontinued.

The lateral extent of landfill perimeter areas requiring a pressure relief/dewatering system for the liner portions in contact with Stratum II is shown on Drawing 3D.4-1 in Part III, Attachment 3D.4 (Liner Uplift, Dewatering System, and Ballast Evaluation) of this permit amendment application. Engineering details showing the proposed pressure relief/dewatering system for Stratum II are presented on Drawing 3D.4-2 in Part III, Attachment 3D.4. Design calculations demonstrating that the hydraulic capacity of the proposed system is adequate are presented in Part III, Attachment 3D.4-1 (Hydraulic Capacity of Stratum II Pressure Relief/Dewatering System).

4.5.2 Strata III and IV Considerations

For the reasons described in Section 4.2, there are no indications of uplift potential on the liner system due to groundwater in Stratum IV. Most importantly, the bottom of the liner system of future proposed landfill sectors is above the historical high potentiometric groundwater levels in Stratum IV. Furthermore, as mentioned Stratum III is a low permeability clayey formation that serves as a confining layer to the underlying groundwater in Stratum IV and is so poorly permeable that groundwater from Stratum IV would not be expected to move upward sufficiently to exert a force against the liner. However, in the unexpected event that water which could exert an uplift force on the liner is observed in the Stratum III clay during construction (e.g., through a

major fracture), an evaluation will be made regarding the magnitude of groundwater present, and if needed an active pressure relief/dewatering system will be installed during liner system construction and operated during the short-term until enough ballast is in place. Although it is not explicitly required for Type IV landfills, the following steps will be taken to evaluate the groundwater conditions in general accordance with 30 TAC §330.337:

1) observe the soil stratigraphy and properties exposed on the bottom and sideslopes of the fracture or fault areas to be lined;
2) measure and estimate the water level conditions (e.g., measure extent of apparent saturated area, measure flow rates by collecting water from seeps in graduated containers (known volume) using the corresponding length of time to fill the container, use results for designing the pressure relief or dewatering system);
3) calculate the required ballast depth and type of ballast to be used (soil or waste) (see Part III, Attachment 3D.4-2 (Ballast Uplift Calculation Procedures and Results) for procedure);
4) evaluate the method of controlling uplift forces during construction and waste placement (e.g., low permeability foundation soil, pressure relief or dewatering systems (active or passive), etc.); and
5) if found to be necessary, install and operate the pressure relief/dewatering system similar to the one proposed for Stratum II, but at depths required to intercept groundwater until sufficient soil and/or waste ballast has been placed to achieve stability against uplift by the groundwater, as documented in a BER and submitted to and approved by TCEQ.

4.6 Long-Term Liner Stability – Ballast

Where groundwater pressure relief/dewatering systems are needed as described previously in this section, long-term liner stability against hydrostatic uplift will be accomplished by the presence of ballast (soil and/or waste). The calculation procedure for determining the required thickness of soil and/or waste ballast to provide an adequate factor of safety against uplift is presented in Part III, Attachment 3D.4-2 (Ballast Uplift Calculation Procedures and Results).

4.7 Verification, Surveying, and Documentation

4.7.1 Soil Ballast Construction

The in-place thickness and unit weight of the protective cover layer, final cover system, and soil ballast (if used) must be monitored during construction and compared with the values used to calculate the required ballast thickness. The POR or his/her representative shall verify that the ballast meets the established criteria and that uplift of the liner system did not occur during construction. This effort considers data from inspections, compaction testing, weight and density of material, material thickness, and top of soil and waste elevations. The verification shall be

documented in the SLER and/or BER, as appropriate, which will be submitted to TCEQ for approval (as described in Section 7). Survey measurements to check against uplift and document soil ballast must be taken at a minimum frequency of one measurement per 10,000 ft^2 of ballasted area.

If the survey results or unit weight evaluations indicate that the ballast criteria have not been met, additional ballast will be placed to compensate for the difference and provide the required factor of safety against uplift. If additional soil is used to ballast the liner system, the in-place unit weight (measured or estimated) and thickness of the soil layer should be documented in the SLER.

4.7.2 Waste Ballast Construction

If waste is to be used for ballast, the SLER must be approved by TCEQ before waste ballast placement may begin. The first 5-ft lift of waste over the area of the liner system requiring ballast will be free of items that could damage underlying parts of the liner system, and all of the waste ballast will be free of items that cannot be compacted to the required density. The waste used for ballast must be compacted with a wheeled trash compactor, or equivalent equipment, weighing in excess of 40,000 pounds, and properly used (e.g., typically at least three compaction passes, must meet interim waste slope steepness considerations) to achieve a minimum unit weight of waste of 1,200 lbs/yd^3.

The landfill manager shall use the required Waste-as-Ballast form to document waste ballast placement (see Section 7.4 of this LQCP) including the above first-lift considerations and compaction equipment/methods used. This documentation will be placed in the site operating record and also attached to the BER. The POR will verify the compacted waste height using survey procedures with a minimum of one survey point every 10,000 ft^2 of top waste area along the ballasted area, or using topographic information from aerial photography.

4.7.3 Ballast Documentation

The calculations of the required soil and/or waste ballast, verification that the liner did not undergo uplift during construction, and documentation of the groundwater control method will be submitted with the SLER for TCEQ approval (see Section 7.2). If soil ballast is required and all of it is placed during liner construction (e.g., placed as additional protective soil), documentation of the soil ballast thickness shall be submitted with the SLER, and a separate BER report is not necessary.

If additional ballast is required after liner construction (e.g., waste as ballast), once the additional ballast is in place, the documentation will be provided in a BER. The BER will contain

documentation substantiating that the appropriate depth of ballast has been placed over the liner system and appropriate placement methods have been used.

5. COMPACTED FILL

5.1 Introduction

This section addresses the specifications and CQA requirements for compacted fill which will be used in areas of the site planned for development that have existing ground elevations lower than the design elevations (i.e., low areas) that will form the subgrade for the landfill liner system.

5.2 Compacted Fill Material and Construction Requirements

A. Compacted Fill Soil. For fill placed within 5-ft of the liner system subgrade, the compacted fill shall be classified as CL, CH, SC, SM, SP, or SW in accordance with the Unified Soils Classification System (USCS). Additionally, compacted fill shall be natural soil, free of organic matter (i.e., roots, vegetation), debris, frozen material, or excessive moisture. Compacted fill soil shall have 98 percent by weight smaller than 3 inches in size.

B. Compacted Fill Material. For fill placed deeper than 5-ft of the liner system subgrade, the material may be the same as specified above for Item A, or is allowed to also be composed of recycled concrete aggregate, crushed concrete or brick, or reclaimed asphalt pavement

C. Compaction Requirements. To achieve the design elevations and to provide foundation support for the overlying liner system, compacted fill soil shall be placed in 12-inch thick (maximum) lifts. Each lift shall be compacted to a density of at least 92% of the standard Proctor maximum dry density (ASTM D 698). The recommended moisture range for compacted fill soil is within +/- three (3) percent of the measured standard Proctor optimum moisture content. For fill materials of the type specified above in Item B, the compacted fill material shall be compacted in accordance with TxDOT Standard Specification 132.3(B) for rock embankments, and since density testing in not practical for rock-like material, the material shall be compacted with at least two passes of a bulldozer or compaction roller.

D. Pre-Placement Ground Preparation. The ground surface on which compacted fill will be placed will be cleared and prepared as necessary to make it free of debris, organic matter (i.e., roots, vegetation), standing water, or excessive moisture. No compacted fill placement may occur in standing water.

D. Non-Conforming Tests. CQA field testing on material within 5-ft of the liner system subgrade shall be performed as described subsequently in Section 5.3. Should the CQA field tests indicate that the density of any compacted fill lift, or portion thereof, does not meet the minimum specified density, the representative portions of that particular lift shall be reworked and retested.

5.3 Compacted Fill Soil CQA

5.3.1 Pre-Construction Evaluation of Compacted Fill Soil Material Sources

Prior to construction of the aforementioned compacted fill soil areas, CQA personnel shall obtain a soil sample from the proposed source(s). Each soil source shall be tested in the laboratory for the pre-construction tests presented in Table 3C-4.

5.3.2 Field Evaluation, Conformance Testing, and Monitoring During Construction

CQA personnel, under the direction of the POR, will be on-site as needed during compacted fill soil construction to periodically observe and document the work. CQA personnel shall visually monitor and document that construction of compacted fill soil is in accordance with the specifications and requirements set forth previously in Section 5.2 of this LQCP. Laboratory material conformance testing beyond the initial pre-construction tests shall be performed using the tests and methods and at the frequency outlined in Table 3C-5

5.3.4 Field Testing of Work Product

5.3.4.1 Routine Field Testing

Field testing (e.g., density testing) of placed/compacted fill soil will be performed by CQA personnel during construction to evaluate the Contractor's work product with respect to the requirements of the specifications as set forth in this LQCP. The test methods and frequencies for routine CQA field testing of the compacted fill soil are given in Table 3C-5. Sampling and test locations shall be selected by CQA personnel.

5.3.4.2 Special Testing

A special testing frequency shall be implemented at the discretion of CQA personnel when observations indicate potential concerns that the material or construction requirements presented herein may not have been met, or as requested by the Owner.

2.3.4.3 Placement of Overlying Recompacted Clay Liner

All testing and evaluation of the compacted fill soil shall be complete prior to installing the overlying recompacted clay liner.

5.3.5 Deficiencies, Problems, and Repairs

If a deficiency or noncompliance in the compacted fill is discovered, CQA personnel shall promptly evaluate the extent and nature of the defect. The extent of the deficient area shall be

evaluated by additional tests, observations, a review of records, or other means deemed appropriate.

Sections of compacted that do not pass the required field tests shall be reworked as appropriate (e.g., additional compaction passes, moisture adjustment, etc.) and retested until the section in question does pass. If a failure occurs, first the failing area shall be defined. This shall be accomplished performing additional tests between the failed test and the nearest adjacent passing test locations. If those additional tests pass, then the area between the failed test and the additional passing tests must be reworked and retested until passing. If the additional tests fail, then additional tests must be performed halfway between the initial additional tests and the adjacent passing tests to further define the failing area. This procedure must be repeated until the failing area is defined, reworked, and retested with passing results.

TABLE 3C-4
PRE-CONSTRUCTION TESTING REQUIREMENTS FOR COMPACTED FILL SOIL

TEST	METHOD	MINIMUM FREQUENCY OF TESTING[1]	PASSING CRITERIA
Particle Size (Sieve) Analysis	ASTM D 422	1 per source	98% by weight < 3-in.
Atterberg Limits	ASTM D 4318	1 per source	None
Soil Classification	ASTM D 2487	1 per source	CL, CH, SC, SM, SP, or SW
Natural (as-received) Moisture Content	ASTM D 2216	1 per source	None
Standard Compaction	ASTM D 698, if "light" weight compactor to be used[2]	1 per source (select either Standard or Modified Compaction Test based on weight of compactor to be used)	None
Modified Compaction	ASTM D 1557, if "heavy" weight compactor to be used[2]		None

Notes:

(1) The testing frequency of one per source refers to a relatively consistent and distinguishable soil type at a borrow source location based on visual observations and field classification procedures. If the same borrow source is utilized for the soil supply of more than one compacted fill placement project, results from previous pre-construction tests may continue to be used.

(2) Compaction test method shall be selected to be representative of the type of compaction equipment planned for use by the Contractor. For reference, CAT 815 series compactors or equivalent are considered "light" weight equipment, representative of Standard Compaction Tests, and CAT 825 series compactors or equivalent are considered "heavy" weight equipment, representative of Modified Compaction Tests. This does not preclude the use of other types of compaction equipment, provided that the compaction specifications are met.

TABLE 3C-5
FIELD TESTING AND ONGOING CONFORMANCE TESTING REQUIREMENTS FOR COMPACTED FILL SOIL

TEST	METHOD	MINIMUM FREQUENCY OF TESTING	PASSING CRITERIA
In-Place Density and In-Place Moisture Content (Nuclear Gauge)	ASTM D 6938	1 per acre of surface area per lift (minimum 1 per per lift)	Within Compaction Range (See Section 5.2.2)
Particle Size Analysis	ASTM D 422	1 per 10,000 yd^3	98% by weight < 3-in.
Atterberg Limits	ASTM D 4318	1 per 10,000 yd^3	None
Soil Classification	ASTM D 2487	1 per source	Meets USCS Category CL, CH, SC, SM, SP, or SW
Oven Moisture Content	ASTM D 2216	As necessary to verify nuclear gauge density results.	None
In-Place Density (Sand Cone, Rubber Balloon, or Drive Cylinder Method)	ASTM D 1556 or ASTM D 2167 or ASTM 2937	As necessary to verify nuclear gauge density results.	None

6. MARKING AND IDENTIFYING COMPLETED AREAS

Red marker posts shall be placed so that all areas for which a SLER has been submitted and approved by TCEQ are readily identifiable. Such markers are to provide site workers immediate knowledge of the extent of approved disposal areas and shall be placed in accordance with the requirements set forth in Section 13.1 of Part IV (Site Operating Plan) of this permit amendment application.

7. DOCUMENTATION

7.1 Overview

Upon completion of all required liner system construction and evaluation of a given sector (i.e., cell, or disposal area) and prior to disposal of solid waste in that sector, the POR shall prepare and submit a SLER to the TCEQ Executive Director. The SLER shall contain the information specified in Section 7.2. The SLER submittal requirements, and the requirements pertaining to when waste disposal is allowed, are as follows:

- Each SLER shall be submitted in triplicate (including all attachments) to the Executive Director and shall be prepared in accordance with the methods and procedures contained in the approved LQCP. If the Executive Director provides no response, either written or verbal, within 14 days of receipt, the owner or operator may continue facility construction or operation.

- If the Executive Director determines that a report is incomplete or that the test data provided are insufficient to support the evaluation conclusions, additional test data or other information may be required, and use of the cell or disposal area will not be allowed until such additional data are received, reviewed, and accepted. Each report must be signed and, where applicable, sealed by the individual performing the evaluation and counter-signed by the facility operator or an authorized representative.

Separate submittals of the reports and documentation during the project may be made if it would facilitate review of the project by the TCEQ. If ballast is used, a BER will be submitted as described in Section 7.4

7.2 Soil and Liner Evaluation Report (SLER)

The SLER shall include the following items at a minimum:

- a properly completed TCEQ SLER Form;

- a narrative construction report describing the conduct of the work and testing programs implemented as required by the LQCP;

- a figure or drawing showing the location of the subject trench or cell with SLER markers in relation to the sector layout plan, and showing previous filled and active areas;

- as-built record drawing(s) showing confirmation of soil liner elevations and thicknesses;

- supporting documentation, including the following items, addressed either through responses to the SLER Form items, in the narrative construction report, or as attachments/appendices to the construction report:

    - provision of full-time CQA by the POR or their representative during soil liner construction;
    - preconstruction soil test results;
    - summary of construction material conformance tests results;
    - summary of field moisture-density control test methods and results;
    - summary of hydraulic conductivity test results;
    - soil liner construction practices for floor and sidewall sections;
    - placement and processing methods;
    - observations of soil conditions prior to and after compaction, including soil structure, clod size, and presence of inclusions;
    - compaction methods, equipment type, compactor weight and foot length, and typical number of passes;
    - lift tie-in and bonding observations;
    - repair of failed and damaged lifts;
    - all deviations from the permitted design;
    - post-construction care of soil liner;
    - laboratory test result worksheets for hydraulic conductivity tests;
    - sample calculation for hydraulic conductivity test; and
    - for liners constructed with an underlying or adjacent pressure relief/dewatering system, provide information and documentation on the groundwater data, the resulting installed pressure relief/dewatering system, and required ballast information with SLER.

7.3 Interim Status Report (ISR)

Constructed soil liners not covered by a protective tarp (e.g., temporary plastic cover) should not remain uncovered by waste for a lengthy period of time. As required by 30 TAC §330.341(d), the surface of a constructed soil liner should be covered or otherwise protected within a period of six months to mitigate the effects of desiccation, surface erosion, and rutting due to traffic. Liner surfaces not covered with in six months shall be checked by the SLER evaluator, who shall then submit an ISR on the findings to the Executive Director. Any required repairs shall be performed promptly. A new SLER shall be submitted on the new construction for all liners that need repair due to damage.

7.4 Ballast Evaluation Report (BER)

As described in Section 4 of this LQCP, if soil ballast is required and all of it is placed during liner construction (e.g., placed as additional protective cover), documentation (including verification that the liner did not undergo uplift during construction, calculation of required ballast thickness, and documentation of the soil ballast thickness) shall be submitted with the SLER, and a separate BER report is not necessary.

If additional ballast is required after liner construction (e.g., waste as ballast), once the additional ballast is in place the documentation will be provided in a BER submitted to TCEQ. The BER shall include verification that the liner did not undergo uplift during construction, certification that ballast met the required criteria, and a properly completed TCEQ BER Form, with attached maps, data, calculations, and signed certifications as required on the BER Form. If waste is used as ballast, the Waste as Ballast (WAB) Record Form shall also be completed and submitted to TCEQ.

APPENDIX 3C-1
SEASONAL HIGH GROUNDWATER ELEVATION INFORMATION

LIST OF DRAWINGS		
Drawing No.	Title	Date
3C-1	Historical High Groundwater Map – Stratum II	August 2013
3C-2	Historical High Groundwater Map – Stratum IV	August 2013

HISTORICAL HIGH GROUNDWATER ELEVATIONS

Stratum II

The highest measured elevations in the piezometers and groundwater monitoring wells screened in Stratum II are presented below in Table 3C.1-1 and were used to develop the historical high groundwater map presented in Drawing 3C-1 for Stratum II. Note that this map may not be reflective of the relative groundwater elevations at a given time because it is a combination of the highest historical readings at each measurement point, even though these readings did not occur at the same time. The map should not be used as a potentiometric map or for interpretation of groundwater flow velocity or direction.

TABLE 3C.1-1
HISTORICAL HIGH GROUNDWATER ELEVATIONS IN STRATUM II

GROUNDWATER MEASUREMENT POINT	HIGHEST MEASURED GROUNDWATER ELEVATION (FT, MSL)	DATE OF READING
MW-1A	106.90	7/23/2007
MW-2A	102.84	7/23/2007
MW-2B	86.53	7/19/2010
MW-3A	77.31	10/18/2012
MW-4A	75.15	10/18/2012
MW-5A	57.39	5/24/2012
MW-6A	73.19	8/27/2012
MW-7A	78.14	9/30/1992
MW-7B	85.35	7/19/2010
BME-2	75.53	10/18/2012
BME-13	Always Dry	11/15/2012

Stratum IV

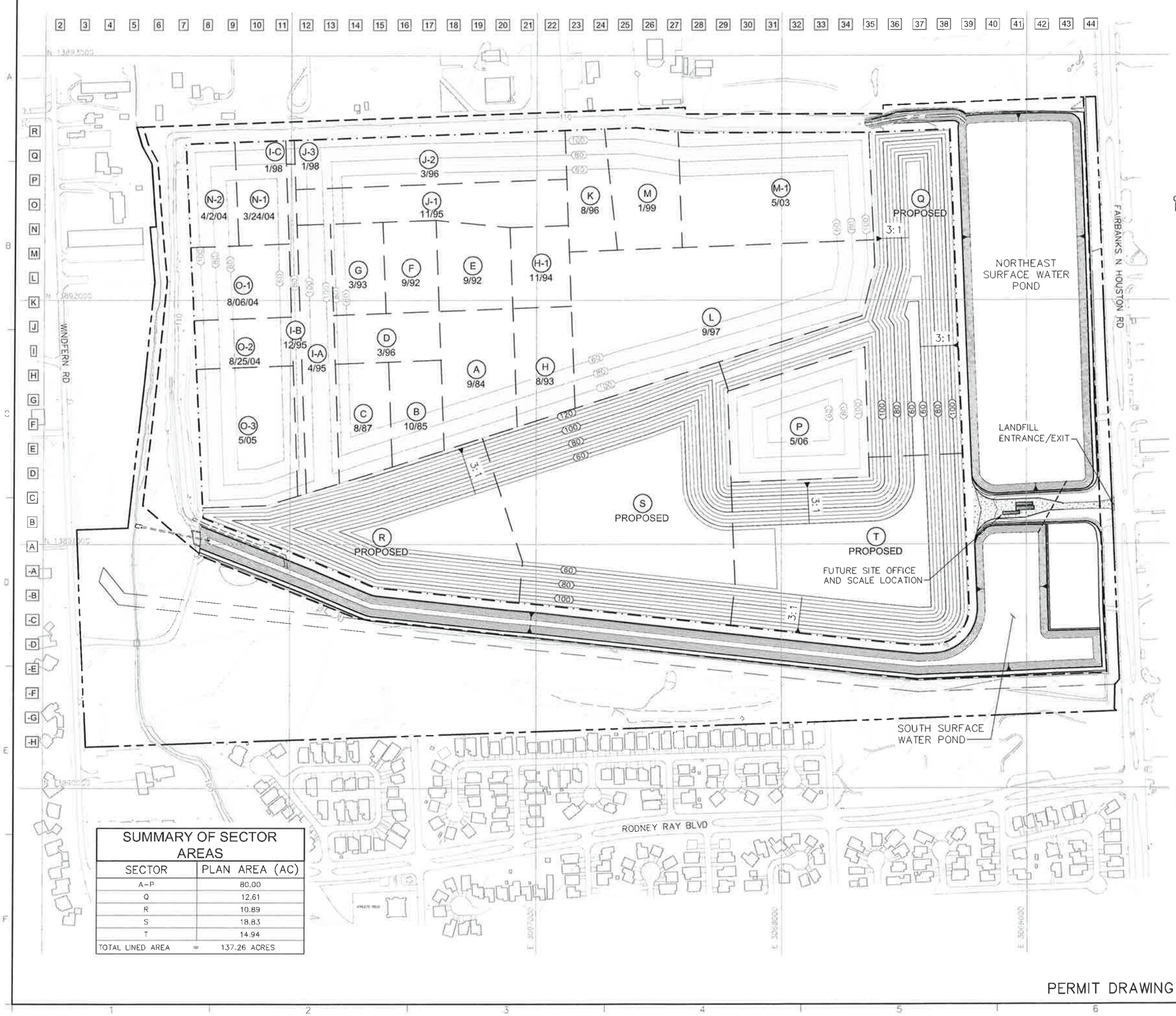
The highest measured elevations in the piezometers and groundwater monitoring wells screened in Stratum IV are presented below in Table 3C.1-2 and were used to develop the historical high groundwater map presented in Drawing 3C-2 for Stratum IV. Note that this map may not be reflective of the relative groundwater elevations at a given time because it is a combination of the highest historical readings at each measurement point, even though these readings did not occur at the same time. The map should not be used as a potentiometric map or for interpretation of groundwater flow velocity or direction.

TABLE 3C.1-2
HISTORICAL HIGH GROUNDWATER ELEVATIONS IN STRATUM IV

GROUNDWATER MEASUREMENT POINT	HIGHEST MEASURED GROUNDWATER ELEVATION (FT, MSL)	DATE OF READING
MW-8	51.44	7/7/2008
MW-9	47.89	7/7/2008
MW-10	47.65	7/7/2008
MW-11	47.24	7/7/2008
MW-12	47.94	7/7/2008
MW-13	48.57	7/7/2008
MW-14	49.07	7/7/2008
MW-15	54.62	7/16/2009
BME-6(P)	47.11	10/18/2012
BME-P12	47.10	10/18/2012

APPENDIX 3C-2
SECTOR LAYOUT PLAN

DRAWING LIST		
Drawing No.	Title	Date
3C-3	Sector Layout Plan	March 2014



SUMMARY OF SECTOR AREAS	
SECTOR	PLAN AREA (AC)
A–P	80.00
Q	12.61
R	10.89
S	18.83
T	14.94
TOTAL LINED AREA =	137.26 ACRES

N

0 200' 400'
SCALE IN FEET

LEGEND

- EXISTING GROUND ELEVATION (FT, MSL) (NOTE 1)
- EXISTING ROAD
- EXISTING WATER LINE
- STATE PLANE COORDINATES (NOTE 2)
- 44 SITE GRID
- PROPERTY BOUNDARY
- PERMIT BOUNDARY
- PROPOSED LANDFILL FOOTPRINT
- (60) PROPOSED TOP OF PROTECTIVE COVER BASE GRADES (FT, MSL)(NOTE 3)
- SECTOR BOUNDARY
- Q SECTOR DESIGNATION
- FUTURE (RELOCATED) ENTERPRISE CRUDE PIPELINE EASEMENT
- LANDFILL ACCESS ROAD
- (60) EXISTING TOP OF PROTECTIVE COVER BASE GRADES (FT, MSL)(NOTES 3, 5)

OVERVIEW:

SECTORS A–P ARE ALREADY CONSTRUCTED AND FILLING IS IN PROGRESS. SECTORS Q–T ARE PROPOSED SECTORS FOR THE LATERAL EXPANSION. LANDFILL DEVELOPMENT (EXCAVATION, LINING, AND FILLING) SEQUENCE OF PROPOSED NEW SECTORS WILL BE IN THE ORDER OF THE ALPHABETICAL SECTORS SHOWN. REFER TO DRAWINGS IIA–13 THROUGH IIA–16 FOR PHASE DEVELOPMENT LAYOUT PLANS SHOWING THE FILLING SEQUENCE AND CONFIGURATION. SECTORS MAY BE FURTHER SUBDIVIDED AT THE FACILITY'S DISCRETION. ALL SECTORS WILL HAVE THE SAME TYPES OF WASTE DISPOSED IN THEM, OF THE TYPES ALLOWED FOR A TYPE IV MSW LANDFILL FACILITY AND AS INDICATED IN THE PERMIT 1565B.

NOTES:

1. THE EXISTING TOPOGRAPHIC BASE MAP SHOWN ON THIS DRAWING WAS COMPILED USING PHOTOGRAMMETRIC METHODS BASED ON AERIAL PHOTOGRAPHY PERFORMED ON 26 MARCH 2012 AND PREPARED BY DALLAS AERIAL SURVEYS (DAS), INC.
2. ELEVATIONS ARE IN FEET ABOVE MEAN SEA LEVEL (FT, MSL), AS DEFINED BY THE USGS NATIONAL GEODETIC VERTICAL DATUM (NAVD) OF 1988. STATE PLANE COORDINATE GRID CORRESPONDS TO TEXAS STATE PLANE COORDINATE SYSTEM, TEXAS SOUTH CENTRAL ZONE (4204), NORTH AMERICAN DATUM OF 1983 (NAD–83).
3. LINER GRADES SHOWN ARE THE TOP OF THE PROTECTIVE COVER COMPONENT OF THE LINER SYSTEM. THE BOTTOM OF EXCAVATION GRADES ARE 4–FT BELOW THOSE GRADES SHOWN HERE. THE ELEVATION OF DEEPEST EXCAVATION (EDE) FOR THE FACILITY IS 51 FT, MSL.
4. OUTSIDE OF THE LIMIT OF WASTE, THE PROPOSED CONTOURS REFER TO FINISHED GRADE OF PERIMETER FEATURES.
5. EXISTING TOP OF PROTECTIVE COVER GRADES WERE TAKEN FROM PERMIT MSW–1565A DRAWING E–4, PREPARED BY METROPLEX INDUSTRIES, INC., DATED JANUARY 2002.
6. EXISTING SECTOR BOUNDARIES WERE TAKEN FROM PREVIOUS SOILS AND LINER EVALUATION REPORTS (SLERs) AS INDICATED ON GOLDER ASSOCIATES "SECTORIZED FILL LAYOUT" (FIGURE 3) OF THE AUGUST 2006 SLER FOR SECTOR P (THE MOST RECENT SECTOR CONSTRUCTED TO–DATE). DATES SHOWN REFER TO THE DATE OF EACH SLER.

STATE OF TEXAS
SCOTT M. GRAVES
86557
LICENSED
PROFESSIONAL ENGINEER
3/3/2014

FOR PERMIT PURPOSES ONLY

REV	DATE	DESCRIPTION	DRN	APP
–	MAR. 2014	ADDED DRAWING, RESPONSE TO NOD 1	JJV	SMG

USA WASTE OF TEXAS LANDFILLS, INC.

LANDFILL SITE ADDRESS:
8205 FAIRBANKS N HOUSTON RD
HOUSTON, TEXAS 77064
PHONE: 713.824.6867

Geosyntec consultants
GEOSYNTEC CONSULTANTS, INC.
TEXAS ENG. FIRM REGISTRATION NO. 1182
8217 SHOAL CREEK BLVD, SUITE 200
AUSTIN, TEXAS 78757
PHONE: 512.451.4003

TITLE: SECTOR LAYOUT PLAN

PROJECT: FAIRBANKS LANDFILL
PERMIT AMENDMENT APPLICATION – PERMIT NO. MSW–1565B

PROJECT NO.: TXL0263	DESIGN BY: JJV	REVIEWED BY: BK	PART NO.: III	DRAWING: 3C–3
FILE: 0263P3C–3	DRAWN BY: JJV	APPROVED BY: SMG		

PERMIT DRAWING

DRAWING: Austin P:\CADD\Projects\FY\Fairbanks Landfill\Permit\Expansion (TXL0263)\Drawings\Dwgs–ReV0\0263P3C–3.dwg PLOTTED: Feb 28, 2014 – 11:20am

Prepared for:

USA Waste of Texas Landfills, Inc.

PERMIT AMENDMENT APPLICATION
PART III – SITE DEVELOPMENT PLAN
ATTACHMENT 3D

GEOTECHNICAL REPORT AND ANALYSES OF LANDFILL DESIGN

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

Prepared by:

Geosyntec consultants

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

3600 Bee Caves Road, Suite 101
Austin, Texas 78746
(512) 451-4003

REFER TO EACH SUB-ATTACHMENT (REPORT OR CALCULATION) WITHIN ATTACHMENT 3D FOR THE RESPONSIBLE PROFESSIONAL ENGINEER'S (P.E.'S) SEAL AND SIGNATURE.

Submitted August 2013
Revised March 2014

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Prepared for:

USA Waste of Texas Landfills, Inc.

PERMIT AMENDMENT APPLICATION
PART III – SITE DEVELOPMENT PLAN
ATTACHMENT 3D.1

GEOTECHNICAL REPORT

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

Prepared by:

Geosyntec consultants

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

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3/3/2014

FOR PERMIT PURPOSES ONLY

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3/3/2014

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Appendix 1 Geotechnical Data – Laboratory Test Results of 2012 Subsurface Investigation
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4.5 Slope Stability

The geotechnical data presented in this report (in particular, the shear strength data, as summarized in Table 3) was used to select the relevant properties to use in the slope stability analyses of the landfill and foundation layers, as presented in Attachment 3D.2.

In the analyses, critical cross sections were selected to analyze landfill stability. As discussed in Attachment 3D.2, selection of these cross-sections were based on the geotechnical properties of the constructed layers and underlying strata as along with the location of the steepest and tallest landfill slopes. The steepest and tallest landfill slopes will are situated by the low areas of the site's existing topography (i.e. low areas (sand pits) of the site where the landfill slopes will grade down to meet existing ground and/or areas to be filled with compacted structural fill soil to build the perimeter berm/road and adjacent features). The analyses of these cross sections in Attachment 3D.2 indicate calculated factors of safety greater than or equal to the target minimum calculated factor of safety.

4.6 Foundation Settlement

The geotechnical data presented in this report (in particular, the consolidation data, as summarized in Table 3) was used to select the relevant properties to use in consolidation and settlement analyses of the landfill, as presented in Attachment 3D.3.

In the attachment, the factors considered for the selection of the critical cross section are discussed. The development of the section was based on the geotechnical properties of the underlying landfill foundation strata and the applied loads. The cross section incorporates the waste thickness that will be placed on areas where no excavation is needed to construct the liner grades (i.e., perimeter areas), areas where excavation is needed to construct the liner grades (i.e., base areas), and areas where filling of low areas (sand pits) is needed (i.e., placement of compacted structural fill soil to build the perimeter berm/road and will be adjacent to constructed sidewall liners). The analysis of the cross section in Attachment 3D.3 indicates that the calculated settlements and calculated liner system strains (resulting from differential settlement between adjacent points along the cross section) are expected to be tolerable, in consideration of the variable foundation conditions (cut areas, fill areas, and underlying strata) and variable applied loads between adjacent points.

Boring Number	Sample Depth		Stratum	USCS[2] Classification	Water Content[3]	Atterberg Limits[4 5]			Fines[6]	Specific Gravity[7]	Dry Unit Weight
	Start	End				LL	PL	PI			
	ft BGS[1]	ft BGS[1]			%	%	%	%	%	-	pcf
BME-14	14	16	Fill	CL	16.8	43	16	27	60.6	-	112.9
	28	30	Fill	CL	18.0	44	15	29	83.0	-	109.4
	34	36	Fill	CL	17.7	30	14	16	57.2	-	103.1
	44	46	III	CL	15.5	35	15	20	93.1	2.51	112.7
	63	65	IV	SP-SM	21.9	NL	NP	NP	8.8	-	-
	83	85	IV	SP-SM	18.7	NL	NP	NP	8.3	-	-
	108	110	IVA	CL	19.5	39	18	21	79.8	2.66	-
	118	120	V	CH	24.3	58	23	35	88.6	-	-
BME-15	42	44	Fill	CL	14.8	31	16	15	70.5	2.56	116.4
	53	55	III	CL	21.7	38	20	18	91.1	-	115.5
	68	70	IV	ML	21.9	NL	NP	NP	62.7	-	-
	108	110	V	CL	14.4	35	13	22	70.1	2.57	-
BME-16	4	6	Fill	CH	24.7	50	17	33	78.9	-	98.3
	12	14	Fill	CH	24.0	50	16	34	79.5	-	-
	20	22	Fill	CH	26.9	56	17	39	82.0	-	-
	26	28	III	CH	24.3	54	26	28	99.1	2.49	101.1
	44	46	IV	ML	24.6	NL	NP	NP	71.9	-	-
	58	60	IV	SP-SM	17.5	NL	NP	NP	7.6	-	-
	88	90	IV	SP-SM	20.4	NL	NP	NP	15.5	-	-
	103	105	V	CH	26.5	72	24	48	90.3	2.5	89.2
BME-17	8	10	I	CH	12.3	38	14	24	50.5	2.69	120
	18	20	II	SM	6.0	NL	NP	NP	22.9	-	-
	38	40	II	SP	22.7	NL	NP	NP	3.7	2.63	-
	58	60	III	CL	21.4	30	15	15	78.4	-	106.7
	53	55	III	-	18.4	-	-	-	-	-	114.8
	63	65	III	-	16.4	-	-	-	-	-	113.4
	68	70	III	-	20.4	-	-	-	-	-	104.9
	78	80	IV	SP-SM	21.4	NL	NP	NP	6.2	-	-

Notes:
1. BGS = Below ground surface
2. USCS = Unified Soil Classification System
3. Water content measured in accordance with ASTM D 2216
4. Atterberg Limits measured in accordance with ASTM D 4318
5. NL and NP results indicate nonplastic soil
6. Fines = Particles finer than #200 sieve (0.074 mm)
7. Specific gravity measured in accordance with ASTM D 854A

ATTACHMENT 3D.2

SLOPE STABILITY ANALYSIS

Written by: Y. Bholat Date: 1/22/2014 Reviewed & Revised by: S. Graves Date: 2/25/14

Client: WM TX Project: Fairbanks Landfill Expansion Project No.: TXL0263 Phase No.: 06

SLOPE STABILITY ANALYSIS
FAIRBANKS LANDFILL



3/3/2014

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CALCULATION PAGES 1
THROUGH 135

GEOSYNTEC CONSULTANTS
TX ENG FIRM REGISTRATION NO. 1182

1 INTRODUCTION

1.1 Purpose

The purpose of this calculation package is to present the slope stability analysis for the proposed expansion of the Fairbanks Landfill. Analyses were performed along critical interim and final slopes where slopes would be the steepest and/or the tallest, combined with critical combinations of subsurface conditions/strengths.

The slope stability factors of safety (FS) are evaluated herein for cross sections that represent critical combinations of geometry and shear strength, and for a variety of potential sliding scenarios. Duncan (1992) and EPA (2004) recommend considering the uncertainty of strength measurements and the consequences of failure in the selection of the target factor of safety. Therefore, minimum acceptable target factors of safety for landfill slope stability depend on project-specific conditions and uncertainties. Values used in the analysis were selected based on recommendations by Duncan (1992) and EPA (2004). The target calculated factor of safety for short-term conditions (i.e., foundation slopes prior to liner system construction, liner system veneer, and interim landfill slopes during operation) is 1.25. The target calculated factor of safety for long-term conditions (i.e., final cover veneer and final landfill slopes at the end of operation) is 1.5.

1.2 Method

The slope stability analyses were performed using a method of slices coded in the computer program SLIDE, Version 6.019 [Rocscience, 2012]. The computer program was

buttressing/support at the toe of the slope. The situation will occur after waste placement on top of the existing waste in the currently permitted landfill area, and where excavation is occurring to construct an adjacent new cell. During waste placement, the exterior landfill slopes will be filled to their final 4H:1V top of waste slopes. The interior interim landfill slopes will be temporary and will be inclined at 3H:1V. The critical interim slope is a south facing 3H:1V slope on the existing landfill, built up to the final top of waste design grade of 248 feet above mean sea level (ft, MSL). Therefore, the critical cross section (Figure 4) located on the south slope (Section 1 on Figures 2 and 3) will have a peak waste elevation of 248 ft, MSL and base grades (top of liner protective cover) of 55 ft, MSL, and be inclined at 3H:1V. As seen in the cross section on Figure 4, Stratum I, Stratum II, and Stratum III are present adjacent to/underneath the liner sideslope. Underneath the base liner areas, Strata IV and V are present.

2.4 Final Landfill Slopes

The critical cases for stability of the landfill at final grades are the south and east cross sections (Sections 2 and 3, respectively, on Figures 2 and 3).

Section 2 (Figure 5) has a peak elevation of 250 ft, MSL, has a landfill slope of 4H:1V, and is about 120 feet high. Under the toe of Section 2, constructed fill will be built on top of the existing Fill Layer present at this portion of the site. At this cross section location, Strata I and II have already been excavated through previous site operations, and are not present. Like the existing landfill, the proposed landfill will be seated in Stratum III. At the lower portion of the cross section, the natural subsurface strata (III, IV, V) are present.

Section 3 (Figure 6) has a peak elevation of 250 ft, MSL, had a landfill slope of 4H:1V, and a slope of 3H:1V on the constructed fill next to the storm water pond. When considering both of these slopes, the resulting total height of the cross section from toe to crest is about 200 feet. At the perimeter edges of this landfill slope, Strata I and II have already been excavated through previous site operations, and are not present. Also as mentioned, the proposed landfill will be seated in Stratum III. On interior portions of this cross section, beneath the existing landfill, Strata I through V were incorporated into the cross section based on nearby borings which indicated their presence.

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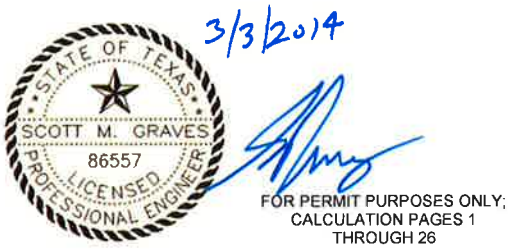
ATTACHMENT 3D.3

SETTLEMENT ANALYSIS

Written by: Y. Bholat Date: 6/24/2013 Reviewed & Revised by: S. Graves Date: 2/25/2014

Client: WM TX Project: Fairbanks Landfill Expansion Project No.: TXL0263 Phase No.: 06

FOUNDATION SETTLEMENT ANALYSIS
FAIRBANKS LANDFILL



GEOSYNTEC CONSULTANTS
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1 INTRODUCTION

1.1 Purpose

The purpose of this calculation package is to evaluate the effect of one-dimensional (1-D) compression of the foundation materials to estimate the settlement beneath the site and to evaluate the post settlement strain in the liner system at the Fairbank Landfill site (site). Soils beneath the landfill liner are expected to compress as waste is placed in the landfill (i.e. as load is applied). The resulting foundation settlements may not be uniform across the site as: (i) not all soil strata are continuous underneath the landfill and (ii) the loading of the foundation by the landfill varies across the length of the cross section. Accordingly, the settlement at multiple points along the liner is estimated to calculate the strain in the liner between each of those points. Based on Geosyntec's experience, a 0.5% up to 1-2% liner strain is considered acceptable for recompacted clay-only liner systems, depending on the plasticity of the clay. This is for non-composite liner systems (not having a geomembrane) such as those for Type IV landfills, including Fairbanks.

1.2 Method

The settlement analysis was performed using a combination of two theories, based on soil types, the theory of elasticity and 1-D consolidation theory. Soils strata classified as sand were assumed to behave elastically while clays were assumed to follow 1-D consolidation theory.

1.3 Overview of the Subsurface Strata

The subsurface strata at the Fairbanks Landfill site can be summarized as follows.

- Fill Layer: High plasticity, lean to fat clay (CL and CH) with some sand;
- Stratum I: A largely excavated clay layer found only in one borehole;
- Stratum II: A largely excavated medium dense to dense sand (SP and SM) layer found in a few boreholes;
- Stratum III: High plasticity, stiff to hard clay layer (CL and CH) found continuously in the subsurface beneath the site;
- Stratum IV: Dense to very dense sand layer (SP and SM) found continuously in the subsurface beneath the site;
- Stratum IV-A: A sub-stratum, intermittently present, of high-plasticity, stiff to hard clay layer found within Stratum IV; and
- Stratum V: High plasticity, stiff to hard clay layer (CH and CL) found continuously in the subsurface beneath the site.

Attachment 3D.1 (the Geotechnical Report) and Attachment 4 (the Geology Report) contain additional information characterizing the site's underlying materials.

2 CRITICAL CROSS SECTION

In evaluating the settlement resulting from the load of the landfill, the critical cross section was first selected. The overall base grading plan (Drawing 3-2 in Attachment 3), overall final cover grading plan (Drawing 3-3 in Attachment 3), geologic sections (Attachment 4C of the Geology Report), borehole logs (Attachment 4B of the Geology Report), and monitoring well data were considered for the development of the critical cross section. Monitoring well data was used to approximate the groundwater elevation at each of the analyzed points along the cross section to determine the effective stress at each point. The resulting cross section is presented in Figure 1 of this calculation package. It was chosen to incorporate the steepest/tallest slope, to include the representative foundation soils beneath the site, and to provide a broad variation of waste thickness throughout the cross section (to evaluate differential settlements). Therefore, from this cross-section, the resulting analysis of the strain in the liner system is likely a worst-case representation of the liner's performance across the site. The base grading plan and final grading plan, showing the location where the cross section (Section 1) was cut, are shown on Figures 2 and 3 of this calculation package, respectively. Seven locations along the critical cross

section were chosen for settlement analysis. The points represent locations along the liner that incorporate changes in slopes and in thickness of the waste or foundation soils.

3 MATERIAL PROPERTIES

3.1 Unit Weights

Soil Strata

Based on lab results presented in Attachment 3D.1, average measured values for unit weight were used for the Fill layer, Stratum I, Stratum III, and Stratum V. Since Strata II and IV are non-cohesive sand layers and undisturbed samples were not obtained, dry unit weights were assumed from published technical literature and lab measured moisture contents were used to calculate total unit weights. Also, correlations from Duncan et al. (1989) were used to estimate the unit weights for the compacted clay liner and cover as well as for the constructed fill. The unit weights used in this analysis for all of the soil layers are presented in Table 1.

Construction and Demolition Waste

Waste that is primarily composed of construction and demolition (C&D) materials will be placed in the Fairbanks Landfill. A typical range of unit weights used for Municipal Solid Waste (MSW) is about 65-80 pcf. Since it is reasonable (and conservative) to assume that C&D waste may be denser and heavier than MSW waste, a unit weight of 90 pcf was used for settlement analyses.

3.2 Elastic Properties of Sands

The sand strata beneath the site (i.e. Stratum II and Stratum IV) were assumed to behave elastically for the settlement analysis. The elastic modulus, the thickness, and the net increase in effective stress of each sand stratum were used to estimate their respective immediate settlement (compression) under the landfill load. Although the elastic moduli of the sands were not directly measured, Standard Penetration Test (SPT) blow counts were evaluated during the subsurface investigations of the site (as discussed in Attachment 3D.1). These blow counts were corrected to obtain N_{60} values which were then used to evaluate the consistency of the sands. Kulhawy and Mayne (1990) provide typical ranges of elastic modulus values for sands of various consistencies. Using the consistency determined from the N_{60} values, typical values of elastic modulus from this reference were selected for the sand strata (Appendix A1.1 and A1.2).

$$\varepsilon = \frac{\Delta s}{d} \tag{11}$$

where ε = the strain in the liner,
d = the distance between two adjacent points, and
Δs = the differential settlement between two adjacent points.

5 RESULTS

The results of the settlement analysis are presented in Appendix 2. The calculated total settlement ranges from 0.9 feet to 3.0 feet. The calculated maximum strain in the liner is 0.18% (compressive strain). The calculated maximum tensile strain is negligible.

6 SUMMARY AND CONCLUSIONS

The analyses presented herein show that the critical cross section was selected and that settlements were estimated at various points along the section using soil and waste properties which were based on laboratory results and published literature.

The calculated magnitude of settlement, based on the conservative approach adopted throughout this evaluation, is not expected to result in any adverse effects on the liner system or the landfill performance in general.

Tensile strain is of primary concern in the landfill liner system; strains in tension could lead to the development of cracks which may have the potential to adversely impact the performance of the liner system. LaGatta et al. (1997) and Sharma and Anirban (2007) discuss that tensile strains at failure for clay are generally between 0.1 and 4 percent. Also, Viswanadham et al. (2012) discuss that tensile strains at the initiation of cracking is about 0.5 to 1% and that the severity of cracks increases when the tensile strain reaches to 1 to 4%. In comparison, the tensile strains computed in this attachment are significantly lower and are, therefore, not expected to adversely impact the performance of the liner system, and concluded to be acceptable.

Compressive strain is less important to the performance of the liner system since compression, by definition, would "tighten" (i.e., densify) the compacted clay (albeit negligibly for the magnitudes calculated). The maximum calculated compressive strain is 0.18%, which is deemed acceptably low.

Therefore, the calculated differential settlements and the resulting strain in the clay liner system is well below the allowable strain for clay-only liner systems, indicating that the predicted differential settlements are tolerable.

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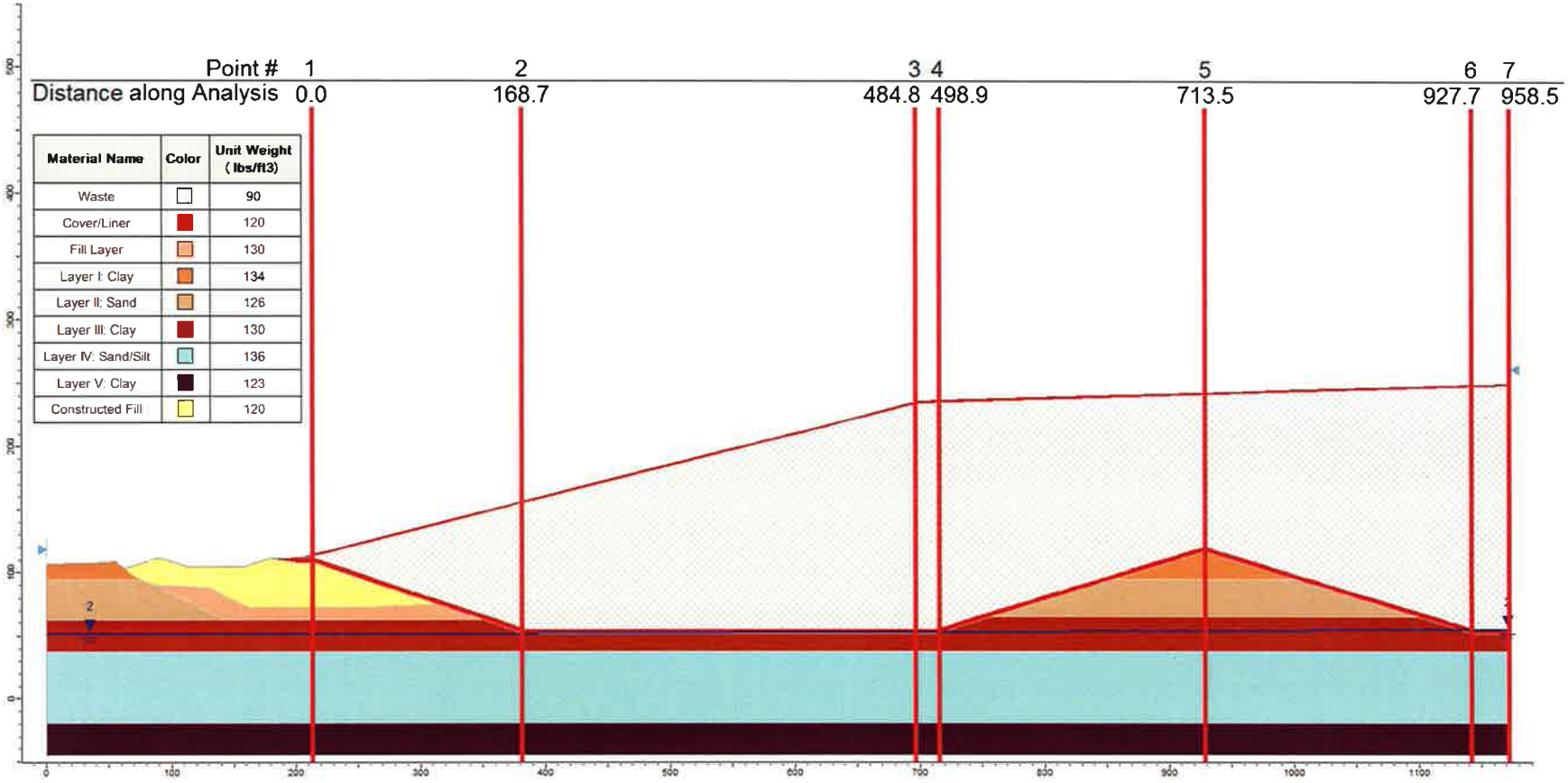


Figure 1: Critical final cross section along the south slope (Section 1 on Figures 2 and 3)

A1.4 Estimating the Time to End of Consolidation of Stratum III

Stratum III is a clay layer. To estimate the secondary compression, the time to the end of primary consolidation is estimated. The time to the end of primary consolidation can be estimated by first determining the time factor, T, using the following equation.

$$T = c_v \frac{t}{H_{dr}^2} \tag{13}$$

where T = time factor,
t = time since start of primary consolidation,
C_v = coefficient of consolidation, and
H_{dr} = length of the longest drainage path.

After estimating the time factor, it can be used to determine the corresponding percent of primary consolidation that has occurred. Using lab measured c_v values and the longest drainage path under the landfill ($H_{dr} \approx 15$ feet), the time factor, T, can be estimated as a function of time, t. This is presented in the following table, where the highlighted boxes represent values of T and the colors represent ranges of percent consolidation completed (see Legend).

Table 5 [Presented with Color Coding. See Table 5A for a repeat, without color coding]
STRATUM III TIME TO END OF PRIMARY CONSOLIDATION CALCULATION

Borehole (Sample Depth)	C_v (ft^2/yr)	t (Years After Application of Load)										
		0	1	2	3	4	5	6	7	8	9	10
BME-3 (36-38)	32.2	0.00	0.14	0.29	0.43	0.57	0.72	0.86	1.00	1.14	1.29	1.43
	29.37	0.00	0.13	0.26	0.39	0.52	0.65	0.78	0.91	1.04	1.17	1.31
	26.79	0.00	0.12	0.24	0.36	0.48	0.60	0.71	0.83	0.95	1.07	1.19
	24.33	0.00	0.11	0.22	0.32	0.43	0.54	0.65	0.76	0.87	0.97	1.08
	12.67	0.00	0.06	0.11	0.17	0.23	0.28	0.34	0.39	0.45	0.51	0.56
BME-5 (33-35)	18.27	0.00	0.08	0.16	0.24	0.32	0.41	0.49	0.57	0.65	0.73	0.81
	20.1	0.00	0.09	0.18	0.27	0.36	0.45	0.54	0.63	0.71	0.80	0.89
	8.76	0.00	0.04	0.08	0.12	0.16	0.19	0.23	0.27	0.31	0.35	0.39
BME-8 (58-60)	25.06	0.00	0.11	0.22	0.33	0.45	0.56	0.67	0.78	0.89	1.00	1.11
	57.62	0.00	0.26	0.51	0.77	1.02	1.28	1.54	1.79	2.05	2.30	2.56
	48.34	0.00	0.21	0.43	0.64	0.86	1.07	1.29	1.50	1.72	1.93	2.15
	23.33	0.00	0.10	0.21	0.31	0.41	0.52	0.62	0.73	0.83	0.93	1.04
Average	27.24	0.00	0.12	0.24	0.36	0.48	0.61	0.73	0.85	0.97	1.09	1.21

Legend	
Less than 10% Consolidated	50%-60% Consolidated
10%-20% Consolidated	60%-70% Consolidated
20%-30% Consolidated	70%-80% Consolidated
30%-40% Consolidated	80%-90% Consolidated
40%-50% Consolidated	90%-100% Consolidated

Table 5A [Repeat of Table 5, but without color coding]
STRATUM III TIME TO END OF PRIMARY CONSOLIDATION CALCULATION

Borehole (Sample Depth)	C_v (ft^2/yr)	t (Years After Application of Load)										
		0	1	2	3	4	5	6	7	8	9	10
BME-3 (36-38)	32.2	0.00	0.14	0.29	0.43	0.57	0.72	0.86	1.00	1.14	1.29	1.43
	29.37	0.00	0.13	0.26	0.39	0.52	0.65	0.78	0.91	1.04	1.17	1.31
	26.79	0.00	0.12	0.24	0.36	0.48	0.60	0.71	0.83	0.95	1.07	1.19
	24.33	0.00	0.11	0.22	0.32	0.43	0.54	0.65	0.76	0.87	0.97	1.08
	12.67	0.00	0.06	0.11	0.17	0.23	0.28	0.34	0.39	0.45	0.51	0.56
BME-5 (33-35)	18.27	0.00	0.08	0.16	0.24	0.32	0.41	0.49	0.57	0.65	0.73	0.81
	20.1	0.00	0.09	0.18	0.27	0.36	0.45	0.54	0.63	0.71	0.80	0.89
	8.76	0.00	0.04	0.08	0.12	0.16	0.19	0.23	0.27	0.31	0.35	0.39
BME-8 (58-60)	25.06	0.00	0.11	0.22	0.33	0.45	0.56	0.67	0.78	0.89	1.00	1.11
	57.62	0.00	0.26	0.51	0.77	1.02	1.28	1.54	1.79	2.05	2.30	2.56
	48.34	0.00	0.21	0.43	0.64	0.86	1.07	1.29	1.50	1.72	1.93	2.15
	23.33	0.00	0.10	0.21	0.31	0.41	0.52	0.62	0.73	0.83	0.93	1.04
Average	27.24	0.00	0.12	0.24	0.36	0.48	0.61	0.73	0.85	0.97	1.09	1.21

	Sub Layer 7 Layer V: Clay									
	Final Midpoint Elevation, yres-mf (ft)	-60.0	-60.0	-60.0	-60.0	-60.0	-60.0	-60.0		
	Initial Total Stress, σ_i (psf)	17,235	17,560	20,848	20,862	22,717	21,692	21,710		
	Final Total Stress, σ_f (psf)	22,269	24,194	31,304	31,349	34,273	32,501	32,582		
	Initial Effective Stress, σ_i (psf)	10,290	10,571	13,815	13,829	15,640	14,578	14,590		
	Final Effective Stress, σ_f (psf)	15,324	17,205	24,272	24,317	27,196	25,387	25,462		
1-D Consolidation Theory (Plastic Method)										
Consolidation Properties										
Preconsolidation pressure, σ'_p (psf)		*21600*	*21600*	*21600*	*21600*	*21600*	*21600*	*21600*		
Modified Primary Compression Index, C_{c_ε}		*0.077*	*0.077*	*0.077*	*0.077*	*0.077*	*0.077*	*0.077*		
Modified Recompression Index, C_{r_ε}		*0.023*	*0.023*	*0.023*	*0.023*	*0.023*	*0.023*	*0.023*		
Modified Secondary Compression Index, $C_{\alpha\varepsilon}$		*0.0025*	*0.0025*	*0.0025*	*0.0025*	*0.0025*	*0.0025*	*0.0025*		
Settlements										
Primary Settlement, (ft)		0.322	0.394	0.675	0.679	0.880	0.752	0.759		
Secondary Settlement (60 Years) (ft)		0.156	0.156	0.156	0.156	0.156	0.156	0.156		
Total Settlement (ft)		0.478	0.550	0.830	0.835	1.036	0.908	0.915		
	Elastic or Plastic (E/P)	p	p	p	p	p	p	p		
		1-D	1-D	1-D	1-D	1-D	1-D	1-D		
	Settlement of Sublayer (ft)	0.478	0.550	0.830	0.835	1.036	0.908	0.915		
TOTAL SETTLEMENT	Total Settlement (ft)	1.0	0.9	1.6	1.6	3.0	1.7	1.7		
GRADES AND STRAINS BASED ON CALCULATED SETTLEMENT										
Intial Liner Segment Length, L_o (ft)			177.752	316.100	14.100	224.315	223.932	30.800		
Post Settle. Liner Segment Length, L_o (ft)			177.717	316.101	14.100	223.910	223.557	30.800		
Post Settlement Liner Strain (+ comp, - tension)			+0.02%	-0.00%	-0.00%	+0.18%	+0.17%	-0.00%		

ATTACHMENT 3D.4

LINER UPLIFT, DEWATERING SYSTEM, AND BALLAST EVALUATION

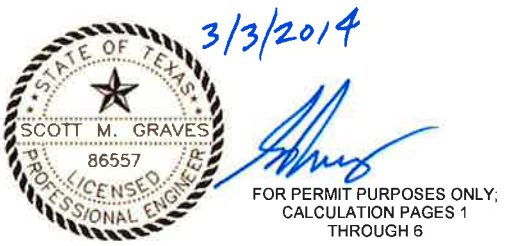
ATTACHMENT 3D.4.1

HYDRAULIC CAPACITY OF STRATUM II PRESSURE RELIEF/DEWATERING SYSTEM

Written by: R.Gupta Date: 11/29/2012 Reviewed & Revised by: S. Graves Date: 2/3/2014

Client: WM TX Project: Fairbanks Landfill Expansion Project No.: TXL0263 Phase No.: 06

HYDRAULIC CAPACITY OF STRATUM II PRESSURE RELIEF/DEWATERING SYSTEM FAIRBANKS LANDFILL



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

1 INTRODUCTION

The purpose of this package is to present the calculations used to estimate the unit rate of groundwater inflow from Stratum II to the bottom of the liner system on the landfill side slope and the hydraulic capacity of the pressure relief/dewatering system required to intercept and collect the seepage without the buildup of excess head on the liner system

2 METHODOLOGY

The underdrain system and temporary dewatering system used at the landfill are shown in Drawing 3D.4-1. The cross-section analyzed for dewatering system is shown as Figure 1. The methodology used to design the dewatering system involved following steps:

1. Estimation of representative flow depth, hydraulic conductivity, and hydraulic gradient of Stratum II;
2. Calculation of inflow into the side slope liner system (Darcy's Law) due to perched groundwater in Stratum II;
3. Sizing of appropriate geocomposite to handle inflow with appropriate factor of safety (FS) taking into account partial reduction factors due to creep, intrusion, biological and chemical degradation;
4. Estimating maximum flow rate in toe drain leading to sump for water collection; and

5. Recommendation for temporary dewatering pump sizing and operation to remove the water collected in the sump.

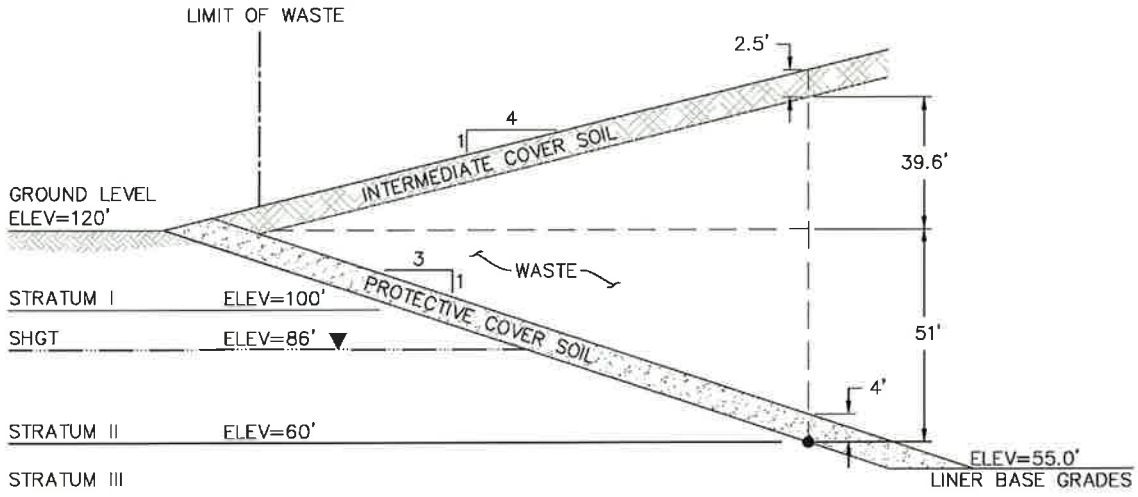


Figure 1: Typical/Idealized Cross-Section

3 CALCULATIONS

Step 1: Stratum II flow depth = 26 ft (Figure 1, based on difference between seasonal high ground water table and Stratum II/III interface (86' – 60')), hydraulic conductivity = 7.84×10^{-4} cm/s (Appendix 4F of the Geology Report), and hydraulic gradient = 0.006 (Appendix 4F of the Geology Report).

Step 2:

$$Q_{IN} = k \times i \times A$$

where

Q_{IN} = Inflow Rate

k = Stratum II hydraulic conductivity = 7.84×10^{-4} cm/s
i = Stratum II hydraulic gradient = 0.006
A = Flow area per meter of slope = 26 feet (Figure 1) x 0.305 m/ft x 1 m

$$Q_{IN} = (7.84 \times 10^{-6} m/s) \times (0.006) \times (7.9 m/m)$$

$Q_{IN} = 3.7 \times 10^{-7} m^3/s$ per meter of slope

Step 3: The transmissivity of geocomposite (θ_{GC}) required to carry flow calculated in Step 2, is computed based on flow rate (Q_{GC}) and thickness (t) of the geocomposite (Koerner, 2005). The overall FS for the design is defined as the ratio of the allowable flow rate (Q_{allow}) to the required flow rated as obtained from design of the actual system ($Q_{required}$).

$$FS = \frac{Q_{allow}}{Q_{required}}$$

For this case,
$Q_{required} = Q_{IN} = k \times i \times A$

$$Q_{allow} = Q_{GC} \frac{1}{(RF_{IN} \times RF_{CR} \times RF_{CC} \times RF_{BC})}$$

Thus,

$$Q_{GC} = (Q_{IN} \times FS) \times (RF_{IN} \times RF_{CR} \times RF_{CC} \times RF_{BC})$$

where,
FS = 2.0 (Overall factor of safety for design)
RF_{IN} = 1.5 (reduction factor for elastic deformation or intrusion)
RF_{CR} = 1.5 (reduction factor for creep deformation)
RF_{CC} = 1.2 (reduction factor for chemical clogging)
RF_{BC} = 1.2 (reduction factor for biological clogging)

$$Q_{GC} = (3.7 \times 10^{-7} m^3/s \times 2) \times (1.5 \times 1.5 \times 1.2 \times 1.2)$$

$$Q_{GC} = 2.4 \times 10^{-6} m^3/s$$

Assuming thickness of typical geocomposite as 0.2" (0.005 mm), the transmissivity is given as,

$$\theta_{GC} = \frac{Q_{GC}}{t} = \frac{2.4\times10^{-6} m^3/s}{0.005\, m} = 4.8 \times 10^{-4} m^2/s$$

Therefore, the geocomposite to be used for design should have transmissivity greater than 4.8×10^{-4} m^2/s. Typical geocomposite products can achieve θ_{GC} is $9\times10^{-4} m^2/s$ (e.g., CETCO Tex Drain TD 300 which is geocomposite with thermally laminated 6 oz/yd^2 nonwoven geotextile on both sides of a polyethylene drainage net). Further, the required geocomposite should be able to operate under stress of 8,860 psf which is based on 93.1 feet of waste (γ_{waste} = 90 pcf) and 4 feet of liner (γ_{liner} = 120 pcf) on a 3H:1V slope (i=0.33) [see Figure 1]. Note that this stress recommendation is conservative because the ballast uplift calculations in attachment 3D.4.2 show that the pressure relief system operations may cease when sufficient ballast is placed (the results require much less than 93 ft of waste ballast).

Step 4: Maximum flow rate through the toe drain is estimated based inflow into the liner from Stratum II as calculated in Step 2, and average length (L) of the longest section of the drain (assumed 2000 feet).

$$Q_{Toe\ Drain} = Q_{IN} \times L = 3.7 \times 10^{-7} \frac{\frac{m^3}{s}}{unit\ length\ of\ slope} \times 610m = 2.3 \times 10^{-4} \frac{m^3}{s} (3.6\ gpm)$$

The toe drain pipe flow capacity should be greater than the flow entering the pipe. The pipe flow capacity for a 4" diameter standard diameter ratio (SDR) 11 high density polyethylene pipe (HDPE) is calculated using Manning's equation as follows:

$$Q_p = \frac{1.486 R_h^{0.66} i_p^{0.5} A_p}{n}$$

where:

Q_p = pipe flow capacity, cfs;

R_h = hydraulic radius, ft (i.e., the flow area (nominal pipe inside diameter = 3.6-inches, i.e., 0.30 ft) divided by the wetted perimeter; assuming flowing full); 0.07065 ft^2 / 0.94 ft = 0.075 ft;

i_p = hydraulic gradient (i.e., slope of the pipe), conservatively designing for a nearly flat 0.1 percent slope for toe drain;

A_p = cross-sectional area of the pipe, $\frac{\pi B_i^2}{4} = \frac{\pi(0.30)^2}{4} = 0.07065 ft^2$; and

n = Manning's roughness coefficient, typically 0.009 for HDPE pipes.

$$Q_p = \frac{1.486 \times 0.075^{0.66} \times 0.001^{0.5} \times 0.07065}{0.009} = 0.0667 \text{ cfs} = 29.9 \text{ gpm (>3.6gpm, OK)}$$

Based on above calculations a 4" SDR-11 HDPE pipe is has sufficient capacity to carry flow well in excess of the predicted flow generation of 3.6 gpm from Stratum II and hence has acceptable capacity to serve as the toe drain for given design conditions. The details of the toe drain are shown on Drawing 3D.4-2.

Step 5: The typical temporary sump at the site was assumed to have dimensions of 3 feet depth, 30 feet width and 30 feet length. Then,

$$Gross\ Volume\ of\ sump\ (V) = 3 \times 30 \times 30 = 2700\ ft^3$$

Assuming porosity of soil as 0.3, the flow is expected as

$$Liquid\ Holding\ Volume\ of\ Sump = 2700\ ft^3 \times 0.3 = 810 ft^3 (6050\ gallons)$$

Time to fill sump $t = \frac{6050 gallons}{3.6\ gpm} = 1{,}680 \text{ min } (28.0\ hours)$

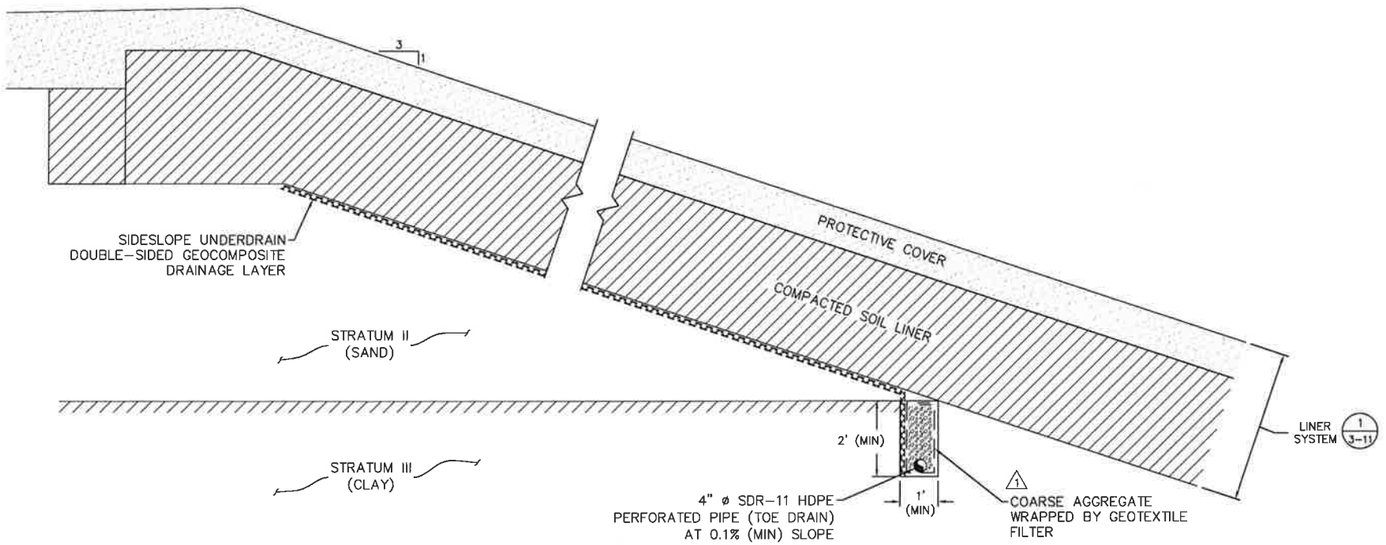
As an example pump sizing, using a pump with rate of 50 gpm, time to empty the sump is 120 minutes. So for this example, one pump cycle per day would be required to empty the temporary dewatering sump at the facility.

4 CONCLUSION

To control seepage during construction from Stratum II into the liner system and the buildup of hydraulic heads beneath the liner system, a temporary underdrain system (i.e., temporary pressure relief and dewatering system) as shown herein is designed for use at the site. The layout of the system is provided in Drawing 3D.4-1, and engineering details of the system are provided on Drawing 3D.4-2.

REFERENCES

Koerner, R.M., (2005), *Designing with Geosynthetics*, Fifth Edition, Prentice Hall, NJ.

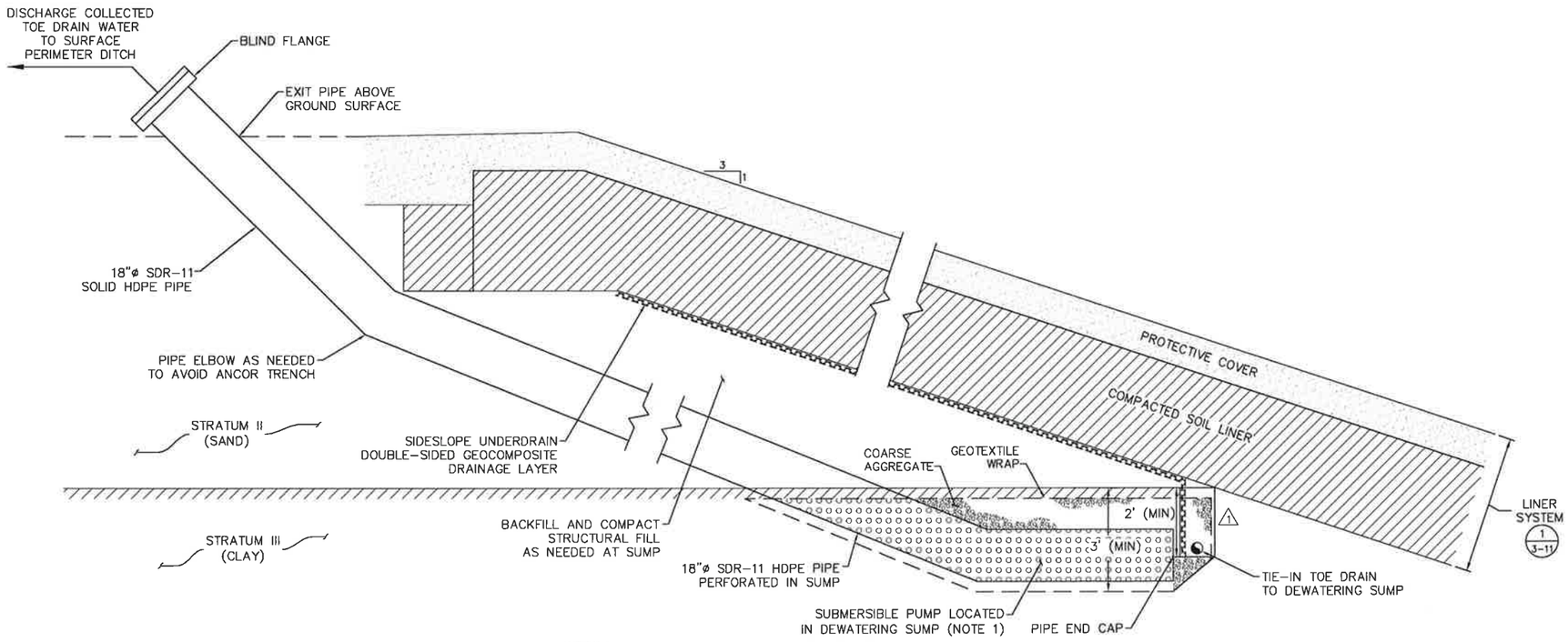


1 / 3D.4-1 DETAIL
SLIDESLOPE DEWATERING SYSTEM
SCALE: 1" = 4'

0 2' 4'
SCALE IN FEET

1 NOTES:

1. GEOCOMPOSITE WILL HAVE A MINIMUM TRANSMISSIVITY OF $4.8X10^{-4}$ m^2/s WITH 6-oz/yd^2 NON-WOVEN GEOTEXTILES BONDED TO BOTH SIDES OF A POLYETHYLENE DRAINAGE NET.
2. COARSE AGGREGATE WILL BE ROUNDED TO SUB-ROUNDED STONE PARTICLES WITH MAXIMUM PARTICLE SIZE OF 1.5", AND LESS THAN 5% PASSING THE #200 SIEVE.
3. GEOTEXTILE WRAP WILL BE AN 8-oz/yd^2 NON-WOVEN GEOTEXTILE FILTER (GSE NW8, OR EQUAL).



2 / 3D.4-1 DETAIL
TEMPORARY DEWATERING SUMP
SCALE: 1" = 4'

0 2' 4'
SCALE IN FEET

PERMIT DRAWING

STATE OF TEXAS
SCOTT M. GRAVES
86557
LICENSED
PROFESSIONAL ENGINEER
3/3/2014

FOR PERMIT PURPOSES ONLY

REV	DATE	DESCRIPTION	DRN	APP
1	MAR. 2014	REVISED, RESPONSE TO NOD 1	JJV/KH	SMG
–	AUG. 2013	INITIAL SUBMITTAL TO TCEQ	JJV	SMG

USA WASTE OF TEXAS LANDFILLS, INC.

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AUSTIN, TEXAS 78757
PHONE: 512.451.4003

TITLE: TEMPORARY PRESSURE RELIEF AND DEWATERING SYSTEM DETAILS

PROJECT: FAIRBANKS LANDFILL
PERMIT AMENDMENT APPLICATION – PERMIT NO. MSW-1565B

PROJECT NO.: TXL0263	DESIGN BY: BK	REVIEWED BY: SMG	PART NO.: III	DRAWING: 3D.4-2
FILE: 0263P3D-4	DRAWN BY: JJV	APPROVED BY: SMG		

DRAWING: Austin P:\CADD\Projects\FY\Fairbanks Landfill\Permit\Expansion (TXL0263)\Drawings\Dwgs-Rev0\0263P3D-4.dwg PLOTTED: Feb 28, 2014 - 4:09pm

ATTACHMENT 3D.4.2

BALLAST UPLIFT CALCULATION

Written by: J. McNash Date: 11/29/2012 Reviewed & Revised by: S. Graves Date: 2/25/2014

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

BALLAST UPLIFT CALCULATION
FAIRBANKS LANDFILL



FOR PERMIT PURPOSES ONLY;
CALCULATION PAGES 1
THROUGH 11

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

1. INTRODUCTION

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

2. METHODOLOGY

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

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

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

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

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

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

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

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

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

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

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

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

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

$$R_N = R_V \times \cos\beta + R_H \times \sin\beta = \Sigma(\gamma_i \times T_i) \times \cos\beta + \Sigma(K_o \times \gamma_i \times T_i) \times \sin\beta$$

- where: R_V = vertical resisting force; R_H = horizontal resisting force; γ_i = total unit weight of the ith ballast component above the liner; T_i = vertical thickness of the ith ballast component above the liner; K_0 = coefficient of static earth pressure provided by the liner; and β = the slope of the liner system. It is noted that the lateral earth pressure from the liner and protective soil at the calculation point provides resisting force against uplift.

- Calculate the provided FS without ballast at each point:

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

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

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

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

3. CALCULATIONS

The following section presents the calculations to evaluate the required thickness of ballast to resist uplift for two potential ballast materials: Waste-as-Ballast (Case I) and Soil-as-Ballast (Case II). Geologic cross sections were developed for the site and are provided in the Geology Report (Part III, Attachment 4), which give an indication of where the water-bearing zone that will encounter the sidewall liner system in places is located (i.e., Stratum II). The base liner system grading plan and final cover grading plan are presented in Part

III, Attachment 3, Drawings 3-2 and 3-3, respectively. Finally, a map of the historical high groundwater elevations in Stratum II is presented in the Liner Quality Control Plan (LCQP) in Attachment 3C. The historical high groundwater elevations in Stratum II are used to calculate the uplift forces.

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

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

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

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

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

$$R_N = \Sigma(\gamma_i \times T_i) \times cos\beta + \Sigma(K_0 \times \gamma_i \times T_i) \times sin\beta$$

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

$$R_N = 509.8\,psf$$

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

The calculated factor of safety without ballast is:

$FS = R_N / U_N = 509.8\ psf / 1622.4\ psf = 0.31$

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

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

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

Therefore, the required thickness of waste if used as ballast in Sector R where it encounters Stratum II along the sidewall is 47.0 ft (rounded up).

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

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

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

Therefore, the required thickness of soil material if soil is used as ballast in Sector R where it encounters Stratum II along the sidewall is 17.0 ft (rounded up).

4. RESULTS

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

5. CONCLUSIONS

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

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

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

TABLES

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

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

Cell No.	Base Elev.	Stratum II Elev.	SHGT Elev. [1]	H_{wt}	U_N	R_V	R_H	R_N	FS[2]	T_{wb}[3]	T_{sb}[4]	FS_{wb}[5]	FS_{sb}[6]
Units	ft msl	ft msl	ft msl	ft	psf	psf	psf	psf	-	ft	ft	-	-
Sector Q (north)	70.0	58.0	85.0	15.0	936.0	436.8	301.8	509.8	0.54	22.0	8.0	1.58	1.31
Sector Q (south)	60.0	60.0	79.5	19.5	1216.8	436.8	301.8	509.8	0.42	32.0	12.0	1.58	1.31
Sector R	55.0	60.0	86.0	26.0	1622.4	436.8	301.8	509.8	0.31	47.0	17.0	1.59	1.26
Sector S	55.0	60.0	84.0	24.0	1497.6	436.8	301.8	509.8	0.34	42.0	16.0	1.57	1.30
Sector T	55.0	59.5	81.0	21.5	1341.6	436.8	301.8	509.8	0.38	36.0	13.0	1.56	1.25

Notes:

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

FIGURES

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

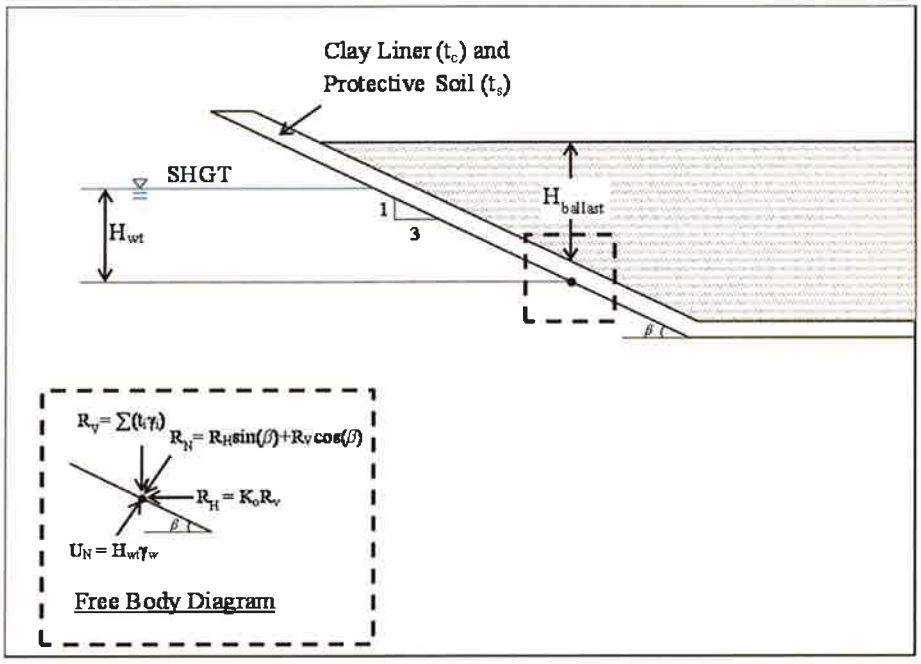


Figure 3D.4.2-1: Example Free Body Diagram at Liner Side Slope

Notes:

1. $H_{ballast}$ is the thickness of ballast (waste or soil) above the calculation point on the liner side slopes.
2. K_o is the coefficient of static earth pressure of the clay liner material and is defined by the equation $K_o = 1-\sin(\phi)$; where ϕ was selected as 18° for this computation.
3. SHGT = Seasonally High Groundwater Table (synonymous with historical high groundwater levels).

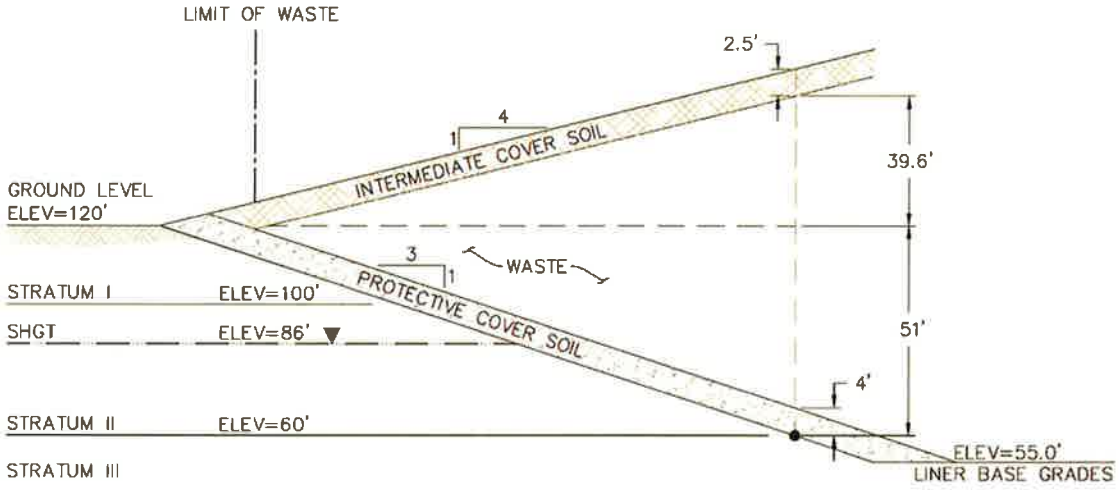


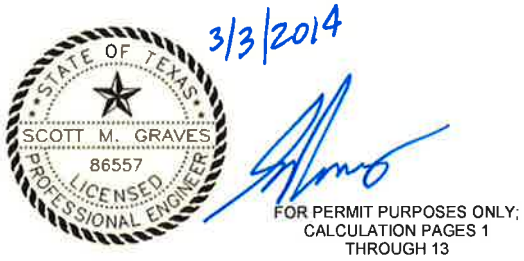
Figure 3D.4.2-2: Typical/Idealized Cross-Section

Note: This figure demonstrates that the typical waste filling operation to final permitted waste grades will provide over 90-ft of waste thickness above the critical sidewall location at the base of Stratum II. The calculations indicate that about 47-ft of waste ballast is required to provide a sufficient factor of safety against uplift in Sector R. This shows that through the course of waste filling, sufficient waste will be placed to resist uplift under the calculated conditions.

ATTACHMENT 3E

FINAL COVER SOIL EROSION LOSS CALCULATIONS

FINAL COVER SOIL EROSION LOSS CALCULATIONS
FAIRBANKS LANDFILL EXPANSION



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

1 PURPOSE

The purpose of this calculation package is to present the evaluation of the long term effects of erosion and soil loss for the completed final cover system of the proposed expansion of the Fairbanks Landfill (Site) in Houston, Texas. The project will consist of both a vertical and lateral expansion at the Site. This package provides calculations for the annual soil loss from the final cover top deck surfaces with a grade of 3% and the external side slopes with a grade of 4H:1V (horizontal:vertical) (i.e., 25%) as shown on the Facility Surface Water Management Plan (Drawing 2-1 of the Drainage Report). The estimated amount of erosion was calculated using the Revised Universal Soil Loss Equation (RUSLE).

2 FINAL COVER SOIL EROSION LOSS CALCULATION METHODOLOGY

The method to calculate the soil erosion loss over the project area was obtained from the guidance document *Predicting Soil Erosion by Water: A Guide to Conservation Planning With the Revised Universal Soil Loss Equation (RUSLE)* (USDA, 1996) as well as previously published information provided by USDA. This document presents the RUSLE methodology and guidance for each of the equation's parameters. The RUSLE is described as follows:

$$A = R \times K \times LS \times C \times P$$

where: A = the computed spatial average annual soil loss (tons/acre/year),

R = the average annual rainfall runoff erosivity factor,

K = the soil erodibility factor,

LS = the topographic factor,

C = the cover management factor, and

P = the erosion control practice factor.

3 RUSLE INPUT PARAMETERS

3.1 Rainfall Runoff Erosivity Factor (R)

The rainfall runoff erosivity factor is defined as the average annual rainfall erosion index specific for the project area. Based on USDA (1996), the value was determined to be approximately 450 for Houston, Texas, as shown in Figure 3E-1 at the end of this document.

3.2 Soil Erodibility Factor (K)

The soil erodibility factor is a function of the physical and chemical properties of the soil and is specific to the source of the cover material. The soil erodibility factor can be thought of as the ease with which soil is detached by splash during rainfall or by surface flow. The soils to be used for the final cover system of the landfill may be from native soils available at the project site or from off-site sources. For soil loss calculation purposes, assessments were made of on-site soils and those nearby, using the Harris County soil survey (USDA, 2004). This information shows that the site and nearby area has soils that are a combination of Gessner loam (Ge), Addicks loam (Ad), and Wockley fine sandy loam (Wo). The Gessner formation constitutes the majority of the site as shown in Figure 2B-1 that is included in Attachment 2B of the Facility Surface Water Drainage Report – "On-Site Drainage Analysis –Hydrology".

The Soil Data Mart tool provided by the Soil Survey Geographic (SSURGO) Database (NRCS, 2012) was consulted for Harris County to determine the corresponding soil erodibility factors. Near-surface soils (i.e., topsoil) will be used to construct the topsoil layer of the final cover system. The value of K for the project location soils near the surface was listed as 0.37, where the estimate considers the erodibility of fine-earth fraction for material less than two mm in size (using the Kf erosion factor provided in Table 3E-1). Table 3E-1 shows that the K factor of soils in and around the site area varies from 0.32 to 0.43. Thus, the use of 0.37 in the calculation is not only using the formation that is most predominant at the site and surrounding areas (i.e., the most likely source of

future final cover topsoil), but also is a typical value in the mid-range of a wider geographic map of nearby soils.

3.3 Topographic Factor (LS)

The slope length factor and slope steepness factor are typically combined into one topographic factor, LS, to facilitate field application of these equation components. USDA (1996) presents values of the LS factor for slope lengths in feet up to 1,000 feet and percent slopes up to 60%, as shown in Table 3E-2, for soils with vegetated cover.

The longest slope lengths for the side slope and top deck surfaces of the final cover system were used to select the LS factor for each area, and these lengths were applied to compute the soil loss for both portions of the landfill. The top deck surface will consist of a 3% slope with a maximum length of 640 ft. The final cover system will consist of 4H:1V (25%) side slopes with "tack-on" side slope drainage terraces built on top of the side slope and having a resulting exterior side slope of 3H:1V. The maximum length of 4H:1V side slope between terraces is 200 ft. Also, a computation was performed for a hypothetical scenario of a 200-ft long side slope at 25% (in order to back-calculate the maximum terrace spacing that would yield an acceptably low soil loss). Based on these slope length, the following LS factors were selected (and interpolated if necessary) from Table 3E-2:

- Side Slopes – 4H:1V (25%) over the maximum Fairbanks Landfill design slope length (between terraces) of 200 ft, LS = 5.76
- Side Slopes – 4H:1V (25%) slope over a hypothetical design slope length of 220 feet (between terraces), LS = 6.01
- Top Deck – 3% slope over the maximum Fairbanks Landfill design slope length of 640 ft, LS = 0.53

3.4 Cover Management Factor (C)

The cover management factor is a function of the type of land cover, based on three factors: (i) the vegetative cover in direct contact with the soil surface, (ii) the canopy cover, and (iii) the effects at and beneath the surface. The final cover is categorized as having no appreciable canopy with a vegetated cover of grass, grass-like plants, decaying compacted duff or litter (which refers to mulch and similar organic matter) at least 2 inches deep. For

the "base case", the ground cover is estimated to be 95-100% ground cover, which is considered a reasonable and appropriate long-term condition because of the favorable climate in the area for establishing vegetation and the Post-Closure Plan's requirements for ongoing inspections, maintenance and mowing, and repairs. This results in a C value given in Table 3E-3 (USDA, 1977) of C = 0.003.

Also, a computation was performed for a hypothetical scenario on the top deck to whether the soil loss would be tolerable on top deck areas having only 70% ground cover (i.e., a C value of 0.0275, interpolating from Table 3E-3).

3.5 Erosion Control Practice Factor (P)

The erosion control practice factor considers topographical practices that will reduce erosion by altering runoff drainage patterns. This factor generally applies to agricultural cropping practices and is not anticipated for the landfill. Therefore, the P factor is assumed to be equal to one (1).

4 SOIL EROSION LOSS RESULTS

Applying the RUSLE with the parameters defined above, the computed soil loss in tons/acre/year is calculated as follows:

$$A = R \times K \times LS \times C \times P$$

- Side Slopes, Base Design Case (maximum of 200-ft between terraces): $A = 450 \times 0.37 \times 5.76 \times 0.003 \times 1 = 2.88$ tons/acre/year
- Side Slopes, Back-Calculated Hypothetical Case (220-ft between terraces) $A = 450 \times 0.37 \times 6.01 \times 0.003 \times 1 = 3.00$ tons/acre/year
- Top Deck, Base Design Case with 95-100% ground cover: $A = 450 \times 0.37 \times 0.53 \times 0.003 \times 1 = 0.26$ tons/acre/year
- Top Deck, Hypothetical Case with 70% ground cover: $A = 450 \times 0.37 \times 0.53 \times 0.0275 \times 1 = 2.43$ tons/acre/year

5 CONCLUSIONS AND RECOMMENDATIONS

Conclusions: Based on the analyses presented herein, the following conclusions are drawn:

- Overall, the calculated soil loss from the final cover system design is below or within the permissible soil loss of 2 to 3 tons/acre/year, as further differentiated below and clarified subsequently in the "Use of Results and Practical Recommendations" section.
    - The average annual soil loss from the final cover on the external side slopes for all of the variables selected as the base design case is 2.88 tons/acre/year, which is within the 2 to 3 tons/acre/year permissible rate of soil loss recommended by TCEQ (2007) for the final cover.
    - The annual soil loss from the final cover on the top deck surface as-designed is 0.26 tons/acre/year when there is 95-100% ground coverage assumed, or 2.43 tons/acre/year when a 70% ground cover age is assumed. Both top deck ground coverage scenarios are below or within the 2 to 3 tons/acre/year permissible rate of soil loss recommended by TCEQ (2007) for the final cover.
- To provide effective erosional stability against soil loss, the maximum spacing of the final cover side slope drainage terraces on the 25% external side slopes should be 220 ft or less. The design meets this requirement.

Use of Results and Practical Recommendations: The following discussion was added to clarify the calculated soil loss and soil stabilization (ground cover) practices and to further explain the basis for the calculation and the intended usage of results. For context, as indicated in Chapter 1 of the RUSLE Handbook, (USDA (1996):

> *The erosion rate for a given site results from a combination of many physical and management variables. Actual field measurements of soil loss would not be feasible for each level of these factors that occurs under field conditions. Soil-loss equations were developed to enable conservation planners, environmental scientists, and others concerned with soil erosion to extrapolate limited erosion data to the many localities and conditions that have not been directly represented in the research.*
>
> *RUSLE is an erosion model designed to predict the longtime average annual soil loss (A)* [emphasis added] *carried by runoff from a specific field slopes in specified cropping management systems as well as from*

> *rangeland... RUSLE users need to be aware that A (in addition to being a longtime average annual soil loss) is the average loss over a field slope and that the losses at various points on the slope may vary differently from one another.*

The above limitations from USDA should be kept in mind when reviewing site conditions and deciding on any corrective actions to take at a given point in time.

It also should be noted that the soil loss calculations use an assumed ground coverage percentage in order to select of the "C" factor in the soil loss equation. For the "base" design case, a long-term ground coverage of 95-100% was assumed, for the reasons justified previously. It should be recognized that this ground coverage is an annual average value and was used in an analysis to demonstrate adequate long-term erosion resistance of the final cover system consistent with the above-referenced RUSLE Handbook. It should also be recognized that the ground coverage factor is one of five (5) variables that are input into the soil loss equation. Since each of those variables contribute to the estimated soil loss, it would be possible to tolerate a lower ground coverage percentage if compensated for by different conditions for the other factors in the equation. For example, if a lower ground coverage exists during a dry year (i.e., a year that was not representative of the "average annual rainfall erosion index" (the "R" factor)), they could offset each other and produce an acceptable average annual soil loss. Similarly, if a lower ground coverage exists in an area where the slope length (the "LS" factor) is less than the maximum slope lengths assumed in the calculation, they could offset each other and produce an acceptable average annual soil loss.

Additionally, as demonstrated herein, the long-term annual average soil loss on the top deck would be calculated to be within permissible limits with a ground coverage of only 70%, all other things being equal.

For the reasons described above including the USDA statements that the RUSLE approach is to estimate longtime average annual conditions, and the potential inter-related variability of the other soil loss parameters, the 95-100% ground coverage is not intended as a specification or absolute requirement. In particular, it has been explicitly demonstrated herein that top deck areas perform adequately with only a 70% average annual ground coverage.

6 REFERENCES

NRCS (2012). Soil Data Mart, Natural Resources Conservation Service, United States Department of Agriculture, Soil Survey Geographic (SSURGO) Database, accessed 4 January 2012, http://soildatamart.nrcs.usda.gov.

TCEQ (2007). *Guidance for Addressing Erosional Stability During All Phases of Landfill Operation (Draft)*, Texas Commission on Environmental Quality, 14 February 2007.

USDA (1977). Procedure for Computing Sheet and Rill Erosion on Project Areas, United States Department of Agriculture, Soil Conservation Services, Engineering Division and Ecological Sciences and Technology Division, Technical Release No. 51, Revision 2.

USDA (1978). Predicting Rainfall Erosion Losses: A Guide to Conservation Planning, United States Department of Agriculture, Science and Education Administration, Agriculture Handbook Number 537.

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USDA (2004). Soil Survey of Fayette County, Texas, United States Department of Agriculture and Natural Resources Conservation Service, with Texas Agricultural Experiment Station and Texas State Soil and Water Conservation Board, Issued 2004.

TABLES

- Table 3E-1. Soil Erodibility Factor K for Gessner Soils (from NRCS, 2012)
- Table 3E-2. Values for Topographic Factor, LS, for High Ratio of Rill to Interrill Erosion (from USDA, 1996)
- Table 3E-3. C Factor Cover Values for Permanent Pasture, Rangeland, Idle Land, and Grazed Woodland (from USDA, 1977)

Table 3E-1. Soil Erodibility Factor K for Gessner Soils (from NRCS, 2012)

Harris County, Texas

Map symbol and soil name	Depth	Sand	Silt	Clay	Moist bulk density	Saturated hydraulic conductivity	Available water capacity	Linear extensibility	Organic matter	Erosion factors			Wind erodibility group	Wind erodibility index
										Kw	Kf	T		
	In	*Pct*	*Pct*	*Pct*	*g/cc*	*micro m/sec*	*In/In*	*Pct*	*Pct*					
Ad:														
Addicks	0-11	35-52	30-45	8-15	1.20-1.50	4.00-14.00	0.15-0.24	0.0-2.9	1.0-2.0	.43	.43	5	5	56
	11-49	30-50	40-60	10-18	1.20-1.50	4.00-14.00	0.15-0.24	0.0-2.9	0.1-0.5	.49	.49			
	49-78	15-50	40-55	10-30	1.20-1.60	4.00-14.00	0.15-0.24	3.0-5.9	0.1-0.5	.49	.49			
Ge:														
Gessner	0-16	---	---	6-15	1.35-1.60	4.00-14.00	0.10-0.15	0.0-2.9	0.5-2.0	.37	.37	5	5	56
	16-80	---	---	12-18	1.40-1.70	4.00-14.00	0.15-0.20	0.0-2.9	0.1-0.5	.43	.43			
Wo:														
Wockley	0-22	---	---	8-20	1.40-1.50	14.00-42.00	0.15-0.20	0.0-2.9	0.5-2.0	.32	.32	5	3	86
	22-60	---	---	18-35	1.50-1.70	1.40-4.00	0.12-0.18	0.0-2.9	0.1-0.5	.28	.28			

"Erosion factor Kw" indicates the erodibility of the whole soil. The estimates are modified by the presence of rock fragments.

"Erosion factor Kf" indicates the erodibility of the fine-earth fraction, or the material less than 2 millimeters in size.

"Erosion factor T" is an estimate of the maximum average annual rate of soil erosion by wind and/or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Table 3E-2. Values for Topographic Factor, LS, for Low Ratio of Rill to Interrill Erosion[1]

(from USDA, 1996)

Values for topographic factor, LS, for low ratio of rill to interrill erosion.[1]

	Horizontal slope length (ft)																
Slope (%)	<3	6	9	12	15	25	50	75	100	150	200	250	300	400	600	800	1000
0.2	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
0.5	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
1.0	0.12	0.12	0.12	0.12	0.12	0.13	0.13	0.14	0.14	0.15	0.15	0.15	0.15	0.16	0.16	0.17	0.17
2.0	0.20	0.20	0.20	0.20	0.20	0.21	0.23	0.25	0.26	0.27	0.28	0.29	0.30	0.31	0.33	0.34	0.35
3.0	0.26	0.26	0.26	0.26	0.26	0.29	0.33	0.36	0.38	0.40	0.43	0.44	0.46	0.48	0.52	0.55	0.57
4.0	0.33	0.33	0.33	0.33	0.33	0.36	0.43	0.46	0.50	0.54	0.58	0.61	0.63	0.67	0.74	0.78	0.82
5.0	0.38	0.38	0.38	0.38	0.38	0.44	0.52	0.57	0.62	0.68	0.73	0.78	0.81	0.87	0.97	1.04	1.10
6.0	0.44	0.44	0.44	0.44	0.44	0.50	0.61	0.68	0.74	0.83	0.90	0.95	1.00	1.08	1.21	1.31	1.40
8.0	0.54	0.54	0.54	0.54	0.54	0.64	0.79	0.90	0.99	1.12	1.23	1.32	1.40	1.53	1.74	1.91	2.05
10.0	0.60	0.63	0.65	0.66	0.68	0.81	1.03	1.19	1.31	1.51	1.67	1.80	1.92	2.13	2.45	2.71	2.93
12.0	0.61	0.70	0.75	0.80	0.83	1.01	1.31	1.52	1.69	1.97	2.20	2.39	2.56	2.85	3.32	3.70	4.02
14.0	0.63	0.76	0.85	0.92	0.98	1.20	1.58	1.85	2.08	2.44	2.73	2.99	3.21	3.60	4.23	4.74	5.18
16.0	0.65	0.82	0.94	1.04	1.12	1.38	1.85	2.18	2.46	2.91	3.28	3.60	3.88	4.37	5.17	5.82	6.39
20.0	0.68	0.93	1.11	1.26	1.39	1.74	2.37	2.84	3.22	3.85	4.38	4.83	5.24	5.95	7.13	8.10	8.94
25.0	0.73	1.05	1.30	1.51	1.70	2.17	3.00	3.63	4.16	5.03	5.76	6.39	6.96	7.97	9.65	11.04	12.26
30.0	0.77	1.16	1.48	1.75	2.00	2.57	3.60	4.40	5.06	6.18	7.11	7.94	8.68	9.99	12.19	14.04	15.66
40.0	0.85	1.36	1.79	2.17	2.53	3.30	4.73	5.84	6.78	8.37	9.71	10.91	11.99	13.92	17.19	19.96	22.41
50.0	0.91	1.52	2.06	2.54	3.00	3.95	5.74	7.14	8.33	10.37	12.11	13.65	15.06	17.59	21.88	25.55	28.82
60.0	0.97	1.67	2.29	2.86	3.41	4.52	6.63	8.29	9.72	12.16	14.26	16.13	17.84	20.92	26.17	30.68	34.71

[1]Such as for rangeland and other consolidated soil conditions with cover (applicable to thawing soil where both interrill and rill erosion are significant).

Table 3E-3. C Factor Cover Values for Permanent Pasture, Rangeland, Idle Land, and Grazed Woodland[1] (from USDA, 1977)

Vegetal Canopy			Cover That Contacts the Surface					
Type and Height of Raised Canopy[2]	Canopy Cover[3] %	Type[4]	Percent Ground Cover					
			0	20	40	60	80	95-100
No appreciable canopy		G	.45	.20	.10	.042	.013	.003
		W	.45	.24	.15	.090	.043	.011
Canopy of tall weeds or short brush (0.5 m fall ht.)	25	G	.36	.17	.09	.038	.012	.003
		W	.36	.20	.13	.082	.041	.011
	50	G	.26	.13	.07	.035	.012	.003
		W	.26	.16	.11	.075	.039	.011
	75	G	.17	.10	.06	.031	.011	.003
		W	.17	.12	.09	.067	.038	.011
Appreciable brush or bushes (2 m fall ht.)	25	G	.40	.18	.09	.040	.013	.003
		W	.40	.22	.14	.085	.042	.011
	50	G	.34	.16	.085	.038	.012	.003
		W	.34	.19	.13	.081	.041	.011
	75	G	.28	.14	.08	.036	.012	.003
		W	.28	.17	.12	.077	.040	.011
Trees but no appreciable low brush (4 m fall ht.)	25	G	.42	.19	.10	.041	.013	.003
		W	.42	.23	.14	.087	.042	.011
	50	G	.39	.18	.09	.040	.013	.003
		W	.39	.21	.14	.085	.042	.011
	75	G	.36	.17	.09	.039	.012	.003
		W	.36	.20	.13	.083	.041	.011

1/ All values shown assume: (1) random distribution of mulch or vegetation, and (2) mulch of appreciable depth where it exists. Idle land refers to land with undisturbed profiles for at least a period of three consecutive years. Also to be used for burned forest land and forest land that has been harvested less than three years ago.

2/ Average fall height of waterdrops from canopy to soil surface: m = meters.

3/ Portion of total-area surface that would be hidden from view by canopy in a vertical projection, (a bird's-eye view).

4/ G: Cover at surface is grass, grasslike plants, decaying compacted duff, or litter at least 2 inches deep.

W:Cover at surface is mostly broadleaf herbaceous plants (as weeds with little lateral-root network near the surface), and/or undecayed residue.

FIGURES

- Figure 3E-1. Average Annual Erosivity Factor, R, Isoerodent Map (from USDA, 1996)

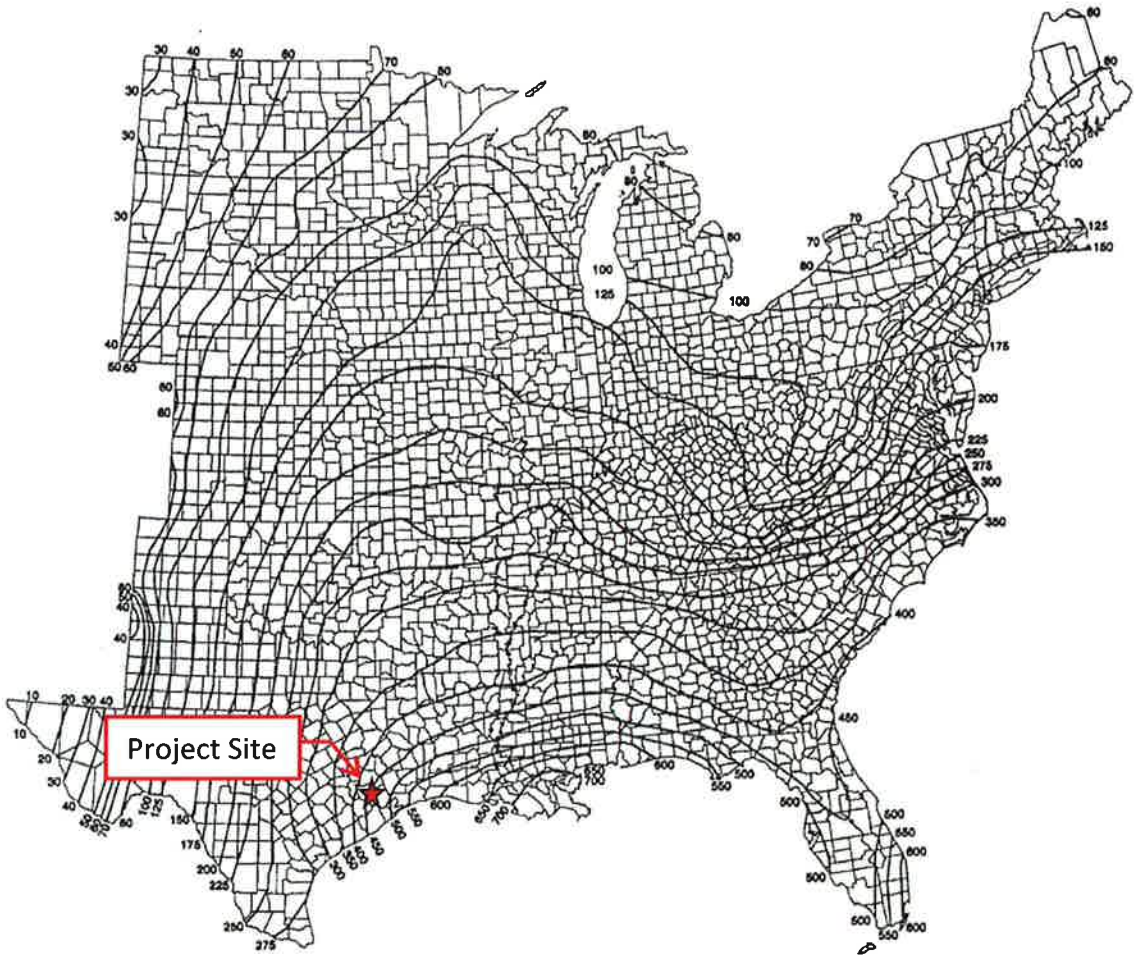


Figure 3E-1. Average Annual Rainfall Runoff Erosivity Factor, R, Isoerodent Map (from USDA, 1996)

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

PERMIT AMENDMENT APPLICATION

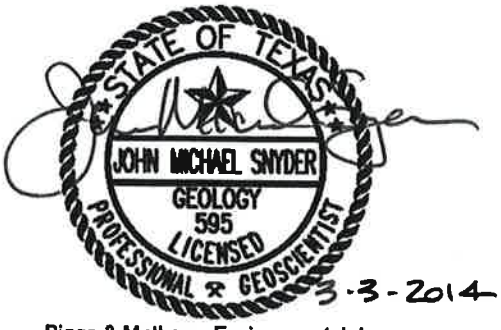
PART III – SITE DEVELOPMENT PLAN
ATTACHMENT 4
GEOLOGY REPORT

Prepared for

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

August 2013

Revised March 2014



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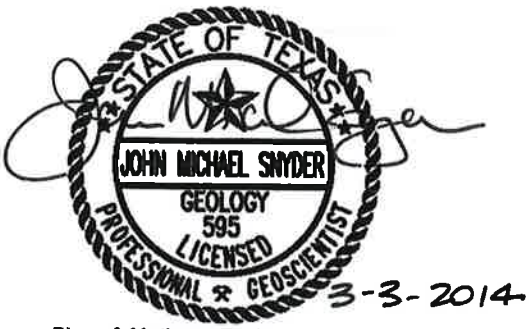

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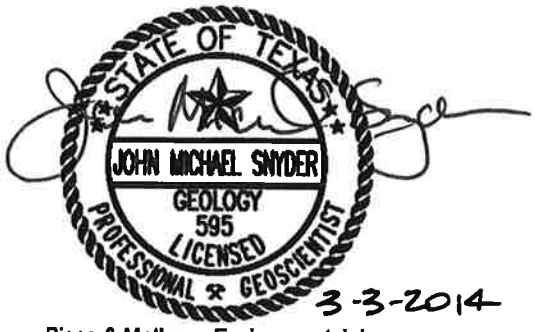

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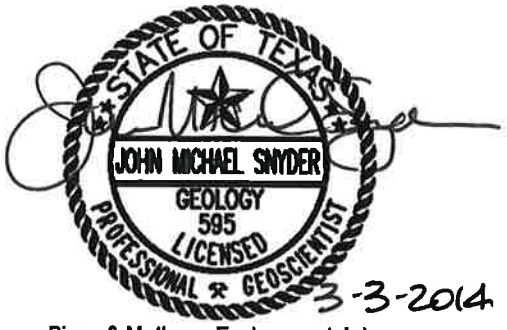

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3 REGIONAL AQUIFERS

30 TAC §330.63(e)(3)

Defined regional aquifers discussed in the following sections are the Chicot and Evangeline (Baker, 1979). The site is excavated within deposits of the Chicot Aquifer. Stratigraphically below the Chicot is the Evangeline Aquifer. The Burkeville confining system of the upper Miocene Fleming Formation serves as the lower confining unit to the Evangeline Aquifer. Results of a search for water wells in the area are also presented. Detailed site-specific hydrogeologic information is presented in Section 6.1 – Groundwater Occurrence and Section 6.3 – Site Hydrogeology.

3.1 Gulf Coast Aquifer

The Gulf Coast Aquifer (Kasmarek and Strom, 2002) is classified by the State of Texas as a major aquifer. In Texas, the Gulf Coast Aquifer extends from the Rio Grande Valley and northeastward to the Louisiana border, encompassing more than 50,000 square miles and all or parts of 54 counties (Ashworth and Hopkins, 1995). The Chicot and Evangeline comprise the Gulf Coast Aquifer (Kasmarek and Strom, 2002). These aquifers are regionally connected in a "leaky artesian aquifer" condition. The Chicot is the uppermost aquifer. The Evangeline occurs below the Chicot. The Burkeville Confining System, including the Fleming Formation, serves as the aquiclude to the Evangeline. The relative stratigraphic positions are shown on Figure 4A.3. Clay interbeds occurring within the Chicot and Evangeline serve as aquicludes to overlying sandy zones preventing local downward migration of groundwater. Deeper, confined zones within each aquifer results in a "leaky artesian aquifer" situation. This upward pressure gradient condition also prevents downward migration of groundwater. Hydraulic properties of the Chicot and Evangeline are summarized in Table 4-2 as follows.

4.4 Site Stratigraphy and Structure

The site is located on the surface outcrop of the Lissie Formation (Figure 4A-1). Field exploration programs have identified lithologies within the site boundary that are consistent with those described for the Lissie Formation (Wood, 1963). Strata encountered to a minimum elevation of 41 feet below msl indicate that sand, silt, and clay of the Lissie Formation are present within the site subsurface. In general, the Lissie Formation consists of beds and lenses of fine to coarse-grained sand grading into and interbedded with sandy clay and clay. Gravel is locally present.

Seven geologic cross sections were developed and interpreted from data provided on the logs of borings in Appendix 4B. Figure 4C-1 shows locations of the cross sections on a site map; the cross sections are on Figures 4C-2 through 4C-8. The cross sections provided data for the interpretation of the distribution of geologic and hydrogeologic units at the landfill site.

The site stratigraphy has been divided into five geologic units, designated Layer I, II, III, IV, and V. The five generalized units are listed in Table 4-4 and are described in the following sections. Layer I through V have been interpreted to be continuous and correlatable across the site. Layer II is a thick, saturated sand layer that has been interpreted as the uppermost groundwater zone. It is confined at its lower limit by a thick, continuous clay layer, designated Layer III. It has been largely excavated by previous sand mining and waste filling. Once the final waste fill excavation on the site is complete, limited Layer II sand will remain (Figure 4C-9). However, no Layer II sand remains at the east and south perimeter of the site. A deeper Layer IV sand was encountered below the Layer III clay and has also been interpreted to be continuous across the site. The Layer IV sand is the uppermost aquifer and is confined at its lower limit by a continuous clay layer, Layer V.

Table 4-4
Fairbanks Landfill
Generalized Site Stratigraphy

Geologic Unit	Average Depth to Top of Unit (ft)	Average Thickness of Unit (ft)	Hydrogeologic Unit
Layer I	Surface	14	Vadose Zone
Layer II	14	32	Uppermost Groundwater Zone
Layer III	46	25	Upper Confining Unit
Layer IV	71	50	Uppermost Aquifer
Layer V	122	*	Lower Confining Unit

* Site borings did not completely penetrate Layer V. The maximum thickness encountered was 30 feet.

4.4.1 Layer I Sand, Silt, and Clay

The Layer I geologic unit consists of surficial fine-grained sand, clayey and silty sand, silty and sandy clay, and clay (predominantly CL classified). In areas where landfill construction activities have taken place, Layer I consists of fill material of similar composition. Layer I soils were encountered from the surface to a maximum depth of approximately 40 feet. Average thickness of this layer is approximately 14 feet across the site. Correlation of individual sand and clay units within this layer was not attempted since they are discontinuous, grading from sandy to clayey lithologies, and because their correlation is not necessary for the hydrogeologic interpretation and design of the groundwater monitoring system.

4.4.2 Layer II Sand

Layer II is a fine-grained sand and silty sand unit with some clayey sand. Layer II sand was encountered in all of the borings completed at the site. As illustrated on the cross sections in Appendix 4C (Figures 4C-2 through 4C-8), this layer is continuous and correlatable across the site. A few discontinuous interbeds of clay and sandy clay occur within the Layer II sand. Over most of the site, Layer II has been largely removed by previous sand mining and waste fill excavation. Once the expansion area is excavated into the Layer III clay, limited Layer II sand will remain (Figures 4C-9, 4F-4, and 4F-3), primarily between excavated waste cells. However, the Layer II sand has been removed and does not exist at the east and south perimeter of the site. The thickness of Layer II ranges from approximately 20 to 40 feet. Average thickness is about 35 feet.

The Layer II sand unit is an unconfined, water-bearing zone and has been interpreted as the uppermost groundwater zone at the site. Groundwater levels within this zone have been affected by open excavations at the site and on adjacent properties throughout the site life. Multiple monitoring wells installed in Layer II are frequently found to be dry. Hydrogeologic characteristics of this unit are addressed in Section 6 of this attachment.

4.4.3 Layer III Clay

Layer III consists of a very stiff to hard, reddish brown and gray clay (mostly CH), silty clay, and sandy clay. This thick clay unit has an average thickness of about 27 feet and is continuous across the site. The Layer III clay, functions as the lower confining unit to the overlying Layer II groundwater zone and the upper confining unit to the underlying Layer IV uppermost aquifer due to the low permeability and continuity of this layer. The existing landfill is and the proposed landfill bottom will be excavated in the Layer III clay.

4.4.4 Layer IV Sand

A deeper sand unit was encountered below the Layer III clay. This deep sand unit, designated Layer IV, consists primarily of sand, silty sand, and gravelly sand. The average thickness encountered was 50 feet. The average depth to the top of this layer is approximately 65 feet. Layer IV is the uppermost aquifer beneath the site. A few discontinuous interbeds of clay and sandy clay occur within this layer of sand and have been labeled Layer IVA on the cross sections (Figures 4C-2 through 4C-8).

4.4.5 Layer V Clay

Layer V is a deep, continuous clay layer, below the Layer IV groundwater zone. Layer V consists of a hard, gray and light brown clay similar to the Layer III clay. The Layer V clay was not completely penetrated during exploration. The maximum thickness explored was 30 feet. The average depth to the top of this layer is 105 feet. Laboratory hydraulic conductivity tests on samples of the Layer V clay resulted in hydraulic conductivity values of 4.8×10^{-8} and 2.1×10^{-8} centimeters per second (cm/sec). Due to of the low permeability and continuity of the Layer V clay, this layer functions as the lower confining unit to the overlying Layer IV uppermost aquifer.

Table 4-9
Hydraulic Conductivity Values
Fairbanks Landfill

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

6.3 Site Hydrogeology

6.3.1 Layer II Groundwater Zone

As described in Section 4.4, site stratigraphy is divided into five geologic units: Layer I (surficial sand, silt, and clay), Layer II (sand), Layer III (clay), Layer IV (sand) and Layer V (clay). The uppermost groundwater zone at the site is the Layer II sand unit. Water levels measured in site monitoring wells and exploratory borings indicate that groundwater in the upper Layer II sand unit occurs under generally unconfined, water-table conditions and is confined or retarded at its lower limit by the underlying Layer III clay. The thickness of Layer II ranges from approximately 20 to 40 feet and has an average thickness of approximately 35 feet. Open excavations on the site and adjacent properties have been excavated for sand mining and waste filling operations. Over most of the existing site the Layer II sand has been removed. When the excavation for the proposed waste area is complete Layer II will have been removed over most of the site across both the existing site and the proposed expansion area (see Figure 4C-9, 4F-2, and 4F-3). As shown on these site cross sections, Layer II sand will remain in place between the previous waste fill units but will not exist on the south and east perimeters of the site. Groundwater levels in Layer II are affected by natural dewatering related to evaporation in the open excavation. Monitoring wells and piezometers near the open excavations are frequently dry. Figure 4F-1 is a potentiometric surface map constructed from water levels in site piezometers during the site characterization prior to site excavation. Figure 4F-2 shows a potentiometric surface constructed from groundwater

monitoring wells and piezometers from a May 2012 water level reading event. Groundwater currently only exists in the limited areas where Layer II still exists. Figure 4F-3 depicts that Layer II sand will have been removed from much of the site when the expansion area is excavated. The Layer II sand has been removed from the east and south perimeter of the site. Natural groundwater flow direction in the Layer II sand is toward the southeast. Because that groundwater flow has been cut off by the excavations, clay liners, clayey fill , and clayey constructed fill groundwater no longer will flow beneath the site, but rather will be diverted around the site to the northeast and southwest parts of the site.

6.3.2 Layer III Confining Unit

The low permeability (predominantly CH clay) and continuity of Layer III enable this thick clay unit to function as the confining unit between the uppermost Layer II sand groundwater zone and the deeper Layer IV sand. The thickness of Layer III clay encountered at the site ranges from approximately 18 to 34 feet and averages approximately 27 feet. The proposed landfill bottom will be excavated in the Layer III clay.

Three Layer III clay piezometers, P-3A, P-E1, and P-5A, were installed in July and August 1997. Water levels measured in these piezometers indicate that groundwater in this clay unit is limited and that the permeability of the clay is low. Piezometer P-E1 in the northwest corner of the site was basically dry until October 1997, with less than one foot of water in the bottom of the well. Water level measurement in P-E1 is 57.80 feet above msl, indicating a very slow recovery rate of less than 0.02 feet per day. P-5A in the southwest corner of the site has had approximately two feet of water column since its installation in August 1997. Because the clay piezometer borings were completed using wet rotary drilling techniques, the small volumes of water observed in these wells are probably artifacts of the drilling fluid. The highest groundwater elevation in P-3A was observed on November 21, 1997, at 63.96 feet above msl. The recovery rate for P-3A is about 0.03 feet per day. The high groundwater elevation (63.96 feet above msl) in the Layer III clay is 35 feet lower than the highest water level in the overlying Layer II groundwater zone and 10 feet higher than the highest water level in the underlying Layer IV groundwater zone.

6.3.3 Layer IV Uppermost Aquifer

The maximum thickness explored was approximately 60 feet; the average thickness of the Layer IV sand is approximately 50 feet.

Three Layer IV sand piezometers, P-3B, P-E2, and P-5B, were installed in July and August 1997. Groundwater elevations measured since August 5, 1997, indicate that water levels are stable in these wells. An additional five Layer IV sand piezometers, P-6 through P-10, were installed in October 1997. Eight monitoring wells (MW-8 through MW-15) were installed in 1997. Two piezometers were installed in the expansion area in 2012 as part of this study. The highest measured water level elevation in Layer IV was observed on July 16, 2009 at 54.62 feet above msl in monitoring well MW-15. This elevation is approximately 10 feet lower than the highest measured elevation in the overlying Layer III clay and approximately 55 feet lower than the highest elevation in the uppermost Layer II groundwater zone, indicating that these three geologic units are not

hydraulically connected. Groundwater in the Layer IV sand is confined. Layer IV groundwater elevations are listed in Table 4-6 and Table 4-7.

6.3.4 Layer V Lower Confining Unit

Layer V is a continuous, low permeability clay layer that functions as the lower confining unit to the overlying Layer IV uppermost aquifer. The maximum thickness explored was approximately 30 feet. Laboratory hydraulic conductivity tests on samples of the Layer V clay resulted in hydraulic conductivity values of 4.8×10^{-8} and 2.1×10^{-8} centimeters per second (cm/sec). Layer V is interpreted to be continuous across the site. Its composition and permeability is similar to the Layer III clay, making it an effective lower confining unit.

6.4 Groundwater Flow Direction and Rate

Shallow Layer II groundwater in the site area naturally flows to the southeast. Because extensive excavation activities have removed a large portion of the sands in the uppermost Layer II zone, shallow groundwater flow within the site boundary is toward open excavations. When the waste fill excavations are complete, nearly all of the Layer II sand will be removed and replaced with clay liners, clayey fill materials, and constructed clay sidewalls and thus no groundwater will be able to flow in this sand beneath the site. Layer II groundwater flowing from the upgradient northwest will be cut off and diverted around the site toward the northeast and southwest corners of the site and toward offsite areas.

Groundwater flow in the deeper Layer IV sand unit is to the northwest. Groundwater in Layer IV is confined at its upper limit by the overlying Layer III clay and at its lower limit by the underlying Layer V clay. Groundwater in the deeper Layer IV zone is not hydraulically connected to groundwater in the uppermost Layer II zone.

Travel times across the site were estimated using the formula:

$$v = (k * i) / n_e$$

Where: v = travel velocity
k = hydraulic conductivity of the aquifer
i = hydraulic gradient
n_e = effective porosity

Groundwater velocity for the deeper Layer IV uppermost aquifer was calculated using the geometric mean of the hydraulic conductivity values from slug tests in Layer IV piezometers (see Section 6.2), hydraulic gradients from the potentiometric surface maps on Figures 4F-4 and 4F-15 in Appendix 4F, and an effective porosity of 30 percent for fine sand. Groundwater flow velocity is estimated to flow at approximately *four feet per year* in Layer IV. All input values and calculation to determine groundwater velocity are shown on the groundwater velocity calculation sheet in Appendix F4, Figure 4F-16.

6.5 Arid Exemption

The applicant is not seeking an arid exemption for the landfill unit; therefore, 30 TAC §330.63(e)(6) is not applicable to this application.

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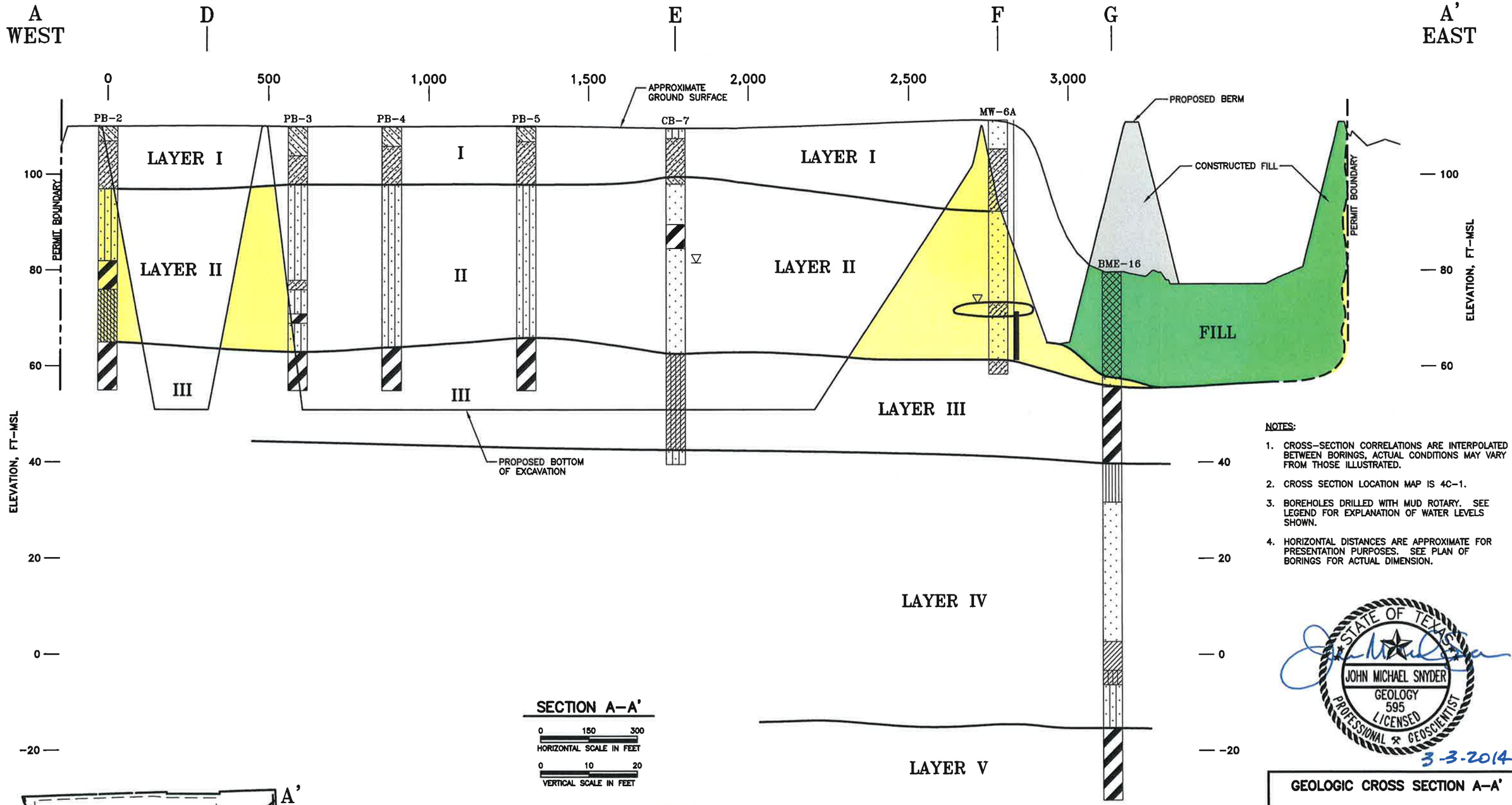


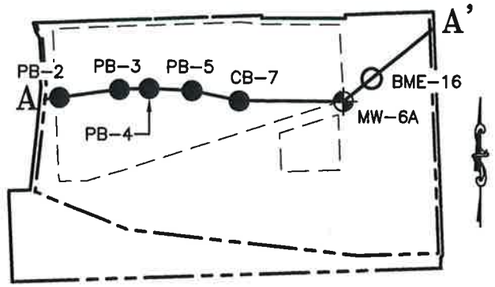
NOTES:

1. CROSS-SECTION CORRELATIONS ARE INTERPOLATED BETWEEN BORINGS, ACTUAL CONDITIONS MAY VARY FROM THOSE ILLUSTRATED.
2. CROSS SECTION LOCATION MAP IS 4C-1.
3. BOREHOLES DRILLED WITH MUD ROTARY. SEE LEGEND FOR EXPLANATION OF WATER LEVELS SHOWN.
4. HORIZONTAL DISTANCES ARE APPROXIMATE FOR PRESENTATION PURPOSES. SEE PLAN OF BORINGS FOR ACTUAL DIMENSION.

SECTION A-A'

0 150 300
HORIZONTAL SCALE IN FEET

0 10 20
VERTICAL SCALE IN FEET



SECTION KEY

LEGEND

- Fill
- Sand
- Clay (CL)
- Silt
- Fill
- Silty Sand
- Clay (CH)
- Sandy Clay
- Clayey Silt
- Layer II Sand Remaining
- Clayey Sand
- Silty Sand w/Clay
- Silty Clay
- Constructed Fill

- Water encountered while drilling
- Water level in piezometer on August 27, 2012
- Screened Interval Piezometer

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GEOLOGIC CROSS SECTION A-A'

WASTE MANAGEMENT OF TEXAS, INC.
FAIRBANKS LANDFILL
PERMIT AMENDMENT APPLICATION

BIGGS & MATHEWS ENVIRONMENTAL
CONSULTING ENGINEERS
MANSFIELD • WICHITA FALLS
817-563-1144

TBPE FIRM NO. F-256 | TBPG FIRM NO. 50222

DSN. JMS	DATE : 7/13	FIGURE	4C-2
DWN. SRC	SCALE : GRAPHIC		
CHK. JMS	DWG : 4C-2_Section-A.dwg		

J:\101\26\102\ATT 4C\4C-2_Section-A.dwg Layout: Layout1 User: scundiff

B WEST — D — E — F — G — B' EAST

0 — 500 — 1,000 — 1,500 — 2,000 — 2,500 — 3,000

PROPOSED BERM — CONSTRUCTED FILL — PROPOSED POND — CONSTRUCTED FILL BME-14

BME-1 — BME-3 — BME-5 — BME-7 — BME-9 — BME-11

APPROXIMATE GROUND SURFACE

PERMIT BOUNDARY

ELEVATION, FT-MSL

100 — 80 — 60 — 40 — 20 — 0 — -20 — -40

II

FILL

FILL

FILL

III

LAYER III

III

PROPOSED BOTTOM OF EXCAVATION

IV-A

IV-A

LAYER IV

IV

IV-A

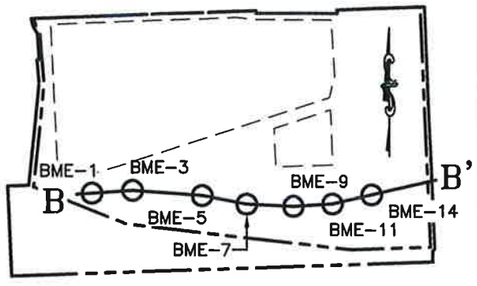
IV

IV

LAYER V

V

V



SECTION KEY

LEGEND

- Fill
- Sandy Clay
- Silty Sand
- Silty Clay
- Clayey Sand
- Silt
- Sand
- Clayey Silt
- Clay (CH)
- Fill
- Clay (CL)
- Layer II Sand Remaining
- Constructed Fill

NOTES:

1. CROSS-SECTION CORRELATIONS ARE INTERPOLATED BETWEEN BORINGS, ACTUAL CONDITIONS MAY VARY FROM THOSE ILLUSTRATED.
2. CROSS SECTION LOCATION MAP IS 4C-1.
3. BOREHOLES DRILLED WITH MUD ROTARY. SEE LEGEND FOR EXPLANATION OF WATER LEVELS SHOWN.
4. HORIZONTAL DISTANCES ARE APPROXIMATE FOR PRESENTATION PURPOSES. SEE PLAN OF BORINGS FOR ACTUAL DIMENSION.

SECTION B-B'

0 150 300
HORIZONTAL SCALE IN FEET

0 10 20
VERTICAL SCALE IN FEET

STATE OF TEXAS
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GEOLOGIC CROSS SECTION B-B'

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DWN.	SRC	SCALE :	GRAPHIC
CHK.	JMS	DWG :	4C-3_Section-B.dwg

FIGURE 4C-3

J:\101\26\102\ATT 4C\4C-3_Section-B.dwg Layout: Layout1 User: scundiff

C WEST | D | E | F | G | C' EAST

0 | 500 | 1,000 | 1,500 | 2,000 | 2,500

BME-2 | BME-4 | BME-6 | BME-10 | BME-12 | BME-13

APPROXIMATE GROUND SURFACE

PROPERTY BOUNDARY

PERMIT BOUNDARY

DRY

FILL

II

III

LAYER III

IV

IV-A

LAYER IV

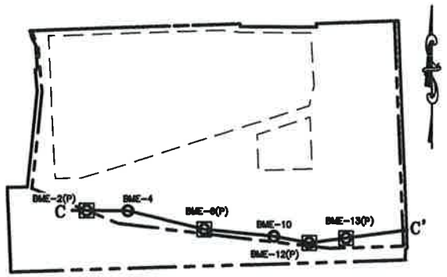
LAYER IV-A

V

LAYER V

ELEVATION, FT-MSL

100 — 80 — 60 — 40 — 20 — 0 — -20 — -40



SECTION KEY

LEGEND

- Fill
- Clay (CL)
- Silty Sand
- Sandy Clay
- Clayey Sand
- Silty Clay
- Sand
- Silt
- Clay (CH)
- Clayey Silt
- Fill
- Layer II Sand Remaining
- Water level in piezometer on August 27, 2012
- Screened interval Piezometer

NOTES:

1. CROSS-SECTION CORRELATIONS ARE INTERPOLATED BETWEEN BORINGS, ACTUAL CONDITIONS MAY VARY FROM THOSE ILLUSTRATED.
2. CROSS SECTION LOCATION MAP IS 4C-1.
3. BOREHOLES DRILLED WITH MUD ROTARY. SEE LEGEND FOR EXPLANATION OF WATER LEVELS SHOWN.
4. HORIZONTAL DISTANCES ARE APPROXIMATE FOR PRESENTATION PURPOSES. SEE PLAN OF BORINGS FOR ACTUAL DIMENSION.

SECTION C-C'

0 150 300
HORIZONTAL SCALE IN FEET

0 10 20
VERTICAL SCALE IN FEET

STATE OF TEXAS
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GEOLOGIC CROSS SECTION C-C'

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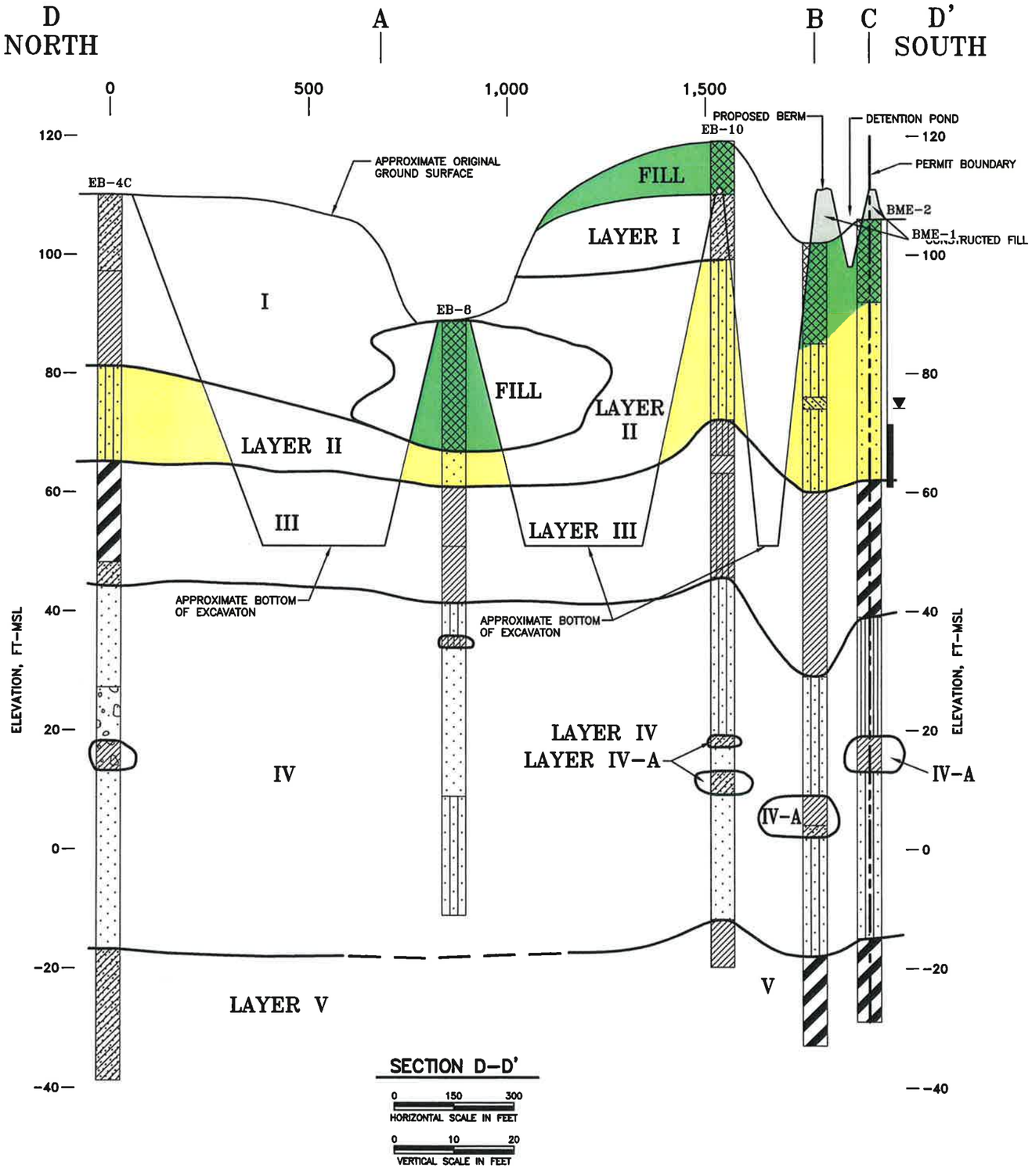
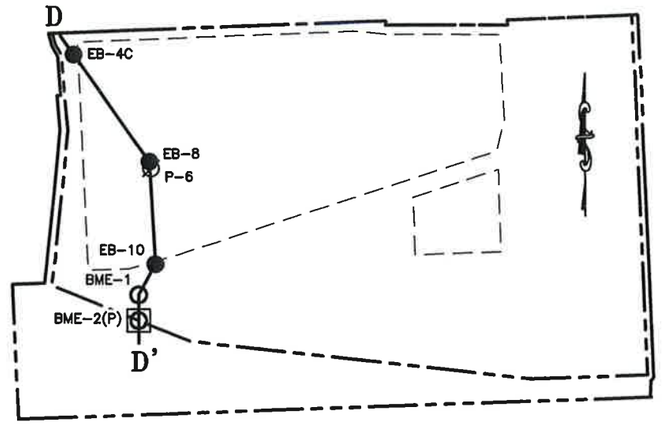
DSN. JMS	DATE : 7/13	FIGURE	4C-4
DWN. SRC	SCALE : GRAPHIC		
CHK. JMS	DWG : 4C-4_Section-C.dwg		

J:\101\26\102\ATT 4C\4C-4_Section-C.dwg Layout: Layout1 User: scundiff





SECTION KEY

LEGEND

- Fill
- Clay (CL)
- Gravelly Sand
- Water level in piezometer on August 27, 2012
- Silty Sand
- Clay (CH)
- Gravelly Clay
- Screened Interval Piezometer
- Clayey Sand
- Sandy Clay
- Silty Clay
- Sand
- Silty Clay
- Clay w/Silt & Sand
- Constructed Fill
- Fill
- Layer II Sand Remaining

NOTES:

1. CROSS-SECTION CORRELATIONS ARE INTERPOLATED BETWEEN BORINGS, ACTUAL CONDITIONS MAY VARY FROM THOSE ILLUSTRATED.
2. CROSS SECTION LOCATION MAP IS 4C-1.
3. BOREHOLES DRILLED WITH MUD ROTARY. SEE LEGEND FOR EXPLANATION OF WATER LEVELS SHOWN.
4. HORIZONTAL DISTANCES ARE APPROXIMATE FOR PRESENTATION PURPOSES. SEE PLAN OF BORINGS FOR ACTUAL DIMENSION.
5. BORINGS DRILLED PRIOR TO 2012 HAVE BEEN ADJUSTED USING THE NEW SITE BENCHMARK OF 105.7 AND ARE APPROXIMATE.

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GEOLOGIC CROSS SECTION D-D'

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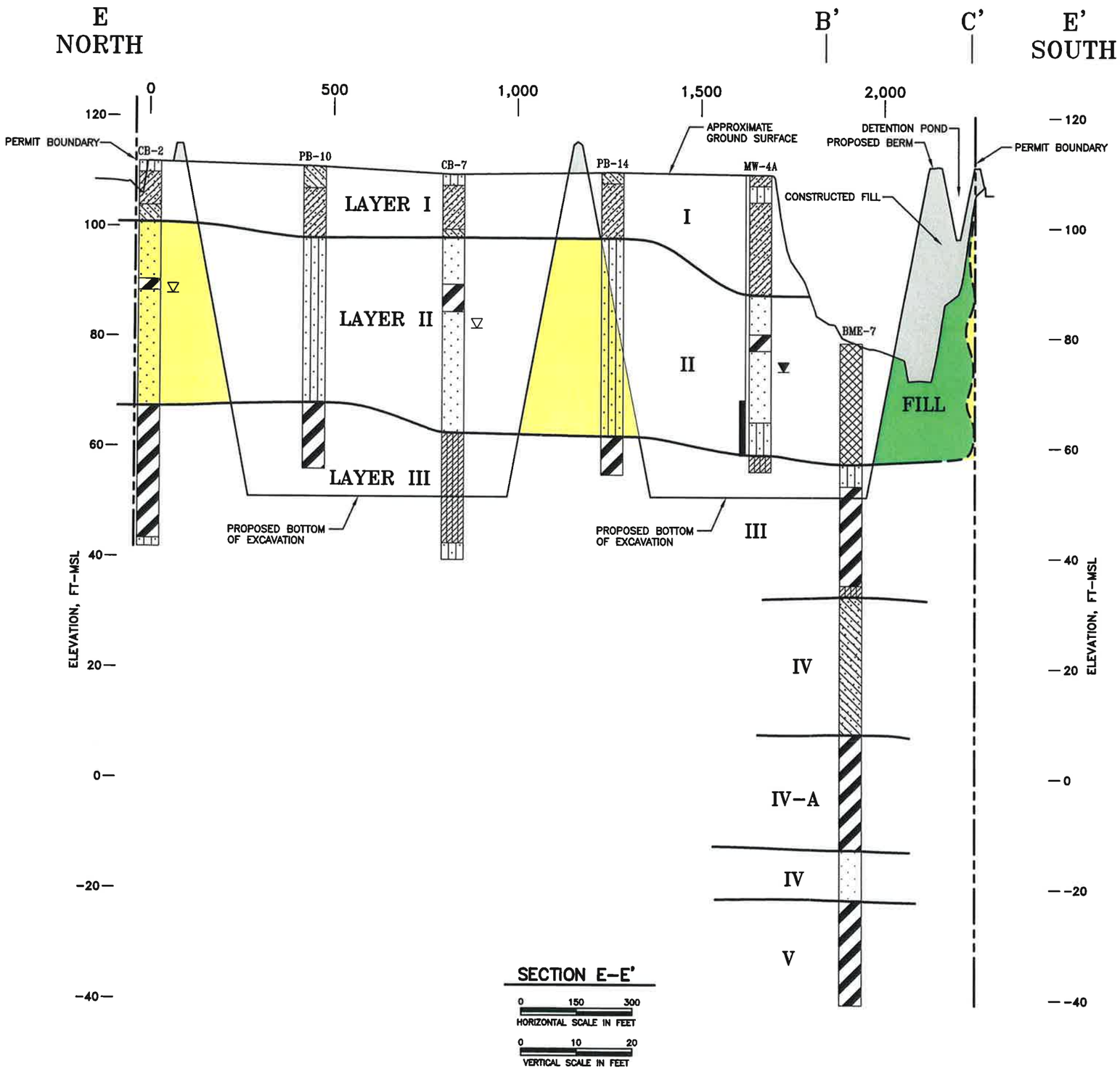
DSN. JMS | DATE : 7/13
DWN. SRC | SCALE : GRAPHIC
CHK. JMS | DWG : 4C-5_Section-D.dwg

FIGURE 4C-5

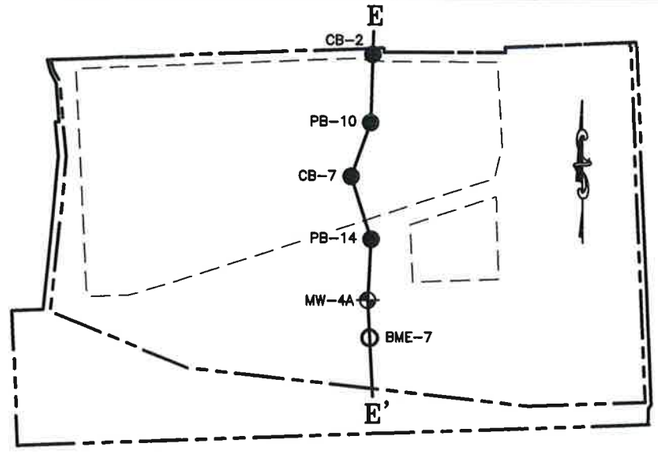
J:\101\26\102\ATT 4C\4C-5_Section-D.dwg Layout: Layout1 User: scundiff



SECTION E–E'

0 150 300
HORIZONTAL SCALE IN FEET

0 10 20
VERTICAL SCALE IN FEET



SECTION KEY

LEGEND

- Fill
- Clay (CH)
- Water encountered while drilling
- Water level in piezometer on August 27, 2012
- Silty Sand
- Sandy Clay
- Screened Interval Piezometer
- Clayey Sand
- Silty Clay
- Fill
- Sand
- Constructed Fill
- Layer II Sand Remaining

NOTES:

1. CROSS–SECTION CORRELATIONS ARE INTERPOLATED BETWEEN BORINGS, ACTUAL CONDITIONS MAY VARY FROM THOSE ILLUSTRATED.
2. CROSS SECTION LOCATION MAP IS 4C–1.
3. BOREHOLES DRILLED WITH MUD ROTARY. SEE LEGEND FOR EXPLANATION OF WATER LEVELS SHOWN.
4. HORIZONTAL DISTANCES ARE APPROXIMATE FOR PRESENTATION PURPOSES. SEE PLAN OF BORINGS FOR ACTUAL DIMENSION.
5. BORINGS DRILLED PRIOR TO 2012 HAVE BEEN ADJUSTED USING THE NEW SITE BENCHMARK OF 105.7 AND ARE APPROXIMATE.

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GEOLOGIC CROSS SECTION E–E'

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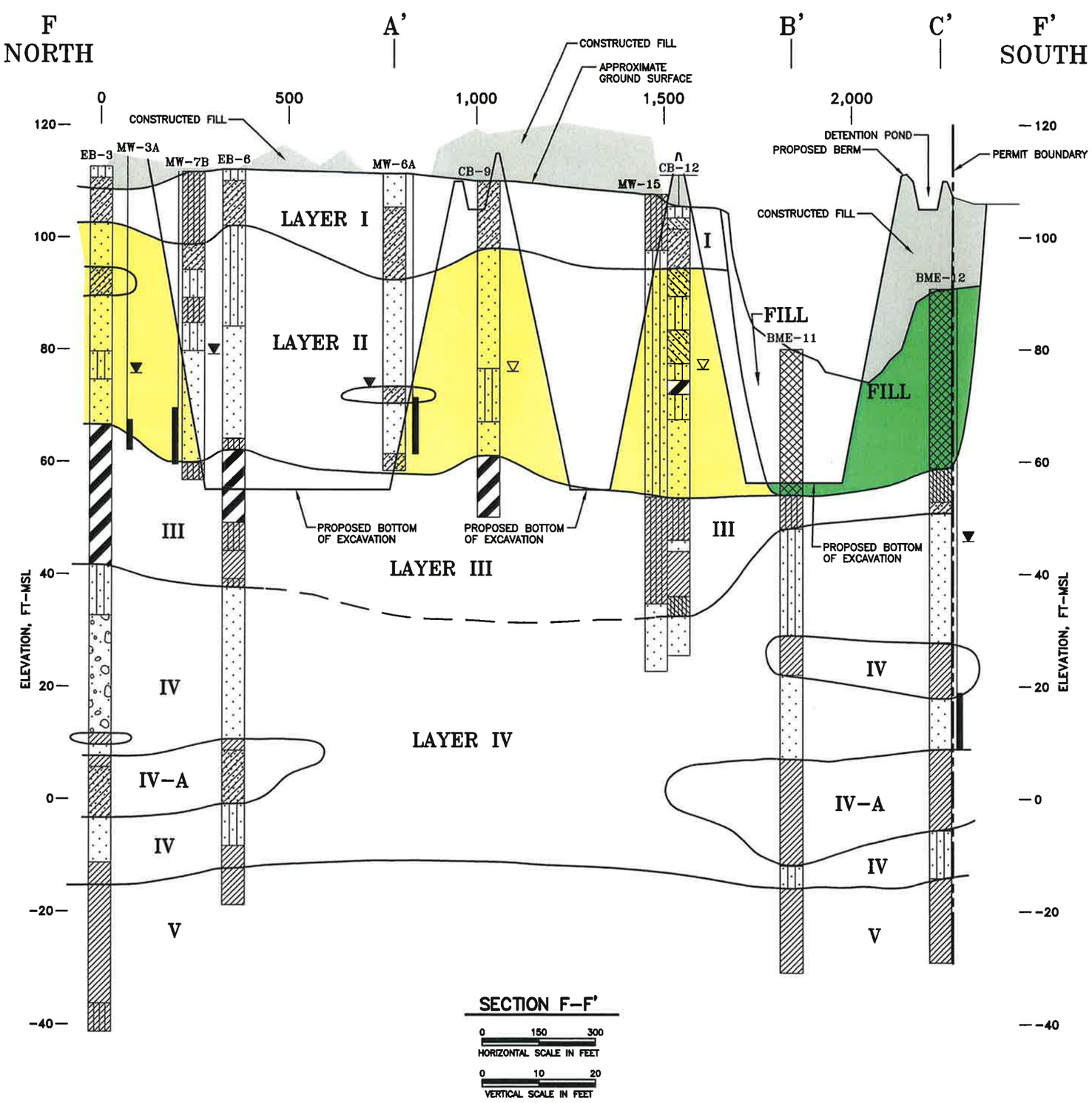
DSN. JMS DATE : 7/13
DWN. SRC SCALE : GRAPHIC
CHK. JMS DWG : 4C-6_Section-E.dwg

FIGURE 4C-6

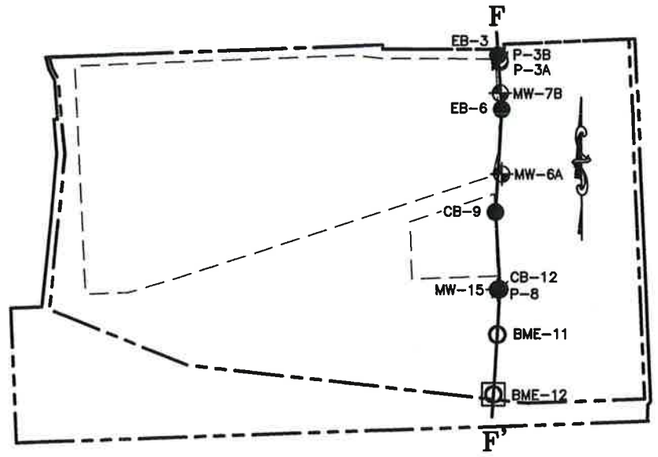
J:\101\26\102\ATT 4C\4C-6_Section-E.dwg Layout: Layout1 User: scundiff



SECTION F–F'

0 150 300
HORIZONTAL SCALE IN FEET

0 10 20
VERTICAL SCALE IN FEET



SECTION KEY

LEGEND

- Fill
- Clay (CH)
- Water encountered while drilling
- Water level in piezometer on August 27, 2012
- Silty Sand
- Sandy Clay
- Screened Interval Piezometer
- Clayey Sand
- Silty Clay
- Constructed Fill
- Sand
- Gravelly Sand
- Fill
- Clay (CL)
- Clayey Silt
- Layer II Sand Remaining

NOTES:

1. CROSS-SECTION CORRELATIONS ARE INTERPOLATED BETWEEN BORINGS, ACTUAL CONDITIONS MAY VARY FROM THOSE ILLUSTRATED.
2. CROSS SECTION LOCATION MAP IS 4C-1.
3. BOREHOLES DRILLED WITH MUD ROTARY. SEE LEGEND FOR EXPLANATION OF WATER LEVELS SHOWN.
4. HORIZONTAL DISTANCES ARE APPROXIMATE FOR PRESENTATION PURPOSES. SEE PLAN OF BORINGS FOR ACTUAL DIMENSION.
5. BORINGS DRILLED PRIOR TO 2012 HAVE BEEN ADJUSTED USING THE NEW SITE BENCHMARK OF 105.7 AND ARE APPROXIMATE.
6. EXCAVATION DEPTHS PROJECTED ON TO THE LINE OF SECTION.

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GEOLOGIC CROSS SECTION F–F'

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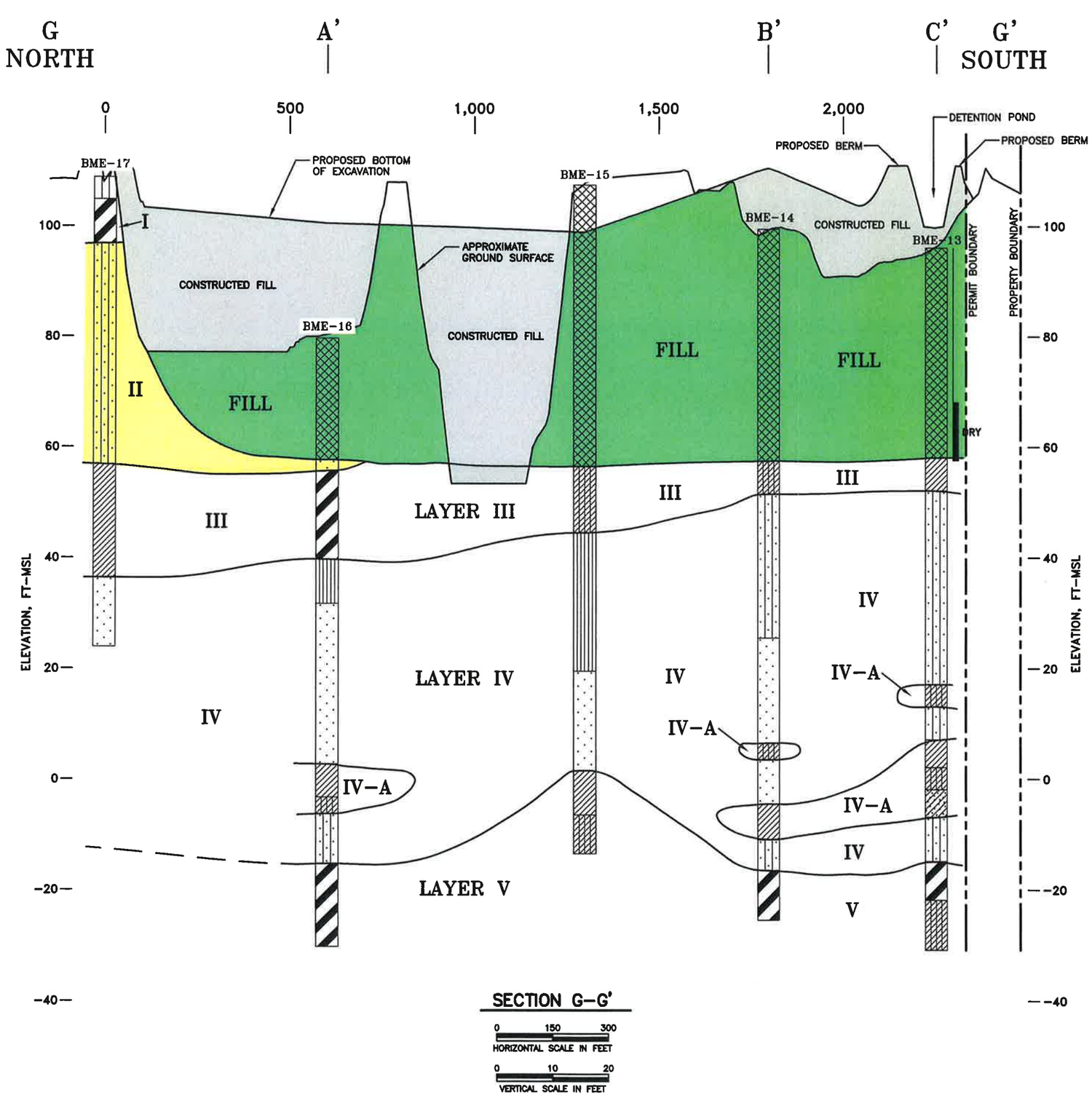
DSN. JMS DATE : 7/13
DWN. SRC SCALE : GRAPHIC
CHK. JMS DWG : 4C-7_Section-F.dwg

FIGURE 4C-7

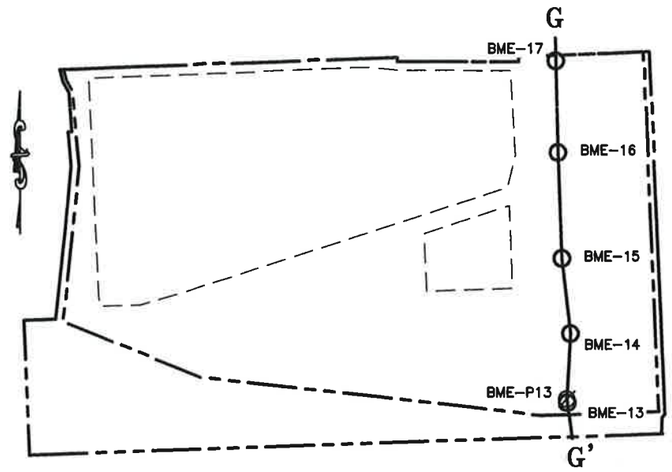
J:\101\26\102\ATT 4C\4C-7_Section-F.dwg Layout: Layout1 User: scundiff



SECTION G–G'

0 150 300
HORIZONTAL SCALE IN FEET

0 10 20
VERTICAL SCALE IN FEET



SECTION KEY

LEGEND

- Fill
- Silt
- Sandy Silt
- Silty Clay
- Clayey Silt
- Constructed Fill
- Silty Sand
- Sandy Clay
- Fill
- Clay (CL)
- Sand
- Layer II Sand Remaining
- Water level in piezometer on August 27, 2012
- Screened interval Piezometer

NOTES:

1. CROSS–SECTION CORRELATIONS ARE INTERPOLATED BETWEEN BORINGS, ACTUAL CONDITIONS MAY VARY FROM THOSE ILLUSTRATED.
2. CROSS SECTION LOCATION MAP IS 4C–1.
3. BOREHOLES DRILLED WITH MUD ROTARY. SEE LEGEND FOR EXPLANATION OF WATER LEVELS SHOWN.
4. HORIZONTAL DISTANCES ARE APPROXIMATE FOR PRESENTATION PURPOSES. SEE PLAN OF BORINGS FOR ACTUAL DIMENSION.

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GEOLOGIC CROSS SECTION G–G'

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REVISIONS						
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DSN. JMS | DATE : 7/13
DWN. SRC | SCALE : GRAPHIC
CHK. JMS | DWG : 4C–8_Section–G.dwg

FIGURE 4C–8

J:\101\26\102\ATT 4C\4C-8_Section-G.dwg Layout: Layout1 User: scundiff



LEGEND

- PERMIT BOUNDARY
- PROPOSED PERMIT BOUNDARY
- PROPERTY BOUNDARY
- PERMITTED FOOTPRINT
- PROPOSED FOOTPRINT
- MW-5A — MONITOR WELL LOCATION
- P-1 — EXISTING PIEZOMETER
- EB-1 — EXISTING BORING LOCATION
- EB-3 — EXISTING BORING THAT REACHED LAYER V CLAY
- BME-1 — BME BORING LOCATION ALL > 30' DEEP
- BME-P6 — BME PIEZOMETER LOCATION (LAYER II & IV)
- LAYER II ABSENT
- LAYER II REMAINING IN PLACE

NOTE:

1. TOPOGRAPHY FROM AERIAL PHOTOGRAPHY BY DALLAS AERIAL SURVEYS, INC., DATED 03/26/2012.

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LAYER II SAND REMOVAL

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MANSFIELD ◆ WICHITA FALLS
817-563-1144

TBPE FIRM NO. F-256 | TBPG FIRM NO. 50222

DSN. JMS	DATE : 7/13	FIGURE	4C-9
DWN. SRC	SCALE : GRAPHIC		
CHK. JMS	DWG : 4C-9_LAYER II ABSENT.dwg		

J:\101\26\102\ATT 4C\4C-9_LAYER II ABSENT.dwg Layout: Layout1 User: scundiff



0 200 400
SCALE IN FEET

LEGEND

- PERMIT BOUNDARY
- PROPOSED PERMIT BOUNDARY
- PERMITTED FOOTPRINT
- PROPOSED FOOTPRINT
- 45 — POTENTIOMETRIC SURFACE CONTOUR
- MW-5A — MONITOR WELL LOCATION
- BME-P6 — BME PIEZOMETER LOCATION (LAYER II & IV)
- LAYER II ABSENT
- LAYER II REMAINING IN EXCAVATION SIDEWALL

NOTE:

1. TOPOGRAPHY FROM AERIAL PHOTOGRAPHY BY DALLAS AERIAL SURVEYS, INC., DATED 03/26/2012.

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POTENTIOMETRIC SURFACE MAP LAYER II – MAY 24, 2012

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REV	DATE	DESCRIPTION	DWN BY	DES BY	CHK BY	APP BY

DSN. JMS	DATE : 07/13	FIGURE
DWN. SRC	SCALE : GRAPHIC	4F-2
CHK. JMS	DWG : 4F-2_Lyrll_5-24-12.dwg	

J:\101\26\102\ATT 4F\LAYER II\4F-2_Lyrll_5-24-12.dwg Layout: Layout1 User: scl



0 200 400
SCALE IN FEET

LEGEND

- PERMIT BOUNDARY
- PROPOSED PERMIT BOUNDARY
- PERMITTED FOOTPRINT
- PROPOSED FOOTPRINT
- MW-5A — MONITOR WELL LOCATION
- BME-P6 — BME PIEZOMETER LOCATION (LAYER II & IV)
- LAYER II ABSENT
- LAYER II REMAINING IN EXCAVATION SIDEWALL

NOTE:

1. TOPOGRAPHY FROM AERIAL PHOTOGRAPHY BY DALLAS AERIAL SURVEYS, INC., DATED 03/26/2012.

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LAYER II SAND – REMOVED

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REV	DATE	DESCRIPTION	DWN BY	DES BY	CHK BY	APP BY

DSN. JMS	DATE : 07/13	FIGURE
DWN. SRC	SCALE : GRAPHIC	4F-3
CHK. JMS	DWG : 4F-3_Lyrll_5-24-12.dwg	

J:\101\26\102\ATT 4F\LAYER II\4F-3_Lyrll_5-24-12.dwg Layout: Layout1 User: scu.

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

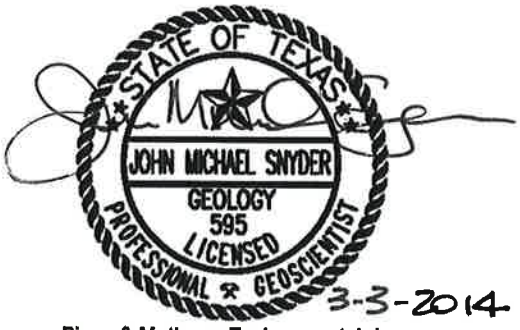
PART III – SITE DEVELOPMENT PLAN
ATTACHMENT 5
GROUNDWATER MONITORING PLAN

Prepared for

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

August 2013

Revised March 2014



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

Prepared by

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

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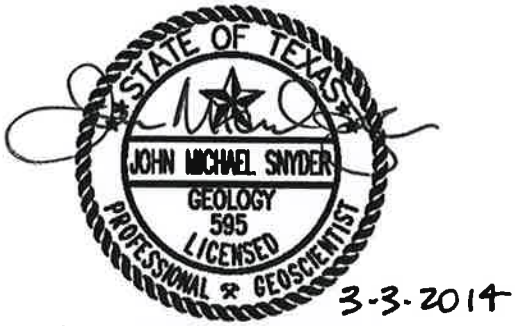

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GROUNDWATER MONITORING SYSTEM DESIGN CERTIFICATION

General Site Information

Site: Fairbanks Landfill

Site Location: Harris County, Texas

MSW Permit Application No.: 1565B

Qualified Groundwater Scientist Statement

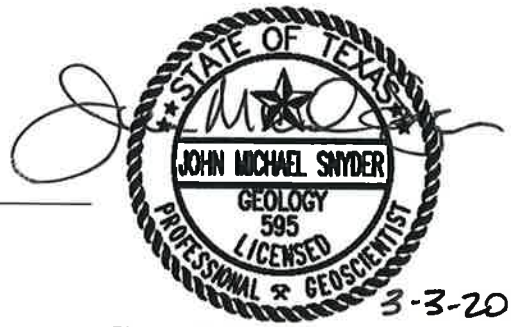
I, Michael Snyder, am a licensed professional geoscientist in the State of Texas and a qualified groundwater scientist as defined in 30 TAC §330.3. I have reviewed the groundwater monitoring system and supporting data contained herein. In my professional opinion, the groundwater monitoring system is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

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

Signature: _____

Michael Snyder, P.G.
No. 595-Texas

Date: _____



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1 SITE HYDROGEOLOGY

1.1 Hydrogeologic Units

1.1.1 Layer II Groundwater Zone

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

Open excavations on the site and adjacent properties have been excavated for sand mining and waste filling operations. Over most of the existing site the Layer II sand has been removed. When the excavation for the proposed waste area is complete Layer II will have been removed across much of the existing site and the proposed expansion area (see Attachment 4, Figure 4C-9, 4F-2, and 4F-3). Groundwater levels in Layer II are affected by natural dewatering related to evaporation in the open excavation. Monitoring wells and piezometers near the open excavations are frequently dry. Figure 4F-1 is a potentiometric surface map constructed from water levels in site piezometers during the site characterization prior to site excavation. Figure 4F-2 shows a potentiometric surface constructed from groundwater monitoring wells and piezometers from a May 2012 water level reading event. Groundwater currently only flows in the limited areas where Layer II still exists. Because that groundwater flow has been cut off by the excavations, clay liners, clayey fill, and clayey constructed fill groundwater no longer will flow beneath the site, but rather will be diverted around the site to the northeast and southwest parts of the site. Figure 4F-3 depicts that Layer II will have been removed from the new site when the expansion area is excavated. No Layer II sand will exist at the downgradient east and south perimeter of the site.

1.1.2 Layer III Confining Unit

The low permeability (predominantly CH clay) and continuity of Layer III enable this thick clay unit to function as the confining unit between the uppermost Layer II sand groundwater zone and the deeper Layer IV sand. The thickness of Layer III clay encountered at the site ranges from approximately 18 to 34 feet and averages approximately 27 feet. The proposed landfill bottom will be excavated in the Layer III clay.

Three Layer III clay piezometers, P-3A, P-E1, and P-5A, were installed in July and August 1997. Water levels measured in these piezometers indicate that groundwater in

this clay unit is limited and that the permeability of the clay is low. Piezometer P-E1 in the northwest corner of the site was basically dry until October 1997, with less than 1 foot of water in the bottom of the well. Water level measurement in P-E1 is 57.80 feet above msl, indicating a very slow recovery rate of less than 0.02 feet per day. P-5A in the southwest corner of the site has had approximately two feet of water column since its installation in August 1997. Because the clay piezometer borings were completed using wet rotary drilling techniques, the small volumes of water observed in these wells are probably artifacts of the drilling fluid. The highest groundwater elevation in P-3A was observed on November 21, 1997, at 63.96 feet above msl. The recovery rate for P-3A is about 0.03 feet per day. The high groundwater elevation (63.96 feet above msl) in the Layer III clay is 35 feet lower than the highest water level in the overlying Layer II groundwater zone and 10 feet higher than the highest water level in the underlying Layer IV groundwater zone.

1.1.3 Layer IV Uppermost Aquifer

Layer IV consists primarily of sand, silty sand, and gravel. It occurs below the Layer III sands and is the uppermost aquifer. The maximum thickness explored was approximately 60 feet; the average thickness of the Layer IV sand is approximately 50 feet.

Three Layer IV sand piezometers, P-3B, P-E2, and P-5B, were installed in July and August 1997. Groundwater elevations measured since August 5, 1997, indicate that water levels are stable in these wells. An additional five Layer IV sand piezometers, P-6 through P-10, were installed in October 1997. Eight monitoring wells (MW-8 through MW-15) were installed in 1997. Two piezometers were installed in the expansion area in 2012 as part of this study. The highest measured water level elevation in Layer IV was observed on July 16, 2009 is 54.62 feet above msl in monitoring well MW-15. This elevation is approximately 10 feet lower than the highest measured elevation in the overlying Layer III clay and approximately 55 feet lower than the highest elevation in the uppermost Layer II groundwater zone, indicating that these three geologic units are not hydraulically connected. Groundwater in the Layer IV sand is confined. Layer IV groundwater elevations are listed in Table 4-6 and Table 4-7.

1.1.1 Layer V Lower Confining Unit

Layer V is a continuous, low permeability clay layer that functions as the lower confining unit to the overlying Layer IV groundwater zone. The maximum thickness explored was approximately 30 feet. Laboratory hydraulic conductivity tests on samples of the Layer V clay resulted in hydraulic conductivity values of 4.8×10^{-8} and 2.1×10^{-8} centimeters per second (cm/sec). Layer V is interpreted to be continuous across the site. Its composition and permeability is similar to the Layer III clay, making it an effective lower confining unit.

1.2 Groundwater Flow Direction and Rate

Shallow groundwater in the site area naturally flows to the southeast. Because extensive excavation activities have removed a large portion of the sands in the

uppermost Layer II zone, shallow groundwater flow within the site boundary is toward open excavations. Once excavation of the Layer II sand at the south and east downgradient perimeter of the site is complete, lined areas will cut off flow within remaining Layer II. Layer II groundwater flowing from the upgradient northwest will be cut off and diverted around the site toward the northeast and southwest corners of the site and toward offsite areas.

Groundwater flow in the deeper Layer IV sand unit is to the northwest. Groundwater in Layer IV is confined at its upper limit by the overlying Layer III clay and at its lower limit by the underlying Layer V clay. Groundwater in the deeper Layer IV zone is not hydraulically connected to groundwater in the uppermost Layer II zone or the deeper Chicot Aquifer sand unit.

Groundwater velocity for the deeper Layer IV uppermost aquifer was calculated using the geometric mean of the hydraulic conductivity values from slug tests in Layer IV piezometers (see Attachment 4, Section 6.2), hydraulic gradients from the potentiometric surface maps on Figures 4F-4 and 4F-15 in Appendix 4F, and an effective porosity of 30 percent for fine sand. Calculations indicate that groundwater in Layer IV moves approximately four feet per year (see Figure 4F-16).

2 GROUNDWATER MONITORING SYSTEM

2.1 Existing Monitoring Well Locations

Groundwater occurs and is being monitored in two subsurface units: the uppermost aquifer, Layer IV and the uppermost groundwater zone, Layer II. The Layer II sand is currently monitored by eight monitoring wells (MW-1A, MW-2A, MW-2B, MW-3A, MW-4A, MW-5A, MW-6A and MW-7B). While Layer IV sand is monitored by eight monitoring wells, seven downgradient (MW-8 through MW-14) and one upgradient monitoring well (MW-15).

2.2 Proposed Groundwater Monitoring System

2.2.1 Layer II Monitoring Wells

Over most of the site Layer II has been removed by previous sand mining and waste fill excavation. Once the expansion area is excavated into the Layer III clay, Layer II will have been removed across most of the existing site and the proposed expansion area (see Figure 4C-9). Sand mining activities have removed all of the Layer II sands up to, and in some cases, beyond the permit boundary on the eastern and southern boundaries as shown on the cross sections included in Attachment 4, Appendix 4C, Figures 4C-2 through 4C-8. Because the Layer II sand will not exist in the permit boundary, no monitoring is proposed for Layer II (see Figures 4C-9, 4F-2, and 4F-3).

2.2.2 Layer IV Monitoring Wells

There will be a total of eight monitoring wells; one upgradient well (MW-15R) and seven downgradient wells (MW-8 through MW-14) monitoring Layer IV. The groundwater monitoring design and monitoring well locations are shown on Figure 5A-1. Monitoring wells details are provided on Figure 5A-2. The point of compliance has been determined at the downgradient northern and most of the western boundary of the site, as shown in Appendix 5A on Figure 5A.1. This POC is located within 500 feet from the waste management unit. TCEQ rules require that the facility owner or operator will submit a documented certification signed by a qualified groundwater scientist that the facility is in compliance with the groundwater monitoring requirements specified in 30 TAC §§330.403, 330.405, 330.407 and 330.409, after each phase of well installation before waste is placed in a sector covered by the phase. If the sequence of development or sector designation changes, the well phasing will be modified accordingly. However, the POC monitoring wells are already installed. No phasing of wells is needed at this site.

2.3 Monitoring Well Design

In accordance with §330.421 – Monitor Well Construction Specifications, a licensed Texas driller will install monitoring wells in accordance with the regulations. Wells will be drilled by a method that will not introduce contaminants into the borehole or casing. A licensed

professional geoscientist or engineer who is familiar with the geology of the area will supervise monitoring well installation and development and will provide a log of the boring. Equivalent alternatives to TCEQ rules may be used if prior written approval is obtained from the executive director. Monitoring well construction details including screen intervals, well locations and elevations, filter pack and bentonite seal elevations, and surface completion are shown on Figure 5A-2. Monitoring well construction will be completed in accordance with §§330.63, 330.403, and 330.421.

If any fluid is required in the drilling of monitoring wells, clean, treated city water shall be used and a chemical analysis provided to the executive director. No glue or solvents will be used in monitoring well construction.

After installation, monitoring wells will be developed to remove drilling artifacts and open the water-bearing zone for maximum flow until all water used or affected during drilling activities is removed and field measurements of pH, specific conductance, and temperature are stabilized.

A registered professional land surveyor will survey the well location and elevation.

Within 30 days of completion of a monitoring well or any other part of a monitoring system, an installation report will be submitted. The report will include construction and installation details for each well on forms available from the commission, a site map drawn to scale showing the location of all monitoring wells and the relevant point(s) of compliance, well elevations to the nearest 0.01 foot above msl (with year of datum shown), latitude and longitude or landfill grid location of each well, copies of detailed geologic logs including soil sample data, and copies of driller's reports required by other agencies.

Damaged monitoring wells that are no longer usable will be reported to the executive director for a determination whether to replace or repair the well. In accordance with 30 TAC §305.70, if a compromised well requires replacement a permit modification request will be submitted within 45 days of the discovery.

Plugging and abandonment of monitoring wells will be performed in accordance with 16 TAC §76.72 and §76.104. No abandonment will be performed without prior written authorization.

All parts of the groundwater monitoring system will be operated and maintained so that they perform at least to design specifications throughout the life of the groundwater monitoring program.

The facility must notify the executive director if changes in site construction or operation or changes in adjacent property affect or are likely to affect the direction and rate of groundwater flow and the potential for detecting groundwater contamination from the facility.

2.4 Groundwater Monitoring Program

A Groundwater Sampling and Analysis Plan (GWSAP) for the site is contained in Appendix 5B. Annual sampling and analytical testing for the proposed monitoring

system will be performed in accordance with the TCEQ regulations outlined in 30 TAC §330.417.

3 GROUNDWATER QUALITY

Groundwater monitoring is being conducted in accordance with the Groundwater Sampling and Analysis Plan (GWSAP) approved by the TCEQ on May 12, 2009. Four quarterly background monitoring events have been completed for each of the monitoring wells at the facility. Background sampling consisted of required TCEQ monitoring parameters that are listed in Appendix 5B, Table 5B-1 of this attachment. Annual detection monitoring is currently conducted for all facility wells. A tabulation of the historical groundwater analytical data is provided in Attachment 4, Appendix 4G.

The Subtitle D monitoring well system for this Type IV facility was installed in 1999 and the first monitoring event was performed in April 2000. Annual groundwater monitoring reports have been submitted each year since 2000 that included the analytical results, a potentiometric map, time series plots of constituent concentrations, and descriptive analysis of the groundwater flow and groundwater quality indicator results.

Since the initial monitoring event, a one-time detection of trichloroethylene at 13 µg/L in MW-1A occurred in the August 2001 event; it has not been detected since that event.

Arsenic was detected above its MCL in 2007 and 2008 in MW-4 and MW-14. An investigation of the arsenic concentrations detected was conducted in March 2007 by Pastor, Behling, and Wheeler, LLC and the results submitted to TCEQ in a report. The investigation findings showed that the elevated arsenic concentrations were a result of localized reduction/oxidation changes in the Layer IV groundwater causing reductive dissolution of naturally occurring arsenic in soils and not due to a release of leachate from the landfill. These results were accepted in both the 2007 and 2008 annual groundwater monitoring report acknowledgement letters from TCEQ (dated November 9, 2007 and September 10, 2008).

No trends or patterns are apparent in examining the groundwater sampling results. Detection monitoring will continue in accordance with the approved GWSAP. Background will be established for new monitoring wells proposed for the site. No facility wells are in assessment monitoring.

APPENDIX 5B

GROUNDWATER SAMPLING AND ANALYSIS PLAN

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

PERMIT AMENDMENT APPLICATION

PART III – SITE DEVELOPMENT PLAN
ATTACHMENT 5B
GROUNDWATER SAMPLING AND ANALYSIS PLAN

Prepared for

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

August 2013

Revised March 2014



Biggs & Mathews Environmental, Inc.
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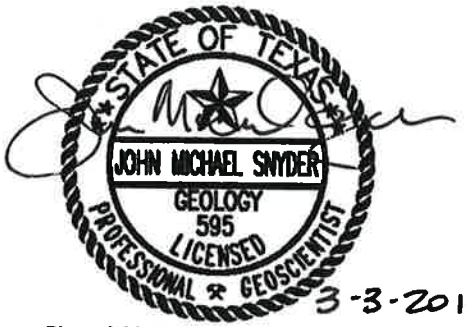

3-3-2014

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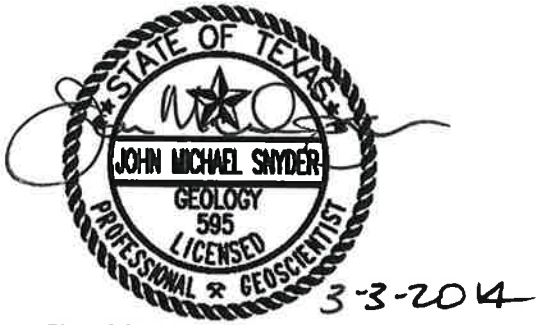

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Water samples collected in the field need to be placed into laboratory-provided bottles of the appropriate size and construction for the chemical parameters to be analyzed. A list of chemical parameters and recommended types and sizes of sample containers are shown in a table on page 5B1-3.

Under normal conditions (i.e., a well that recovers relatively quickly and to 90 percent of the initial static water elevation), the sample bottles will be filled in the order of decreasing volatilization sensitivity. Generally, that will be in the following order, as applicable:

- Volatile organic compounds (VOCs), if required
- Non-purgeable organic carbon (NPOC)
- Total metals
- Other inorganic parameters

Sampling for analysis of VOCs and NPOC: Filling the sample containers involves extra care. The sample containers used for water analysis of these parameters should consist of glass vials (of the appropriate size) with Teflon-lined caps. Water should flow slowly from the discharge tube of the pump into each sample vial, until a positive meniscus is formed over the top of the container. After the cap has been placed on the vial and tightened, the vial should be checked for air bubbles by turning it upside down and tapping with your finger. If an air bubble is seen rising to the bottom of the vial, the process outlined above should be repeated. Air bubbles can be eliminated by removing the cap, topping off the vial with water to a positive meniscus, and resealing. If no air bubbles are seen in each vial, the process is complete.

Laboratory-supplied bottles will be filled from the discharge tube of the sample pump. A physical description of the sample will be recorded on the Field Information Form, including the sample color, odor, clarity, foaming, and any other physical characteristics. If the field values obtained are not within the expected ranges, the Project Manager or Coordinator will be notified immediately, as it may be necessary to resample. The initial sample will not be discarded. Additional samples may be requested by the Project Manager or Coordinator to ascertain the cause of the erratic field measurements.

If the well becomes dry prior to completion of the sampling event, the sampling team will return to the well no less than 48 hours or more than 7 days later, allowing up to 7 days recovery before declaring a well dry. Upon return, the sampling team will measure the depth of water in the well and calculate the volume of water present in the well casing. If this volume is sufficient, the team will complete the sampling. If the volume of water in the well casing is not sufficient, the team will not complete sampling and will send the samples (if collected) to the laboratory. If after 7 days a well has not recovered sufficiently for a complete sample set, a partial set of samples will be collected in an order dictated by data needs. Whether or not the sampling team is able to complete the sampling, all occurrences and conditions will be recorded on the Field Information Form.

Field activities must be thoroughly documented on the Field Information Form. Below is an outline of the information typically documented during field activities.

- Project name and number
- Date and time of all activities
- Weather conditions
- Sampling personnel
- Field instrument calibration methods and remarks
- Well location (identification number)
- Well description, including casing size
- Description of well condition
- Initial water-level measurement with point of reference (top of casing) and time of measurement
- Well volume calculations, if needed
- Initial pH, temperature, turbidity, and conductivity measurements
- Presence and thicknesses of immiscible layers (if applicable)
- Time starting and ending well evacuation, volume purged, and method of removal
- Sampling equipment and remarks
- Sample time and date
- Description of groundwater sample
- Quality control remarks
- Samples collected (number of bottles)
- Analysis to be performed
- Preservatives added
- Mode of sample transport

3.1.4 Preservation and Shipment

Samples will be preserved immediately after sample collection. These sample containers may have preservatives included in the sample bottle as discussed below. When filling them, the bottles will not be allowed to overflow any more than necessary to eliminate headspace.

Pre-measured amounts of preservative reagents are usually supplied with the sample bottles by the laboratory. Analysis methods determine what samples require preservation, the specific preservative, and how much preservative is required. For samples that do not have preservatives in the bottle but that require preservation, the preservatives will be added to the sample bottle after it has been filled. Bottles will not be overfilled and will be inverted (once capped) to mix the preservative with the sample. Bottle lids will not be placed on the ground or interchanged among sample bottles.

Subsequent to sample collection, samples will be immediately placed in insulated shipping containers, chilled to 4 degrees C using ice, and "locked" with a security seal. Ice packs (if) used in containers will be frozen prior to use. The sampler will record sample designations on Chain-of-Custody form(s). The forms will be reviewed to ensure completeness, and all paperwork will be placed in a plastic bag, sealed, and placed inside the shipping container.

The containers and packing materials provided by the laboratory are designed to prevent breakage and spills during shipping. Tight, shock-resistant bottle holders are provided around each glass bottle.

The filled, sealed containers will be sent to the laboratory. All arrivals are scheduled for next day delivery. A member of the sampling team will be appointed to arrange sample pickup and transportation to the laboratory. Friday shipment of samples to subcontract laboratories will be avoided, when possible, to ensure that holding times are not exceeded over a weekend.

To comply with packaging regulations and to take practical measures to prevent damage to expensive samples, the sampling personnel will follow packaging and shipping instructions supplied by the certified testing laboratory.

In the unlikely event materials to be shipped are considered hazardous or if their nature is uncertain, the samples will be appropriately labeled and will be transported by sampling personnel directly to the analytical facility. The other alternative is that they are shipped using a carrier licensed to transport hazardous materials. However, in most instances, the concentration and type of compounds present in sample media are considered non-hazardous by the U.S. Department of Transportation (DOT).

3.1.5 Chain-of-Custody Record

To help maintain the integrity of the samples, strict chain-of-custody procedures will be utilized. An example of a Chain-of-Custody form is provided in Appendix 5B1. These procedures ensure that the bottles and samples will be recorded from the time the sample bottles leave the laboratory until the issuance of the analytical laboratory results.

In order to maintain the Chain-of-Custody, the samples will be either in sight of the assigned custodian, locked in a tamper-proof location, or sealed with a tamper-proof seal. A record of sample bottle possession and any transfers of samples must be maintained and documented on the Chain-of-Custody form.

The Chain-of-Custody form will be signed with each date and time that the container's seal is broken. When the shipment container is initially opened for inspection of its contents, the seal number (if any) will be noted. The signature of the responsible party, time, and date will also be recorded each time the sample container is transferred to the custody of another person and immediately before sealing the container for transport to the laboratory.

In addition, the sample point designation date, and time of sampling will be recorded on the form. Use of pre-filtration bottles and any problems with the sample also are noted on the form. Upon receipt of the sample container by the laboratory, the seal will be broken, and the condition of the samples, temperature, date, and time are recorded on the Chain-of-Custody form by the log-in personnel receiving the sample shipment.

The Chain-of-Custody form indicates by bottle and analysis group if samples are to be preserved. If actual preservation and filtration procedures vary from the instructions provided in these spaces, the Chain-of-Custody instructions will be modified by a

member of the sampling team and initialed in the appropriate locations provided on the Chain-of-Custody form.

4 LABORATORY ANALYSIS

This section describes the procedures for completing successful laboratory analyses of the samples that are collected from the site.

4.1 Program Quality Assurance/Quality Control Procedures

Trip blanks, field blanks, field forms, and the Chain-of-Custody forms provide quality assurance/quality control measures for the monitoring program.

4.1.1 Trip Blanks

Trip and field blanks are a required part of the field sampling QA/QC program. They are used to detect contamination that may be introduced in the field (either atmospheric or from sampling equipment), in transit (to or from the sampling site), or in the bottle preparation, sample log-in, or sample storage stages at the laboratory. Laboratory method blanks are used during the analytical process to detect any laboratory introduced contamination that may occur during analysis.

Trip blanks are samples of organic-free water (e.g., deionized) prepared at the laboratory and will only be prepared and analyzed for volatile organic compounds (VOCs) if they are collected during the sample event. They remain with the sample bottles while in transit to the site, during sampling, and during the return trip to the laboratory. Trip blank sample bottles are not opened at any time during this process. Upon return to the laboratory, trip blanks are analyzed using the same procedures and methods that are used for the collected field samples.

During sampling events requiring VOC analyses, a minimum of one trip blank per sampling event will be collected. Trip blank results will be reported in the laboratory results as separate samples, using the designations TB-(well #) as their sample point designation.

4.1.2 Field Blanks

Field blanks are prepared in the field (at the sampling site) using laboratory-supplied bottles and deionized or laboratory reagent-quality water. Field blank water for VOC samples, which is the same type of water as that used to prepare trip blanks, can be supplied by the laboratory. The field blank is prepared by pouring the deionized water into the sample bottles at the location of one of the wells in the sampling program. The purpose of the field blank is to detect any contamination which might be introduced into the groundwater samples through the air. Once a field blanks are collected, they are handled and shipped in the same manner as the rest of the samples.

For dedicated or disposable equipment requiring no filtration, the deionized or laboratory reagent-quality water is exposed to the air, transferred to the field blank bottles, and the proper preservative added as required.

For the field blank, water is placed into the field blank bottles and the proper preservative added (as required).

Field blank results will be reported in the laboratory results as separate samples, using the designations FB-(well #) as their sample point designation.

4.1.3 Field Duplicates

Sample duplicates are collected to assure the precision of the sampling and analytical processes. For sampling events involving collection of five or less samples, no sample duplicates are required. For sampling events that involve the collection of five or more samples, one duplicate will be obtained during each day of the sampling event. Each duplicate will be a blind sample, meaning the sample will be labeled with a sample number but no site designation.

4.1.4 Equipment Blanks

Since sampling equipment consists of dedicated pumps, an equipment blank sample is not necessary at this site.

4.1.5 Chain-of-Custody Forms

The quality control of sample integrity including field operations and laboratory operations (i.e., chemical laboratory analysis) will be administered by the field sampling personnel. An example Chain-of-Custody form is provided in Appendix 5B1. The specific information that is required for documentation is both listed on the form and described in Sections 3.1.4, Preservation and Shipment, and 3.1.5, Chain-of-Custody Record. Copies of the Chain-of-Custody forms will be filed in the Operations Record after the laboratory has returned the form with the analytical results.

4.2 Quality Assurance/Quality Control

Fairbanks Landfill has historically utilized a NELAC (National Environmental Laboratory Accreditation Council) certified laboratory for analysis of groundwater samples and will continue to use a NELAC certified laboratory for future groundwater analyses. Laboratory data analyses with a laboratory case narrative, or with a Laboratory Review Checklist, will be performed and submitted for each sampling event. NELAC standards require that laboratories have an established quality system that includes a comprehensive laboratory quality manual (LQM) and an authorized quality assurance officer. A copy of the LQM will be maintained in the Fairbanks Landfill Site Operating Records (SOR) for use in data evaluation.

The laboratory calibrates equipment and instrumentation according to the laboratory's LQM and referenced methodologies. Quality control including matrix spikes, matrix spike duplicates or sample duplicates, laboratory control samples, method blanks, and surrogates are analyzed along with field groundwater samples and field QC samples also in accord with LQM and method requirements. The laboratory evaluates and reports this information in a report with laboratory case narrative (LCN), with qualifiers and narrative detail where appropriate such that Fairbanks Landfill may ensure that all sample collection, preparation and analyses, and data management activities have been conducted. The laboratory report (including the LCN) will report the number of samples, sampling parameters, and sample matrix, the name of the laboratory (including subcontract labs) involved in the analysis, an explanation of each failed precision and accuracy measurement determined to be outside the laboratory and/or method control limits and whether such a quality control excursion represents a positive or negative bias and the limitations these excursions have on data quality. Additionally exceedance of sample holding times and identification of matrix interferences shall be identified in the LCN. Any dilutions implemented due to sample matrix interference will be done to the smallest dilution possible to bring the sample into control for analysis.

In addition to the exceptions listed above, the LCN report for all problems and anomalies observed will be included in the laboratory report for each sampling event. The LCN will report, at a minimum, the following information:

1. The exact number of samples, testing parameters and sample matrix.
2. The name of the laboratory involved in the analysis. If more than one laboratory is used, all laboratories shall be identified in the case narrative.
3. The test objective regarding samples.
4. Explanation of each failed precision and accuracy measurement determined to be outside of the laboratory and/or method control limits.
5. Explanation if the effect of the failed precision and accuracy measurements on the results induces a positive or negative bias.
6. Identification and explanation of problems associated with the sample results, along with the limitations these problems have on data usability.
7. A statement on the estimated uncertainty of analytical results of the samples when appropriate and/or when requested.
8. A statement of compliance and/or noncompliance with the requirements and specifications. Exceedance of holding times and identification of matrix interferences must be identified. Dilutions shall be identified and if dilutions are necessary, they must be done to the smallest dilution possible to effectively minimize matrix interferences and bring the sample into control for analysis.
9. Identification of any and all applicable quality assurance and quality control samples that will require special attention by the reviewer.

10. A statement on the quality control of the analytical method of the permit and the analytical recoveries information shall be provided when appropriate and/or when requested.

The analytical laboratory report for each sampling event will document the results and methods for each sample and analyte along with the quantification limit. The report will also include a copy of the chain-of-custody and an understandable correlation between the chain-of-custody and the sample results reported to the TCEQ. The analytical laboratory report will be submitted either electronically or in hard copy upon TCEQ request.

The Fairbanks Landfill shall ensure that a data reviewer consider the project data quality objectives as appropriate to determine if the results meet the project needs with respect to completeness, representativeness, and accuracy. Prior to submittal of the data to the Commission all analytical data will be examined to ensure that the data quality objectives are considered and met and that the results representing the samples are accurate and complete. The data will be reviewed, including the laboratory quality control results, the relative percent difference (RPD) of the monitor well results and its duplicate analysis (DUP) as a measure of accuracy. The data review will include a statement assessing data usability by a certified groundwater scientist with respect to the project data quality objectives (primarily a statistical evaluation of the groundwater analytical data) and, when necessary, provide comment to further explain or supplement the quality control data on the laboratory report. If the facility determines that the analytical data may be utilized, any and all problems and corrective action that the laboratory identified during the analysis will be included in the report submitted to the TCEQ. Either a completed version of the laboratory review checklist or the laboratory analytical report with LCN will be submitted to the TCEQ for each sampling event. For every response of "No, NA, or NR" reported on the Laboratory Review Checklist the facility will ensure the laboratory provides a detailed description of the exception in the LCN.

A record of laboratory sample receipt, storage and analysis procedures will be kept for each sample received. A summary of this record will be part of the laboratory analysis report. A copy of the NELAC Certified LQM is maintained as part of the facility's Site Operating Record (SOR). If at any time the Site changes analytical laboratories, the new laboratory's LQM will be submitted by the laboratory and the site SOR updated.

Although the QA/QC procedures in use at this facility apply predominantly to groundwater analytical data, it is possible that soil sample analytical results may be reported in the future. If the data is from soils and/or sediment samples, it will be reported on a dry weight basis with the percent solids and the percent moisture reported so that any back calculations of the wet analysis may be performed.

4.3 Analytical Methodologies

Table 5B-3 presents the analytical methodologies to be used by the laboratory for all of the parameters required in the monitoring program. All methods are USEPA approved and are fully described in the laboratory method and standard operating procedure documents.

Table 5B-3
Analytical Methods

Parameter	Method Description	Reference Method
Chloride	Ion chromatography	300.0
Total metals	ICP/ICP-MS	6010B
Total dissolved solids	Gravimetric	160.1
Non-purgeable organic carbon	Combustion or oxidation	415.1
pH	Probe	150.1
Specific conductance	Probe	120.1
Reference: Methods for Chemical Analysis of Water and Wastes, EPAS 600/4-79-020, EMSL, Cincinnati, OH (Revision March 1983).		

Note: Analytical methods listed above may be substituted as necessary provided that the alternate methods provide adequate analytical data to fulfill monitoring requirements and meet regulatory performance standards.

Precision and accuracy targets shown in the table below represent TCEQ guidance as of the date of this document. Should TCEQ guidance change, the targets will be adjusted accordingly. The specification limits below are intended to be applied to the approved (or as otherwise required by the executive director) constituent list for this Type IV facility.

The practical quantitation limit (PQL) is defined as the lowest concentration reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions and is considered equivalent to the limit of quantitation (LOQ) described in the most recent National Environmental Laboratory Accreditation Conference (NELAC) Standard (www.nemc.us/epa12/2003standards.html). The PQL is method, instrument, and analyte specific and may be updated as more data becomes available. To help ensure these practices will be observed the following information is provided:

- The PQL will be at or below the groundwater protection standard established for each analyte in accordance with 30 TAC §330.409(h) unless approved otherwise by the executive director.
- The PQL will be determined as the concentration that corresponds to the following precision and accuracy criteria:

Table 5B-4
QC Specification Limits for the PQL and Lower Limit of Quantitation Check Samples

Constituent/Chemical of Concern	Precision (% RSD)	Accuracy (% Recovery)
Metals	10	70-130
Volatiles	20	50-150
Semi-Volatiles	30	50-150

- The precision and accuracy of the PQL initially will be determined from the PQLs reported over the course of a minimum of eight groundwater monitoring

events. The results obtained from these events will be used to demonstrate that the PQLs meet the specified precision and accuracy limits. The PQL may be updated as more data becomes available.

- The PQL will be supported by analysis of a PQL check sample, consisting of a laboratory reagent grade sample matrix spiked with constituents/chemicals of concern at concentrations equal to or less than the PQL. At a minimum, a PQL check sample will be performed quarterly during the calendar year to demonstrate that the PQL continues to meet the specified limits for precision and accuracy.

- Analytical results for data below the limit of detection ("non-detect" results) must be reported as less than the established PQL that meets the specified precision and accuracy requirements.

- If a PQL cannot be established according to the specified precision and accuracy limits, the owner or operator will ensure that the laboratory provides sufficient documentation to justify the alternate precision and accuracy limits. This information will be reported to the executive director by the owner or operator and will be evaluated on a case-by-case basis.

4.4 Data Recordkeeping

All analytical data are maintained by the laboratory indefinitely. The laboratory ensures that, at each stage of a process where a permanent data record is required, security measures are in place to guarantee the integrity of the data. Standard Operating Procedures are in place for computer security, computer data storage, and back-up.

5 DATA EVALUATION, REPORTING AND RECORDKEEPING

The following sections describe the evaluation, reporting, and recordkeeping procedures that are followed upon receipt of the analytical report.

5.1 Data Evaluation Methods

Since no previous impacts to the water bearing units (due to the facility) have been determined, an intrawell monitoring approach will be employed to monitor for potential impacts. Even though no statistics will be utilized at the site, it is still much more effective to eliminate the confounding effects of spatial chemistry variability of up versus downgradient comparisons. The point of compliance (POC) will be defined at the downgradient edge of the facility for all of the monitoring units.

The potential for sample contamination is assessed by measurements of "blank" samples. Blanks are samples of ultra-pure laboratory water that are not spiked with any analyses and are carried through the field sampling and laboratory environments. These samples are known as "field," "lab," and "trip" blanks. It is assumed that any analyses that occur in the field or laboratory which might add to the concentration of the analyte in the sample will be picked up by the blank samples and measured. If any of the analyses of interest are found in the blank samples, it is an indication of potential contamination of the unknown sample. Control criteria for blank determinations are taken from regulatory method requirements.

Analytical data will be evaluated qualitatively by examining the quality control data accompanying the report from the laboratory. Relevant quality control data include measures of accuracy (percent recovery), precision (relative percent difference, RPD), and sample contamination (blank determinations). Data that fail any of these checks will be flagged for closer evaluation. Laboratory Quality Control Procedures may be initiated after any sampling event or for any anomalous data.

Once the background database has been established, it will be necessary to examine the database for outliers, anomalies, and trends.

For the detection monitoring parameters, routinely collected data will be evaluated based on time vs. concentration plots for each constituent. Should a significant trend of a constituent, an unexpected geochemical signature or an anomalously high result (outlier) or a result equal to or greater than the USEPA maximum contaminant limit (MCL) for a constituent be verified after the results have been checked for QA/QC, Texas Commission on Environmental Quality will be notified in the annual report that is required to be submitted within 60 days of the annual groundwater monitoring event in accordance with 30 TAC §330.417 (b)(5). MCL refers specifically to constituents that have established MCLs under 40 CFR, Part 258, Appendix I or Appendix II. The methods that might be used to make this determination are both event and data-specific and are appropriately selected based on the dataset under review after each event. Methods may include anion-cation balance techniques or Piper plots and Stiff diagrams to evaluate the groundwater geochemical signature compared to previous events. Trends may be evaluated using graphing software, statistical software or other appropriate methods. Should the background concentrations of a constituent with an MCL exhibit results that

are naturally above the MCL, a risk based concentration will be used for evaluation of that constituent and described in the annual report.

5.2 Data Record Keeping Requirements

The Fairbanks Landfill will maintain indefinitely a copy of all water quality monitoring data collected in accordance with this plan in the facility operating record.

5.3 Reporting Requirements

In accordance with 30 TAC 330.417, not later than 60 days after each sampling event, the owner or operator shall determine whether the landfill has released contaminants to the uppermost aquifer.

The executive director may require additional sampling, analyses of additional constituents, installation of additional monitoring wells or other sampling points, and/or other hydrogeological investigations if the facility appears to be contaminating the uppermost aquifer.

If the owner or operator finds the facility to have contaminated or be contaminating the uppermost aquifer, the executive director may order corrective action appropriate to protect human health and the environment up to and including that in §330.411, 330.413, and 330.415 of this title (relating to Assessment of Corrective Measures; Selection of Remedy; and Implementation of the Corrective Action Program).

5.4 Annual Reports

The owner or operator shall provide an annual report, including background sampling reports, detection monitoring reports, and verifications sampling reports, and any other groundwater monitoring report required to be submitted to TCEQ, within 60 days after the facility's annual groundwater monitoring event that includes the following information determined since the previously submitted report:

A. The results of all monitoring, testing, and analytical work obtained or prepared in accordance with the requirements of this permit, including a summary of background groundwater quality values, groundwater monitoring analyses, any statistical calculations, graphs, and drawings.

B. The groundwater flow rate and direction in the uppermost aquifer. The groundwater flow rate and direction of groundwater flow shall be established using the data collected during the preceding calendar year's sampling events from the monitoring wells of the Detection Monitoring Program. The owner or operator shall also include in the report all documentation used to determine the groundwater flow rate and direction of groundwater flow.

C. A contour map of piezometric water levels in the uppermost aquifer based at a minimum upon concurrent measurement in all monitoring wells. All data or documentation used to establish the contour map should be included in the report.

D. Recommendation for any changes.

E. Any other items requested by the executive director.

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ATTACHMENT 6

LANDFILL GAS MANAGEMENT PLAN

Prepared for:
USA Waste of Texas Landfills, Inc.

PERMIT AMENDMENT APPLICATION
PART III – SITE DEVELOPMENT PLAN
ATTACHMENT 6

LANDFILL GAS MANAGEMENT PLAN

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

Prepared by:

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3/3/2014

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3.2.2 Basis for Gas Monitoring Probe Locations

The GP locations were selected based on the geometry of the landfill in relation to the property boundary, the subsurface characterization, surface hydrology/hydraulics features, and the land use of adjacent properties. A description of the surrounding land use and nearby structures and inhabitable buildings was previously presented in Section 2.3 of this plan. As shown on Drawing 6-1 and summarized above in Table 6-2, a network of gas probes are proposed for monitoring the facility permit boundary. Gas probes that already exist will retain their numerical probe designation. A description of and rationale for the selected locations is presented below.

- The landfill currently has ten (10) existing gas monitoring probes around its perimeter (GP-1 through GP-10). Six of these probes are proposed to continue. These six existing gas monitoring probes are: GP-1, GP-2, GP-3A GP-4A, GP-9, and GP-10; which are already being routinely monitored as part of the current landfill gas monitoring program. These probes are situated around the north and west sides of the existing landfill.
- Four existing gas monitoring probes (GP-5, GP-6, GP-7 and GP-8) are located on the east and south side of existing landfill footprint. As shown on Drawing 6-1, the permit boundary is changing to be further to the east and south, and these existing probes will no longer be at the permit boundary and will eventually be on areas that will become landfill footprint. The replacement probes are situated adjacent to their previous location, but relocated to reflect the new permit boundary. Gas probes GP-5, GP-6, GP-7, and GP-8 will be replaced with gas probes designated as GP-5A, GP-6A, GP-7A, and GP-8A respectively. As indicated in Table 6-2, prior to new sector construction affecting an existing gas probe (GP-5, GP-6, GP-7, and GP-8), the corresponding replacement gas probe (GP-5A, GP-6A, GP-7A, and GP-8A, respectively) will be installed. Then the existing gas probe will be plugged and abandoned in accordance with 16 TAC §76.72 and §76.104.
- Four new gas monitoring probes are proposed around the new lateral expansion permit boundary of the landfill, to supplement the six existing and four relocated gas probes. This will increase the number of gas monitoring probes at the facility from ten (10) to fourteen (14). The new gas monitoring probes are designated as GP-11 through GP-14. As shown on Drawing 6-1, the additional gas monitoring probes are being added between several existing and relocated gas probes on the east and south sides of the landfill. The phased installation of these probes will be as indicated in Table 6-2. If the sequence of development or sector designation changes, the probe phasing will be modified accordingly.

ATTACHMENT 7

CLOSURE PLAN

Prepared for:
USA Waste of Texas Landfills, Inc.

PERMIT AMENDMENT APPLICATION

PART III – SITE DEVELOPMENT PLAN
ATTACHMENT 7

CLOSURE PLAN

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

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WITHIN EACH ATTACHMENT, ITEMS THAT REQUIRE A SIGNATURE AND SEAL BY A LICENSED PROFESSIONAL (E.G., ENGINEER, SURVEYOR, OR GEOSCIENTIST) ARE SIGNED AND SEALED, AS APPROPRIATE, BY THE RESPONSIBLE PROFESSIONAL

Attachment 7A Closure Plan Drawings
Attachment 7B Final Cover Quality Control Plan

1. INTRODUCTION

This Closure Plan (Plan) for the Fairbanks Landfill was prepared to meet the requirements of 30 TAC §330.63(h) and 30 TAC §330.453(e). This Plan also includes closure information not specifically required for Type IV landfills but that are required for Type I landfills – and this level of detail is included here to provide more information on the steps necessary for facility closure, and to facilitate the development of the closure cost estimate presented in Part III, Attachment 9 (Cost Estimate for Closure and Post-Closure Care) of the Permit Amendment Application. Closure of the landfill primarily involves the construction of a final cover system that minimizes infiltration of precipitation into the closed landfill area, includes a topsoil layer that is capable of sustaining native plant growth and is vegetated immediately after construction to minimize erosion, promotes and controls drainage, and functions with relatively low maintenance. Final facility closure includes not just closure of the landfill, but also closure of the recycling areas (i.e., the staging area to collect large/heavy/bulky items for recycling/salvaging; the wood recycling area; and the construction and demolition (C&D) waste recycling area). Closure of these recycling areas will involve primarily removing collected materials (to an off-site recycler) and/or properly disposing of materials remaining in these areas as described further herein.

This Plan identifies the steps required to completely close the facility at any point during the active life of the facility. The Plan includes the following:

- a description of the final cover system design, methods, and procedures to install the final cover system;
- an estimate of the largest area of the landfill ever requiring a final cover system at any time during the active life of the landfill;
- an estimate of the maximum inventory of wastes ever on site over the active life of the landfill;
- closure sequence and schedule;
- a final contour map of the proposed final cover grading plan, including surface-water drainage features;
- landfill cross sections; and

- closure recording and certification requirements.

Post-closure care activities, which will be implemented upon completion of final closure, are included in Part III, Attachment 8 (Post-Closure Plan) of the Permit Amendment Application.

2. GENERAL INFORMATION

2.1 Introduction

This section provides the largest area requiring closure, maximum waste inventory, and final contour plan.

2.2 Largest Area Requiring Closure

Closure of the landfill (i.e., installation of the final cover system) is planned to be performed incrementally as landfill areas reach final grade. The largest area of the landfill that could potentially be open and require final cover is 52.2 acres, as shown on Drawing 7-1 in Attachment 7A of this Plan.

2.3 Maximum Waste Inventory

The maximum waste inventory of the landfill at final grade is calculated to be 26,212,000 yd^3 in Part III, Attachment 3B (Volume and Site Life Estimate) of this Permit Amendment Application.

2.4 Final Contour Map

A final contour map, showing the proposed final cover system elevations, slopes, and surface-water drainage features is presented on Drawing 2-1 in Part III, Attachment 2A (Landfill Stormwater Management System Drawings) of this Permit Amendment Application. A copy of this drawing is provided in Attachment 7A to this Plan. Inspection of Drawing 2-1 shows that the location of the 100-year floodplain will not encroach on the landfill footprint; therefore, special provisions for protection from a 100-year flood are not applicable to the facility or this Plan.

2.5 Landfill Cross Sections

Landfill cross sections are shown on Drawings 3-6 to 3-10 in Part III, Attachment 3A (Landfill Design Drawings) of this Permit Amendment Application. Copies of the cross-section location map (Drawing 3-5 from that attachment) and the cross sections are provided in Attachment 7A to this Plan. The cross sections were selected to pass through key site features to accurately depict the existing and proposed depths of all fill areas within the site.

3. DESCRIPTION OF CLOSURE DESIGN AND CLOSURE SEQUENCE

3.1 Introduction

This section describes the design and installation requirements for the landfill final cover system, and discusses the closure sequence.

3.2 Final Cover System Design

The final cover system is designed to meet the requirements of 30 TAC §330.453(a), (b), and (c).

3.2.1 Cross Section and Areas of Installed Final Cover

The proposed final cover system for the facility is shown on an engineering detail on Drawing 3-11 in Attachment 3A (Landfill Design Drawings) of this Permit Amendment Application, and is described as follows (from bottom to top):

- 1.5-ft thick compacted soil layer composed of clayey soil, classified by the Unified Soil Classification System (USCS) as "SC" (sandy clay), "CL" (lean clay), or "CH" (fat clay); and

- a 6-inch or 12-inch thick topsoil layer[(1)] capable of sustaining native plant growth and seeded or sodded immediately after installation.

[(1)] If the underlying compacted soil layer is classified as SC or CL, the minimum topsoil thickness is 6 inches. If the underlying compacted soil layer is classified as CH, the minimum topsoil thickness is 12 inches.

The material requirements specified for the final cover system are included in the Final Cover Quality Control Plan (FCQCP) provided in Attachment 7B to this Plan. Soils with USCS classifications other than those listed above may be used in the final cover system with prior written approval from the TCEQ Executive Director.

As mentioned in Section 2.2, it is anticipated that the largest area of the landfill that could potentially be open and require final cover is 52.2 acres, as shown on Drawing 7-1 in Attachment 7A of this Plan. Drawing 7-1 also shows that as of March 2014, 30.6 acres have been final capped; and a note on the drawing references the Final Cover System Evaluation Reports (FCSERs) for the two capping events to-date. These 30.6 acres were final capped with the same final cover system as listed above.

3.2.2 Erosion Potential

The annual soil loss from the topsoil layer due to erosion is calculated in Part III, Attachment 3E (Final Cover Soil Erosion Loss Calculations) of this permit application. The calculated soil loss is less than the permissible value, indicating that the final cover system is designed with adequate resistance to erosion. For additional clarification on the usage of results of the erosion soil loss calculations, including a discussion on soil stabilization (ground cover) practices on the final cover and the inter-relationship between soil loss factors, please refer to the "Conclusions and Recommendations" section of the soil loss calculation writeup in Attachment 3E.

3.2.3 Surface-Water Drainage

The final cover system is designed to collect runoff and direct it to a perimeter drainage system through the use of drainage terraces and downchutes. The locations of surface-water drainage features on the final cover system are shown on Drawing 2-1 in Part III, Attachment 2A (Landfill Stormwater Management System Drawings) of this Permit Amendment Application. A copy of this drawing is provided in Attachment 7A to this Plan. The maximum grades of side slopes are 4 horizontal: 1 vertical (4H:1V) or 25%. The grades of the top deck are 3%, which is considered sufficient to preclude ponding of surface water when total fill height and expected subsidence are taken into consideration. Additional information on the surface-water drainage is presented in Part III, Attachment 2 (Facility Surface Water Drainage Report) of this Permit Amendment Application.

3.2.4 Landfill Gas Control System

A Landfill Gas Management Plan has been prepared for the facility, and is included in Part III, Attachment 6 of the Permit Amendment Application. As reflected in that plan, there is no planned or required layout design of a landfill gas control system for this facility. However, passive landfill gas vents that extend through the final cover system may be used as needed to help control landfill gas migration. Currently four of the existing gas vents (i.e., GV-1 to GV-4) are located adjacent to areas of the landfill that are completed to final grades. Any future gas vents installed are expected to be in response to verified exceedances of methane detected during ongoing routine landfill gas monitoring. Portions of any required landfill gas control system that have not been constructed prior to closure will be installed as part of closure activities. However, for the purpose of estimating closure costs, since there is no required layout or number of gas vents, it is assumed that all necessary landfill gas control system features will have been constructed prior to initiation of final closure. Additional information on the landfill gas control system is presented in the aforementioned Landfill Gas Management Plan.

3.3 Installation of Final Cover System and Closure Sequence

The construction procedures and quality assurance/quality control (QA/QC) requirements for the landfill final cover system installation are included in the FCQCP presented in provided in Attachment 7B to this Plan.

The overall steps, procedures, and processes to be used during installation of the landfill final cover system and final closure of the facility including closing the recycling areas are described below.

1. *Engineering Activities.* At the outset of closure of a given area (and for the final facility closure), engineering and related activities will be performed. This will likely include a pre-design site evaluation and preparation of a topographic survey as needed to obtain the information for preparing design documents. Next, engineering plans and design documents will be prepared, and a contractor will likely be procured. As part of final facility closure, the required boundary survey for the affidavit described in Section 4 will be performed. During closure construction, engineering activities will be provided through the provision of quality assurance/quality control (QA/QC) services and related surveying, and preparation of final certification reports described subsequently.

2. *Final Cover Subgrade Preparation.* Closure of a given area will begin by preparing the final cover system subgrade (surface on which the final cover system will be constructed). For routine closure, it is anticipated that the subgrade will be configured in a manner consistent with permitted final waste grades. In the event of premature closure, the surface will be regraded as necessary to provide a minimum slope of two percent and to allow for proper surface water run-off.

3. *Final Cover System Construction.* The final cover system components will be constructed, tested, documented, and certified in accordance with the FCQCP. The general final cover system construction activities and sequence are listed below.

    a. Final cover system construction on top of the prepared subgrade will begin by placing and compacting the clayey soil material of the compacted soil layer.

    b. The topsoil layer will be placed on top of the compacted soil layer.

    c. Surface-water drainage features (e.g., drainage terraces, downchutes, channels, etc.) will then be graded/installed in the general locations shown on Drawing 2-

1 in Part III, Attachment 2 of this permit application. A copy of this drawing is provided in Attachment 7A to this Plan.

d. Finally, the surface of the final cover system will be vegetated by seeding or sodding. Temporary erosion and sediment controls (e.g., mulch cover, silt fence, etc.) will also be installed and maintained while the permanent vegetation is being established.

4. *Landfill Gas Control System Construction.* As mentioned, there is no planned layout design of a landfill gas control system for this facility. Therefore, this item may not be an applicable component of final cover construction or closure. However, if there are any passive landfill gas vents required at the time of final cover system construction, they will be installed.

5. *Closure of Recycling Areas.* As part of facility closure, the on-site recycling areas (i.e., the staging area to collect large/heavy/bulky items for recycling/salvaging; the wood recycling area; and the construction and demolition (C&D) waste recycling area) will be cleaned up. This will involve removing any materials stored in these areas from the site (i.e., hauled away by a recycler), and/or disposing of the materials in the landfill. The recycling areas will then be graded and reshaped as needed to provide positive drainage slopes, and will then be vegetated to minimize erosion. Closure of the recycling areas must be completed within 180 days following the most recent acceptance of processed or unprocessed materials unless otherwise directed or approved in writing by the Executive Director.

6. *Closure Certification.* After completion of final cover installation of the landfill unit, or an incremental portion thereof an independent licensed professional engineer (P.E.) will prepare a Final Cover System Evaluation Report (FCSER) which will include all applicable documentation necessary for to make a P.E. certification that the closure was completed in accordance with the approved Plan. The minimum documentation to be included in the FCSER is listed in the FCQCP. Similarly, after completion of closure of recycling area(s), a P.E. will prepare a report describing the recycling area(s) closure and applicable documentation necessary for to make a P.E. certification that the recycling area closures were completed in accordance with the approved Plan. For each given area, after the closure certification report and documentation have been approved by the Texas Commission on Environmental Quality (TCEQ), a copy of the certification will be placed in the Site Operating

Record. Please note that the certification of final facility closure shall be as described in Section 4.

7. *Termination of Landfill Operation and Closure.* Following receipt of the required closure documents, as applicable, and an inspection report from the agency's regional office verifying proper closure of the MSW landfill unit according to the approved Closure Plan, the Executive Director may acknowledge the termination of operation and closure of the unit and deem it properly closed.

4. CLOSURE ACTIVITIES IMPLEMENTATION SCHEDULE

4.1 Introduction

As mentioned, the final cover system is planned to be installed incrementally during the active life of the landfill. Final facility closure is planned to commence when the permitted disposal capacity has been exhausted; however, it could commence prior to completely exhausting the permitted disposal capacity if it becomes necessary to final close the facility at an earlier time. Final facility closure includes not just closure of the landfill, but also closure of the recycling areas. The remainder of this section describes the required submittals and related notices to occur in conjunction with final facility closure.

4.2 Submit Final Closure Plan

In accordance with 30 TAC §330.453(e), the design and specifications for closure of the landfill must be submitted to the Executive Director for review and approval no later than 60 days prior to the initiation of closure activities. This Closure Plan, and the FCQCP provided in Attachment 7B to this Plan, were prepared to fulfill this requirement.

4.3 Notices

4.3.1 TCEQ Notification

Pursuant to 30 TAC §330.461(a), at least 90 days prior to the initiation of final facility closure, the owner or operator will provide written notification to the Executive Director of the intent to final close the facility. The owner or operator will place this notification in the Site Operating Record.

4.3.2 Public Notification

Pursuant to 30 TAC §330.461(a), at least 90 days prior to the initiation of final facility closure, the owner or operator will publish public notice of final facility closure in the newspaper of largest circulation in the vicinity of the facility. This notice will include the name, address, and physical location of the facility; the permit number; and the last date of intended receipt of waste. The owner or operator will also make available an adequate number of copies of this Plan and the Post-Closure Plan presented in Part III, Attachment 8 of this permit application for public access and review.

4.3.3 Access Signs and Barriers

Pursuant to 30 TAC §330.461(b), upon notification of the Executive Director of the intent to close the landfill, the owner or operator will post a minimum of one sign at the main entrance and all other frequently used points of access for the facility providing notification of the date of closing for the entire facility and the prohibition against further receipt of waste material after the stated date. Additionally, barriers will be installed at all gates or access points to prevent the unauthorized dumping of solid waste at the closed facility.

4.3.4 Affidavit to the Public and Engineer's Certification

Pursuant to 30 TAC §330.461(c), within ten (10) days after completion of final facility closure activities, the owner or operator will submit to the Executive Director by registered mail:

- a certified copy of an affidavit to the public in accordance with 30 TAC §330.19(c) and place a copy of the affidavit in the Site Operating Record. The affidavit will include an updated metes and bounds description of the extent of the disposal areas and the restrictions to future use of the land. A certified notation will be recorded on the deed to the facility that will in perpetuity notify any potential purchaser of the property that the land has been used as a landfill and that future land use is restricted. The owner or operator will submit a certified copy of the modified deed to the Executive Director and place a copy of the modified deed in the Site Operating Record within the same time frame specified for the affidavit to the public; and

- a certification, signed by an independent licensed P.E., verifying that final facility closure has been completed in accordance with the approved Closure Plan. The submittal to the Executive Director shall include all applicable documentation necessary for certification of final facility closure.

4.4 Closure Sequencing and Post-Closure

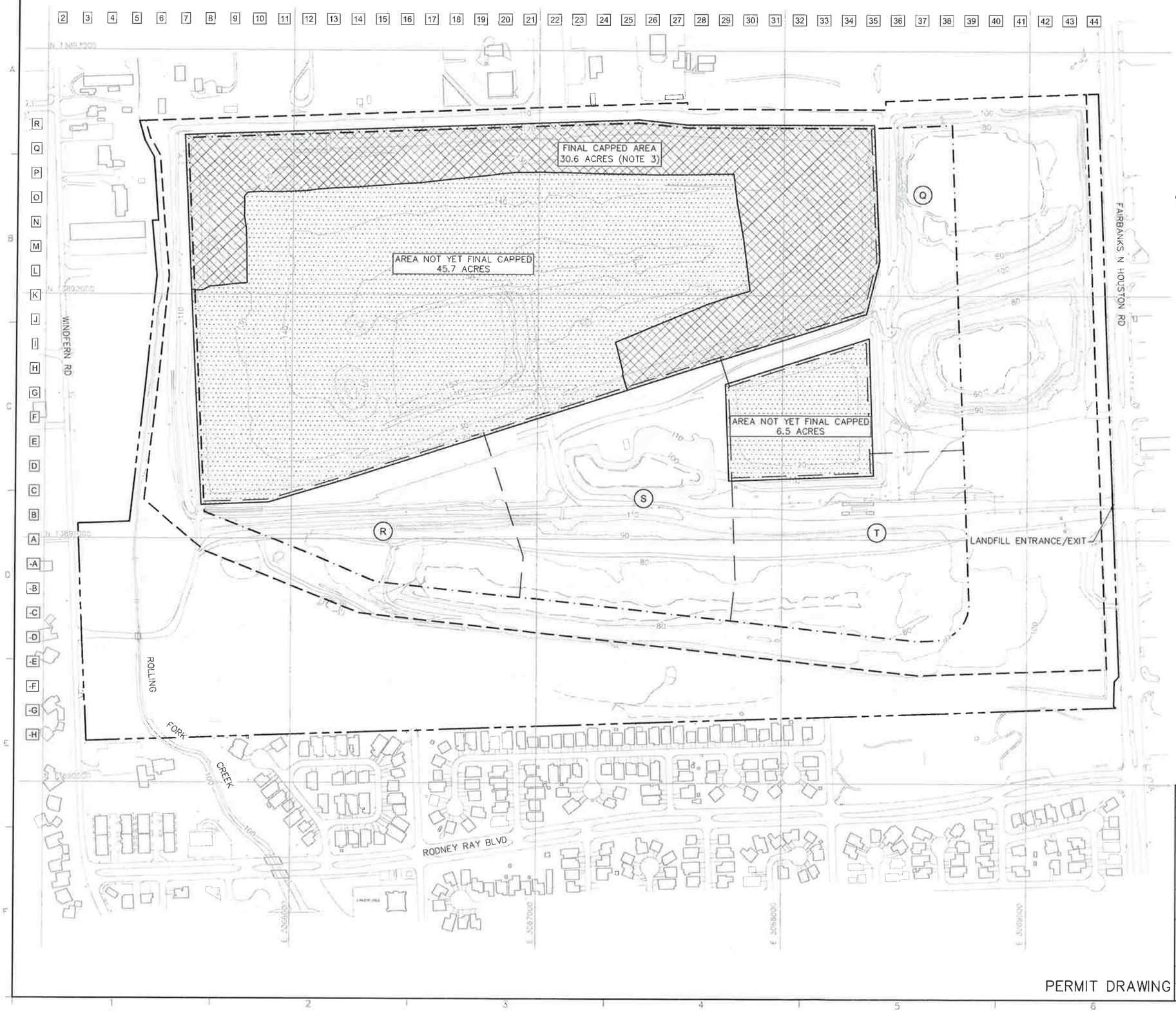
After providing written notice to TCEQ and the public of the initiation of final facility closure as described in Sections 4.3.1 and 4.3.2 and meeting the facility posting requirements described in Section 4.3.3, final facility closure activities can commence. A summary of the closure activities is provided in Section 3.3.

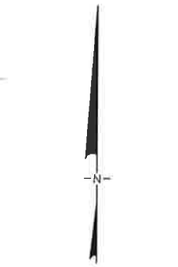
Following completion of all closure activities, the owner or operator will comply with the post-closure care requirements for the facility as specified in the Post-Closure Plan (Attachment 8).

ATTACHMENT 7A

CLOSURE PLAN DRAWINGS

LIST OF DRAWINGS		
Drawing No.	Title	Drawing Date (latest revision)
7-1	Largest Area Requiring Closure	March 2014
Copies of Drawings from Other Attachments		
2-1	Facility Surface Water Management Plan	March 2014
3-5	Landfill Cross Section Location Map	August 2013
3-6	Landfill Cross-Section A	March 2014
3-7	Landfill Cross-Section B	March 2014
3-8	Landfill Cross-Section C	March 2014
3-9	Landfill Cross-Section D	March 2014
3-10	Landfill Cross-Section E	March 2014





LEGEND

- EXISTING GROUND ELEVATION (FT, MSL) (NOTE 1)
- EXISTING ROAD
- EXISTING WATER LINE
- STATE PLANE COORDINATES (NOTE 2)
- SITE GRID
- PROPERTY BOUNDARY
- EXISTING (PERMIT MSW-1565A) LANDFILL FOOTPRINT
- PERMIT BOUNDARY
- PROPOSED LANDFILL FOOTPRINT
- FUTURE SECTOR BOUNDARY
- FUTURE SECTOR DESIGNATION
- FINAL CAPPED AREA TO-DATE (NOTE 3)
- AREA NOT YET FINAL CAPPED

NOTES:

1. THE EXISTING TOPOGRAPHIC BASE MAP SHOWN ON THIS DRAWING WAS COMPILED USING PHOTOGRAMMETRIC METHODS BASED ON AERIAL PHOTOGRAPHY PERFORMED ON 26 MARCH 2012 AND PREPARED BY DALLAS AERIAL SURVEYS (DAS), INC.
2. ELEVATIONS ARE IN FEET ABOVE MEAN SEA LEVEL (FT, MSL), AS DEFINED BY THE USGS NATIONAL GEODETIC VERTICAL DATUM (NAVD) OF 1988. STATE PLANE COORDINATE GRID CORRESPONDS TO TEXAS STATE PLANE COORDINATE SYSTEM, TEXAS SOUTH CENTRAL ZONE (4204), NORTH AMERICAN DATUM OF 1983 (NAD-83).
3. EXISTING FINAL CAPPED AREA IS DERIVED FROM FINAL COVER SYSTEM EVALUATION REPORTS (FCSERs) BY GOLDER ASSOCIATES DATED NOVEMBER 2004 (WITH JANUARY 2005 ADDENDUM) AND OCTOBER 2006, FOR 19.9 ACRES OF CAPPING AND 10.7 ACRES OF CAPPING, RESPECTIVELY.
4. RECYCLING AREAS ARE PROPOSED FOR THIS FACILITY AS IDENTIFIED ON PART III, ATTACHMENT 1, DRAWING 1-2, AS INDICATED ON THAT DRAWING, THE RECYCLING AREAS WILL ALWAYS BE LOCATED WITHIN THE LIMITS OF THE PROPOSED LANDFILL FOOTPRINT. ACCORDINGLY, THE FACILITIES ARE NOT WITHIN THE 100-YEAR FLOODPLAIN.

STATE OF TEXAS
SCOTT M. GRAVES
86557
LICENSED
PROFESSIONAL ENGINEER
3/3/2014

FOR PERMIT PURPOSES ONLY

REV	DATE	DESCRIPTION	DRN	APP
1	MAR. 2014	REVISED, RESPONSE TO NOD 1	JJV/KH	SMG
-	AUG. 2013	INITIAL SUBMITTAL TO TCEQ	JJV	SMG

USA WASTE OF TEXAS LANDFILLS, INC.

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Geosyntec consultants
GEOSYNTEC CONSULTANTS, INC.
TEXAS ENG. FIRM REGISTRATION NO. 1182
8217 SHOAL CREEK BLVD, SUITE 200
AUSTIN, TEXAS 78757
PHONE: 512.451.4003

TITLE:
LARGEST AREA REQUIRING CLOSURE (FINAL CAPPING)

PROJECT:
FAIRBANKS LANDFILL
PERMIT AMENDMENT APPLICATION – PERMIT NO. MSW-1565B

PROJECT NO.: TXL0263	DESIGN BY: RG	REVIEWED BY: SMG	PART NO.: III	DRAWING: 7-1
FILE: 0263P7-1	DRAWN BY: JJV	APPROVED BY: SMG		

PERMIT DRAWING

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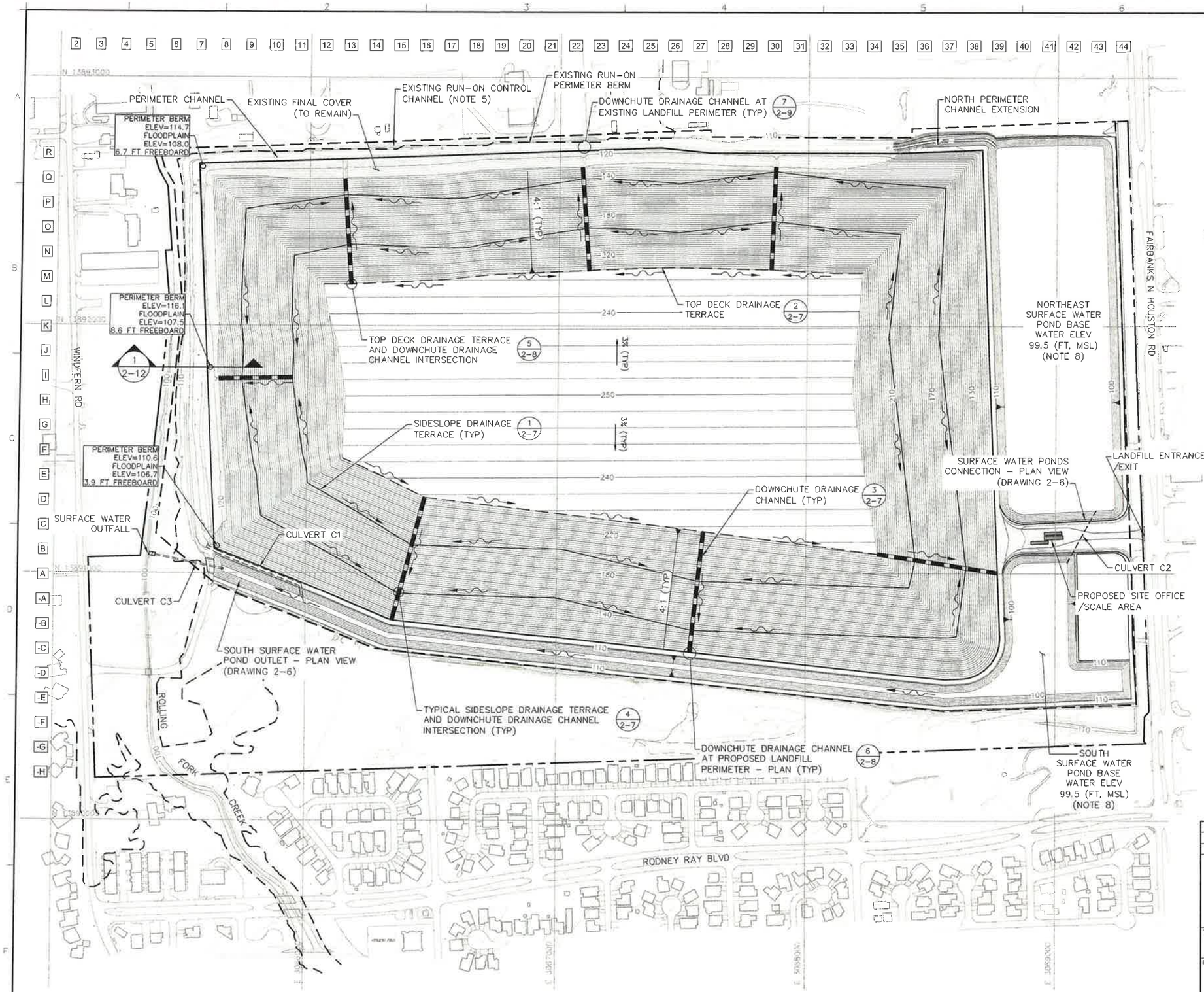

PERMIT DRAWING

LEGEND

- EXISTING GROUND ELEVATION (FT, MSL) (NOTES 1,2)
- EXISTING ROAD
- EXISTING WATER LINE
- STATE PLANE COORDINATES (NOTE 2)
- SITE GRID
- PROPERTY BOUNDARY
- PROPOSED PERMIT BOUNDARY
- OVERALL LIMIT OF FINAL COVER
- TOP DECK DRAINAGE TERRACE
- SIDESLOPE DRAINAGE TERRACE
- DOWNCHUTE DRAINAGE CHANNEL
- DRAINAGE FLOW DIRECTION
- PROPOSED GROUND ELEVATION (FT, MSL) (NOTE 3)
- 100-YEAR FLOODPLAIN (NOTE 7)

N

0 200' 400'
SCALE IN FEET

NOTES:

1. THE EXISTING TOPOGRAPHIC BASE MAP SHOWN ON THIS DRAWING WAS COMPILED USING PHOTOGRAMMETRIC METHODS BASED ON AERIAL PHOTOGRAPHY PERFORMED ON 26 MARCH 2012 AND PREPARED BY DALLAS AERIAL SURVEYS (DAS), INC.
2. ELEVATIONS ARE IN FEET ABOVE MEAN SEA LEVEL (FT, MSL), AS DEFINED THE USGS NATIONAL GEODETIC VERTICAL DATUM (NAVD) OF 1988. STATE PLANE COORDINATE GRID CORRESPONDS TO THE TEXAS STATE PLANE COORDINATE SYSTEM, TEXAS SOUTH CENTRAL ZONE (4204), NORTH AMERICAN DATUM OF 1983 (NAD 83).
3. TOP OF FINAL COVER SYSTEM REFERS TO THE PROPOSED FINISHED GRADE (TOP OF THE TOPSOIL COMPONENT OF THE FINAL COVER SYSTEM). LIMIT OF FINAL COVER SYSTEM REFERS TO THE TOE OF SLOPE OF THE TOPSOIL LAYER.
4. OUTSIDE OF THE LIMIT OF FINAL COVER, THE PROPOSED CONTOURS REFER TO FINISHED GRADE.
5. EXISTING RUN-ON CONTROL CHANNEL IS LOCATED AT TOE OF NORTHERN SLOPE PERIMETER BERM, WITHIN PERMIT BOUNDARY AND WILL BE MAINTAINED AS NEEDED FOR POSITIVE DRAINAGE.
6. INFORMATION ON SURFACE WATER POND APPURTENANCES IS PROVIDED ON SHEET 2-6.
7. 100-YEAR FLOODPLAIN LIMITS ARE FROM FEMA MAPS, AS DESCRIBED IN PART II, NARRATIVE REPORT, SECTIONS 10.1.2 AND 10.1.3.
8. SURFACE WATER PONDS WILL BE "WET" PONDS. ACCORDINGLY, THE BASE WATER ELEVATION REFERS TO THE OUTFALL ELEVATION. THUS, THE DETENTION VOLUME OF THE PONDS IS CALCULATED AS THE STORAGE VOLUME ABOVE THIS BASE WATER ELEVATION.

STATE OF TEXAS
SCOTT M. GRAVES
86557
LICENSED
PROFESSIONAL ENGINEER
3/3/2014

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REV	DATE	DESCRIPTION	DRN	APP
1	MAR. 2014	REVISED, RESPONSE TO NOD 1	JJV/KH	SMG
-	AUG. 2013	INITIAL SUBMITTAL TO TCEQ	JJV	SMG

USA WASTE OF TEXAS LANDFILLS, INC.

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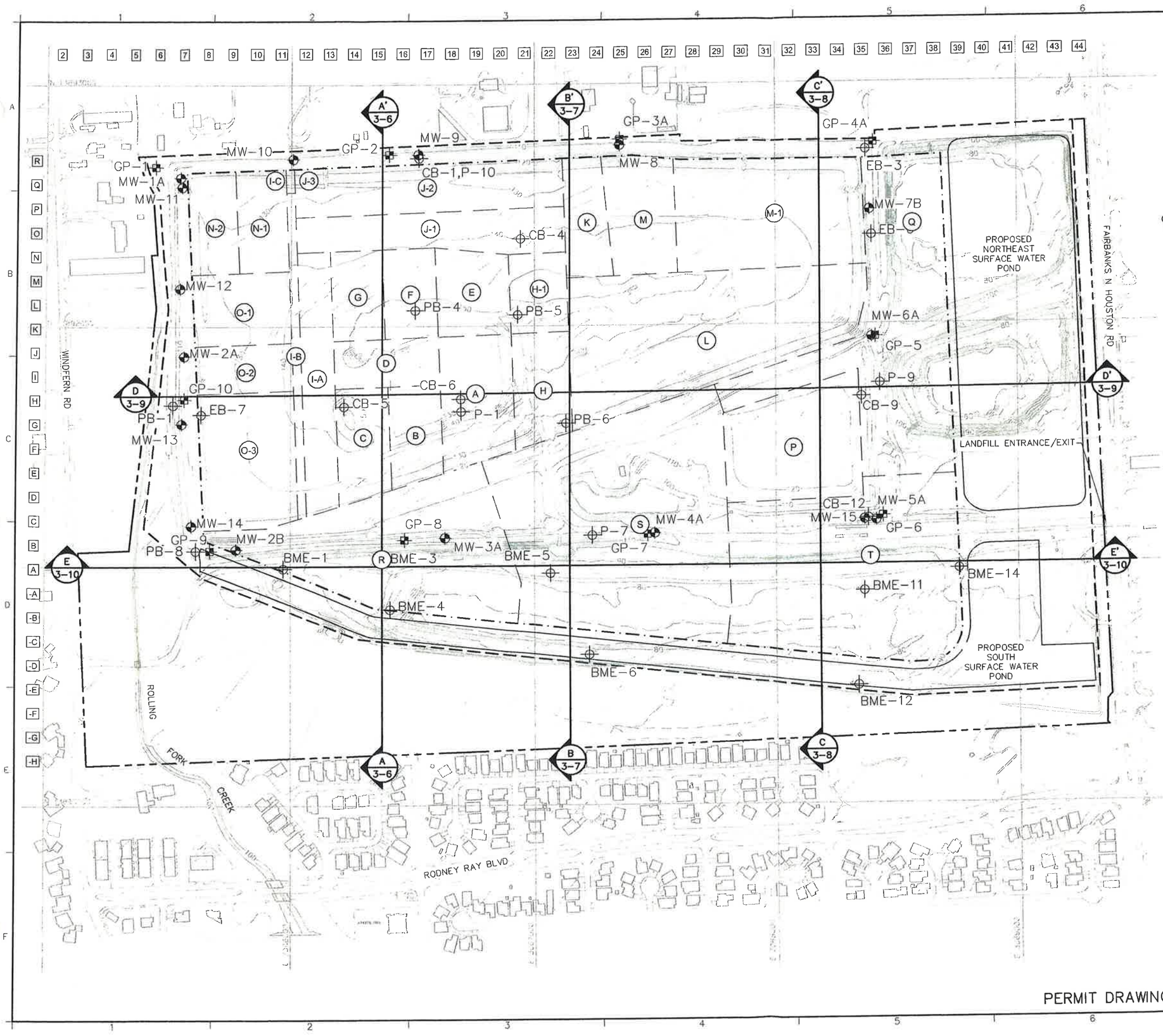
TITLE:
FACILITY SURFACE WATER MANAGEMENT PLAN

PROJECT:
FAIRBANKS LANDFILL
PERMIT AMENDMENT APPLICATION - PERMIT NO. MSW-1565B

PROJECT NO.:	TXL0263	DESIGN BY:	BK	REVIEWED BY:	SMG	PART NO.:	DRAWING:
FILE:	0263P2-1	DRAWN BY:	JJV	APPROVED BY:	SMG	III	2-1

DRAWING: Austin P:\CADD\Projects\T\Fairbanks Landfill\Permit\Expansion (TXL0263)\Drawings\Dwgs-ReviX\0263P2-1.dwg PLOTTED: Feb 28, 2014 - 11:07am



LEGEND

- EXISTING GROUND ELEVATION (FT, MSL) (NOTE 1)
- EXISTING ROAD
- EXISTING WATER LINE
- STATE PLANE COORDINATES (NOTE 2)
- 44 SITE GRID
- PROPERTY BOUNDARY
- PERMIT BOUNDARY
- PROPOSED LANDFILL FOOTPRINT
- SECTOR BOUNDARY
- Q SECTOR DESIGNATION
- MW-6A EXISTING GROUNDWATER MONITORING WELL
- GP-5 EXISTING LANDFILL GAS PROBE
- P-9 SOIL BORING

NOTES:

1. THE EXISTING TOPOGRAPHIC BASE MAP SHOWN ON THIS DRAWING WAS COMPILED USING PHOTOGRAMMETRIC METHODS BASED ON AERIAL PHOTOGRAPHY PERFORMED ON 26 MARCH 2012 AND PREPARED BY DALLAS AERIAL SURVEYS (DAS), INC.
2. ELEVATIONS ARE IN FEET ABOVE MEAN SEA LEVEL (FT, MSL), AS DEFINED BY THE USGS NATIONAL GEODETIC VERTICAL DATUM (NAVD) OF 1988. STATE PLANE COORDINATE GRID CORRESPONDS TO TEXAS STATE PLANE COORDINATE SYSTEM, TEXAS SOUTH CENTRAL ZONE (4204), NORTH AMERICAN DATUM OF 1983 (NAD-83).
3. SEE DRAWING 3-2 FOR OVERALL BASE GRADING PLAN.
4. SEE DRAWING 3-3 FOR OVERALL FINAL COVER GRADING PLAN.
5. THE PURPOSE OF THIS DRAWING IS TO SHOW THE LOCATIONS OF THE LANDFILL CROSS SECTIONS IN RELATION TO THE SITE LAYOUT AND PREVIOUSLY-DRILLED/INSTALLED SOIL BORINGS, GAS PROBES, AND MONITORING WELLS. REFER TO PART III, ATTACHMENT 5 AND 6 FOR THE PROPOSED GROUNDWATER MONITORING WELL LAYOUT AND PROPOSED LANDFILL GAS PROBE LAYOUT, RESPECTIVELY.

STATE OF TEXAS
SCOTT M. GRAVES
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LICENSED
PROFESSIONAL ENGINEER
8/26/2013

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REV	DATE	DESCRIPTION	DRN	APP
-	AUG. 2013	INITIAL SUBMITTAL TO TCEQ	JJV	SMG

USA WASTE OF TEXAS LANDFILLS, INC.

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TITLE: LANDFILL CROSS-SECTION LOCATION MAP

PROJECT: FAIRBANKS LANDFILL
PERMIT AMENDMENT APPLICATION – PERMIT NO. MSW-1565B

PROJECT NO.: TXL0263	DESIGN BY: SMG	REVIEWED BY: SMG	PART NO.: III	DRAWING: 3-5
FILE: 0263P3-5	DRAWN BY: JJV	APPROVED BY: SMG		

PERMIT DRAWING

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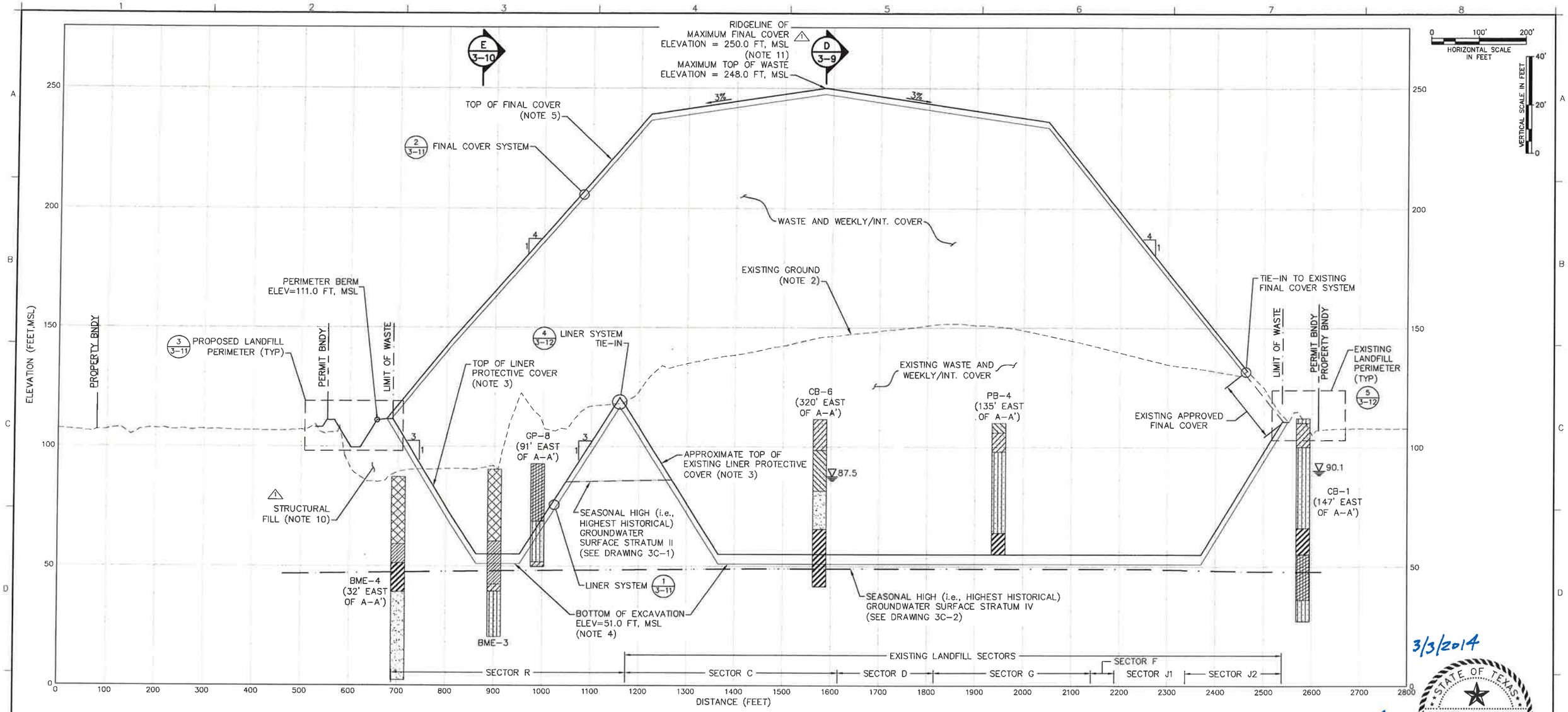
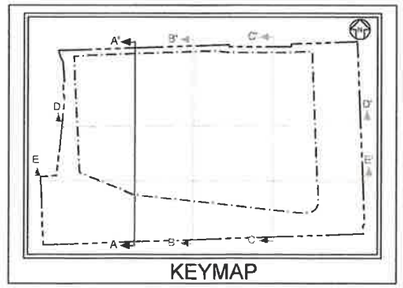


NOTES:

1. ELEVATIONS ARE IN FEET ABOVE MEAN SEA LEVEL (FT, MSL).
2. EXISTING GROUND SHOWN ON THIS DRAWING IS TAKEN FROM THE TOPOGRAPHIC BASE MAP SHOWN ON DRAWING 3-5.
3. TOP OF LINER PROTECTIVE COVER SHOWN ON THIS DRAWING IS TAKEN FROM THE OVERALL BASE GRADING PLAN ON DRAWING 3-2.
4. BOTTOM OF EXCAVATION SHOWN ON THIS DRAWING REFERS TO THE BOTTOM OF CLAY LINER, BASED ON THE BASE GRADING PLAN ON DRAWING 3-2. THE ELEVATION OF DEEPEST EXCAVATION (EDE) FOR THE FACILITY IS 51.0 FT, MSL.
5. TOP OF FINAL COVER TAKEN FROM OVERALL FINAL COVER GRADING PLAN ON DRAWING 3-3.
6. GROUNDWATER INITIAL AND/OR STATIC WATER LEVELS ARE PROVIDED FOR THOSE LOCATIONS WHERE THE INFORMATION IS AVAILABLE ON BORING LOGS AND WELL INSTALLATION REPORTS/ONGOING MONITORING, AS APPROPRIATE. REFER TO PART III, ATTACHMENTS 4 AND 5 FOR GEOLOGY AND GROUNDWATER INFORMATION, RESPECTIVELY, INCLUDING BORING AND WELL INSTALLATION LOGS, HYDROGEOLOGIC INTERPRETATIONS, AND POTENTIOMETRIC SURFACE(S).
7. PROPOSED TOP OF FINAL COVER IS SLOPED AT 4H:1V ON THE LANDFILL SIDESLOPES AND THREE PERCENT ON THE LANDFILL TOP AREAS. SLOPES AND FINAL COVER SYSTEM LAYER THICKNESS MAY APPEAR DISTORTED ON THESE CROSS SECTIONS DUE TO THE EXAGGERATED VERTICAL SCALE AND THE SKEWED ANGLE AT WHICH THE SECTIONS WERE CUT COMPARED TO THE THREE-DIMENSIONAL SLOPE DIRECTIONS.
8. LINER SYSTEM IS SLOPED AT 3H:1V ON THE LANDFILL BASE SIDESLOPES. SLOPES AND LINER SYSTEM THICKNESS MAY APPEAR DISTORTED ON THESE CROSS SECTIONS DUE TO THE EXAGGERATED VERTICAL SCALE AND THE SKEWED ANGLE AT WHICH THE SECTIONS WERE CUT COMPARED TO THE THREE-DIMENSIONAL SLOPE DIRECTIONS.
9. THIS CROSS-SECTION SHOWS THE SOIL PROFILE (BORING LOG) TAKEN FROM PREVIOUSLY DRILLED BORINGS AND/OR PREVIOUSLY-INSTALLED GROUNDWATER MONITORING WELLS AND LANDFILL GAS PROBES THAT THE CROSS-SECTION PASSES THROUGH OR NEAR. REFER TO PART III, ATTACHMENTS 5 AND 6 FOR THE PROPOSED GROUNDWATER MONITORING WELL LAYOUT AND PROPOSED LANDFILL GAS PROBE LAYOUT, RESPECTIVELY.
10. AREAS WHERE EXISTING GROUND ELEVATIONS ARE BELOW THE LINER SYSTEM SUBGRADE, OR BELOW FINISHED GRADE OF PERIMETER LANDFILL FEATURES (PERIMETER BERM/ROAD, STORMWATER CONVEYANCES, STORMWATER PONDS) SHALL BE FILLED WITH COMPACTED FILL SOIL, IN ACCORDANCE WITH SECTION 5 OF THE LINER QUALITY CONTROL PLAN (LQCP-ATTACHMENT 3C).
11. TOP OF FINAL COVER ELEVATIONS ARE FOR THE 2-FT THICK FINAL COVER SYSTEM SHOWN ON DETAIL 2 ON DRAWING 3-11. AS INDICATED ON NOTE 4 OF DRAWING 3-11, A TOPSOIL LAYER THAT IS AN ADDITIONAL 6-INCHES THICKER (I.E., 1-FT THICK INSTEAD OF 0.5-FT THICK) MAY BE REQUIRED, DEPENDING ON THE ACTUAL SOIL CLASSIFICATION OF THE COMPACTED SOIL INFILTRATION LAYER AT THE TIME OF FINAL COVER CONSTRUCTION OF A GIVEN AREA, RESULTING IN A 2.5-FT THICK FINAL COVER. IF THIS OCCURS ALONG THE PEAK RIDGELINE OF THE LANDFILL, THE MAXIMUM FINAL COVER ELEVATION WOULD BE ELEVATION 250.5 FT, MSL INSTEAD OF THE 250.0 FT, MSL SHOWN.

LEGEND OF SOIL/ROCK CLASSIFICATIONS AND GROUNDWATER

- FILL
- SAND
- CLAY (CL)
- CLAY (CH)
- CLAYEY SAND
- SILTY SAND
- SANDY CLAY
- SILTY CLAY
- INITIAL GROUNDWATER ELEVATION (NOTE 6)



PERMIT DRAWING

3/3/2014

STATE OF TEXAS
SCOTT M. GRAVES
86557
LICENSED PROFESSIONAL ENGINEER

FOR PERMIT PURPOSES ONLY

1	MAR. 2014	REVISED, RESPONSE TO NOD 1	JJV/KH	SMG
-	AUG. 2013	INITIAL SUBMITTAL TO TCEQ	JJV	SMG
REV	DATE	DESCRIPTION	DRN	APP

USA WASTE OF TEXAS LANDFILLS, INC.

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8217 SHOAL CREEK BLVD, SUITE 200
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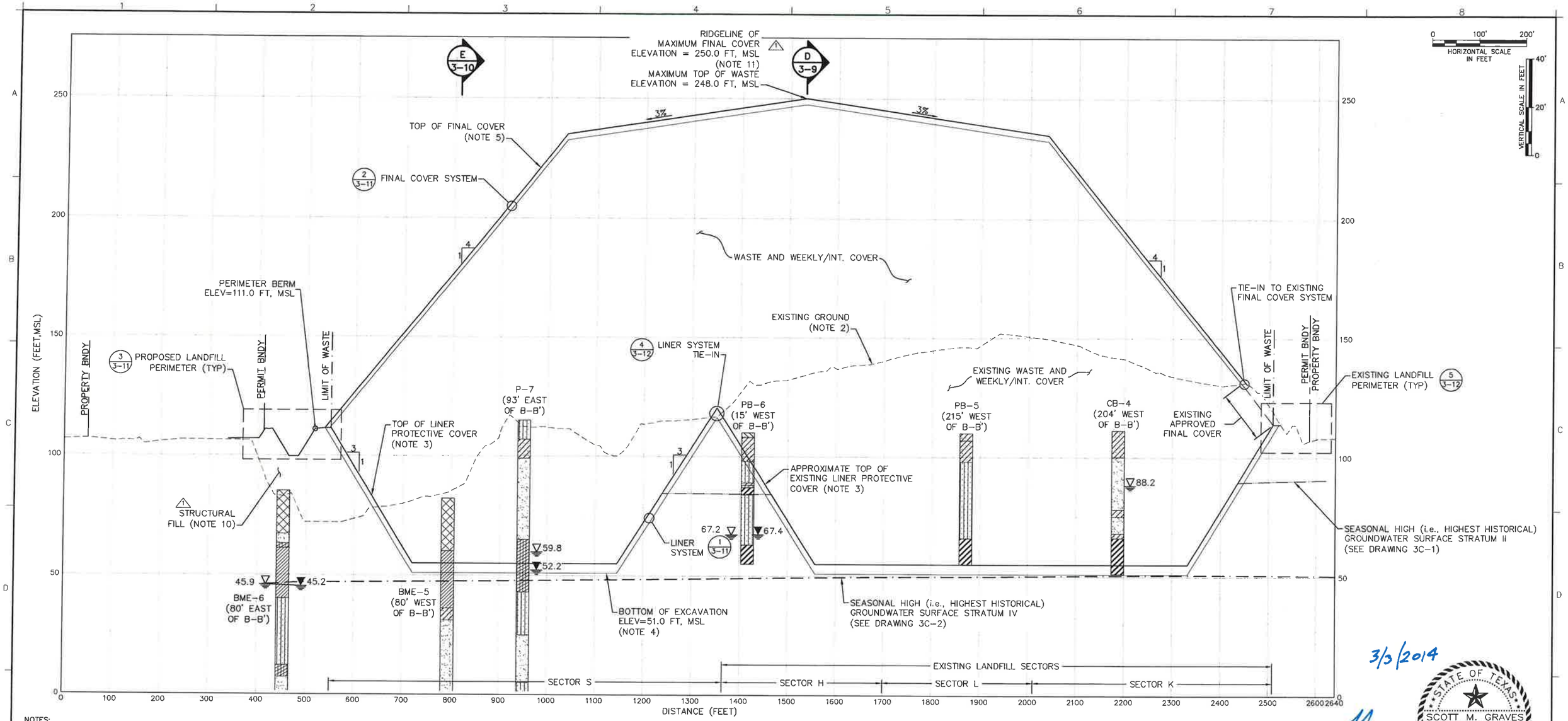
PHONE: 512.451.4003

TITLE:
LANDFILL CROSS-SECTION A-A'

PROJECT:
FAIRBANKS LANDFILL
PERMIT AMENDMENT APPLICATION – PERMIT NO. MSW-1565B

PROJECT NO.:	TXL0263	DESIGN BY:	SMG	REVIEWED BY:	SMG	PART NO.: III	DRAWING: 3-6
FILE:	0263P3-6	DRAWN BY:	JJV	APPROVED BY:	SMG		

DRAWING: Austin P:\CADD\Projects\FV\Fairbanks Landfill\Permit\Expansion (TXL0263)\Drawings\Dwgs-Rev0\0263P3-6.dwg PLOTTED: Feb 28, 2014 - 1:52pm



NOTES:

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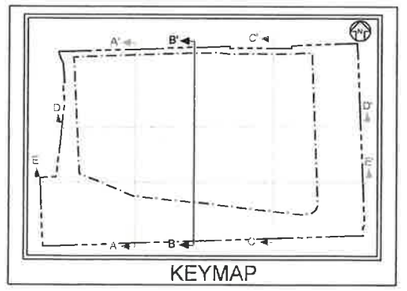

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3/3/2014

STATE OF TEXAS
SCOTT M. GRAVES
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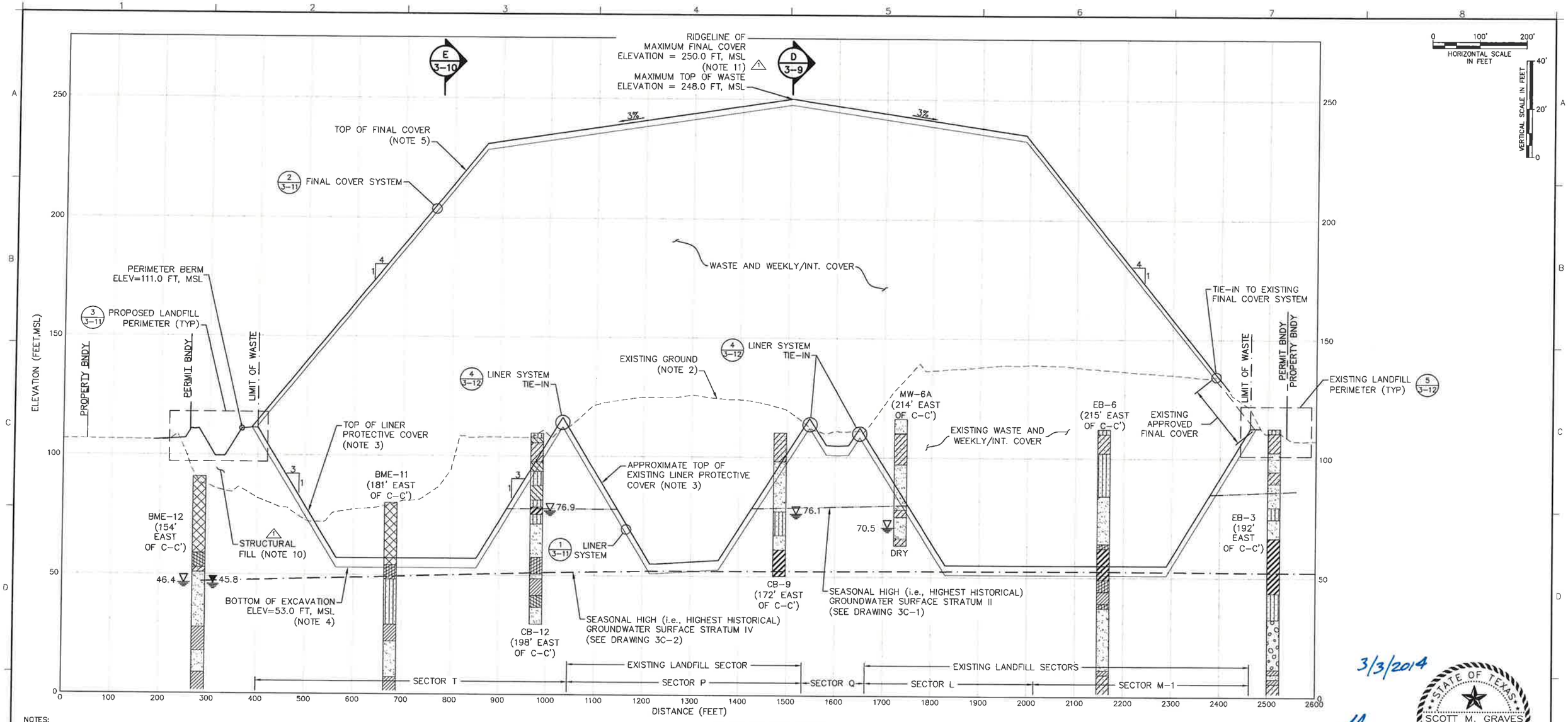
AUSTIN, TEXAS 78757
PHONE: 512.451.4003

TITLE: LANDFILL CROSS-SECTION B-B'

PROJECT: FAIRBANKS LANDFILL
PERMIT AMENDMENT APPLICATION – PERMIT NO. MSW-1565B

PROJECT NO.:	TXL0263	DESIGN BY:	SMG	REVIEWED BY:	SMG	PART NO.:	DRAWING:
FILE:	0263P3-7	DRAWN BY:	JJV	APPROVED BY:	SMG	III	3-7

DRAWING: Austin P:\CADD\Projects\V\Fairbanks Landfill\Permit\Expansion (TXL0263)\Drawings\Dwgs-Rev0\V0263P3-7.dwg PLOTTED: Feb 26, 2014 - 1:52pm



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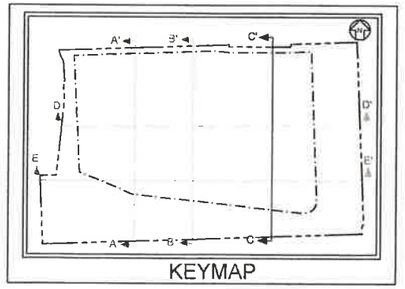

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TITLE:
LANDFILL CROSS-SECTION C-C'

PROJECT:
FAIRBANKS LANDFILL
PERMIT AMENDMENT APPLICATION – PERMIT NO. MSW-1565B

PROJECT NO.: TXL0263	DESIGN BY: SMG	REVIEWED BY: SMG	PART NO.: III	DRAWING: 3-8
FILE: 0263P3-8	DRAWN BY: JJV	APPROVED BY: SMG		

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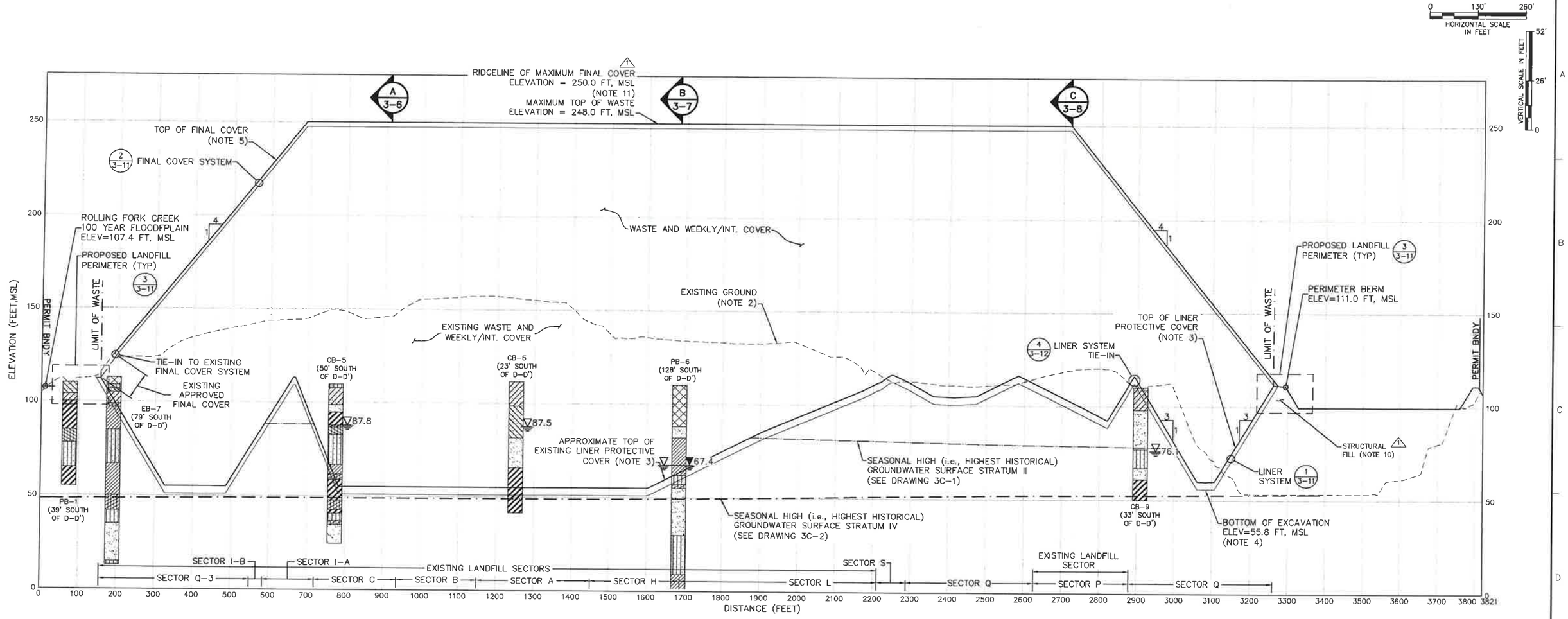

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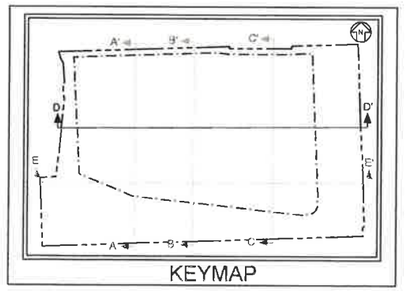

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TITLE: LANDFILL CROSS-SECTION D-D'

PROJECT: FAIRBANKS LANDFILL
PERMIT AMENDMENT APPLICATION – PERMIT NO. MSW-1565B

PROJECT NO.: TXL0263	DESIGN BY: SMG	REVIEWED BY: SMG	PART NO.: III	DRAWING: 3-9
FILE: 0263P3-9	DRAWN BY: JJV	APPROVED BY: SMG		

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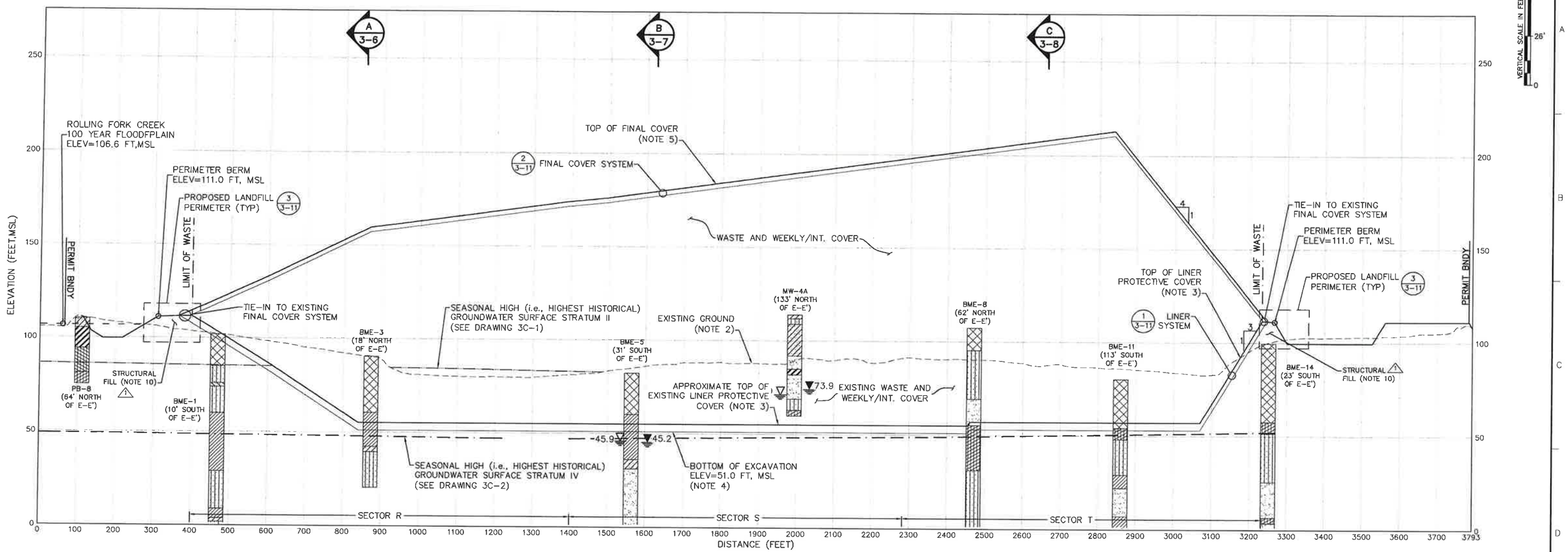

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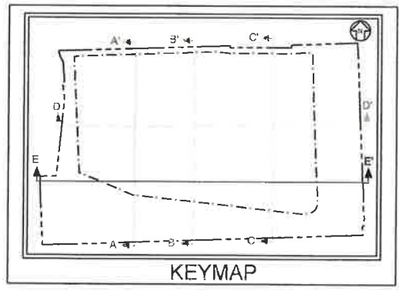

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ATTACHMENT 7B

FINAL COVER QUALITY CONTROL PLAN

Prepared for:
USA Waste of Texas Landfills, Inc.

PERMIT AMENDMENT APPLICATION

PART III – SITE DEVELOPMENT PLAN
ATTACHMENT 7B

FINAL COVER QUALITY CONTROL PLAN

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

Prepared by:

Geosyntec consultants
Texas Board of Professional Engineers Firm Registration No. F-1182
3600 Bee Caves Road, Suite 101
Austin, Texas 78746
(512) 451-4003



FOR PERMIT PURPOSES ONLY

Submitted August 2013
Revised March 2014

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3/3/2014

STATE OF TEXAS
SCOTT M. GRAVES
86557
LICENSED
PROFESSIONAL ENGINEER

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1. INTRODUCTION

1.1 Purpose

This Final Cover Quality Control Plan (FCQCP) for the Fairbanks Landfill was prepared to meet the requirements of 30 TAC §330.453(e). This FCQCP establishes the material requirements; construction installation requirements; quality control program; and quality assurance monitoring, testing, documentation, and reporting procedures that shall be used during construction of the soils for the final cover system at the Fairbanks Landfill (the facility). This FCQCP shall be followed during closure of the disposal cells to verify that the final cover is constructed in accordance with the site-specific permitted design and with the applicable state regulations for final closure.

A copy of the current version of this FCQCP must be maintained on site at all times. The FCQCP shall also be made available to facility employees, construction personnel, and testing personnel at the outset of each final cover system project, and at any time upon request by Texas Commission on Environmental Quality's (TCEQ's) inspectors. Revisions to this FCQCP shall receive written approval from TCEQ before implementation.

1.2 Final Cover System Cross Section

The proposed final cover system for the facility is shown on an engineering detail on Drawing 3-11 in Attachment 3A (Landfill Design Drawings) of this permit amendment application, and is described as follows (from bottom to top):

- 1.5-foot thick compacted soil layer composed of clayey soil, classified by the Unified Soil Classification System (USCS) as "SC" (sandy clay), "CL" (lean clay), or "CH" (fat clay) and having a coefficient of permeability (i.e., a hydraulic conductivity) no greater than 1×10^{-5} cm/sec (i.e., $k \leq 1 \times 10^{-5}$cm/sec); and

- a 6-inch or 12-inch thick topsoil layer[(1)] capable of sustaining native plant growth and seeded immediately after installation.

[(1)] If the underlying compacted soil layer is classified as SC or CL, the minimum topsoil thickness is 6 inches. If the underlying compacted soil layer is classified as CH, the minimum topsoil thickness is 12 inches.

Soils with USCS classifications other than those listed above may be used in the final cover system with prior written approval from the TCEQ Executive Director. To date, approximately

30.6 acres of the existing landfill have been covered and approved as final capped with a final cover system meeting the above requirements (and using the 6-inch thick topsoil layer specified above).

1.3 Definitions of Quality Assurance and Quality Control

In the context of this document, it is important to distinguish between construction quality assurance and construction quality control. These terms are defined as follows:

- Construction Quality Assurance (CQA) refers to means and actions employed by the CQA personnel to assure conformity of final cover system construction with the requirements of the permitted design, as shown on project-specific Construction Documents including this FCQCP. CQA is provided by a third-party consultant who is independent from production and installation (i.e., independent of the Contractor and any other material suppliers).

- Construction Quality Control (CQC) refers to those actions taken by the Contractor to ensure that the materials and the workmanship meet the requirements of the permitted design, as shown on project-specific Construction Documents including this FCQCP.

1.4 Contractor Responsibilities

In this document, the term Contractor refers to the parties who are constructing and installing the final cover system components. It is the responsibility of the Contractor to provide materials meeting the physical specifications provided herein, to construct the final cover system in accordance with the installation specifications provided herein, and to follow at least the minimum QC requirements set forth in this document.

1.5 CQA Personnel Roles and Responsibilities

1.5.1 CQA Professional of Record (POR)

Each phase of the final cover system installation evaluation shall be conducted by the CQA POR (hereafter referred to simply as "POR") or by a qualified representative (described subsequently) under the direct supervision of the POR. It is the responsibility of the POR to oversee implementation of the FCQCP during construction of the final cover system to verify that the final cover system (materials, construction activities, and QA/QC activities) is constructed in accordance with the site-specific permitted design. The POR shall be an independent third-party professional engineer (P.E.) registered in Texas and experienced in geotechnical engineering and

soils testing. In addition, the POR must also be familiar with the use of soils for landfill construction and with the applicable regulatory requirements.

1.5.2 CQA Technician

A properly qualified CQA Technician may work under the direct supervision of the POR to monitor, test, and document the final cover system construction. As such, the CQA Technician's responsibility is to serve as a field representative of the POR, to monitor, test, and document that the final cover system is constructed in accordance with the requirements of this FCQCP and as further directed and overseen by the POR. The CQA Technician shall have one of the following minimum levels of experience: (i) a minimum of two years of directly related landfill construction experience (or experience with similar low permeability compacted soil layers used in other containment applications); or (ii) for an engineer or geologist with a bachelor of science degree, a minimum of six months of directly related experience. If there is more than one CQA Technician on-site at the same time on a project, a Lead CQA Technician shall be designated, who shall meet the above CQA Technician requirements.

Note – the above CQA Technician experience requirement intentionally excludes references to National Institute for Certification in Engineering Technologies (NICET) certification. A previously-published TCEQ guidance document known as the "1994 Liner Construction and Testing Handbook" (currently out-of-print), suggested the technician should have NICET Level 2 certification in soils testing. NICET Level 2 for soils construction requires two years of experience and passing a written examination, but this examination is not specific to landfills or construction of low permeability soil layers. As a suitable alternative since NICET is no longer the landfill industry standard, this FCQCP requires a minimum of two years of landfill construction experience or equivalent for a non-graduate engineer or geologist level, instead of the two years of general soils experience plus examination required by NICET for Level 2.

1.6 Construction Timing and Full-Time CQA

Final cover system components and related surface water management features shall be constructed in a systematic and timely manner. Once construction is started, delays should be avoided unless adverse weather conditions prevent construction progress. Work areas for final cover system construction should be selected, sized, and sequenced so that each day's work can be protected from adverse weather conditions. Furthermore, the selection of size and shape of work areas shall be consistent, so that uniform construction/installation techniques and equipment can be selected.

Full-time CQA shall be provided during construction and installation of the final cover system soils by the POR or his/her qualified representative(s) serving as CQA Technicians as described above. In the remainder of this document, the term "CQA personnel" refers collectively to either the POR or to the CQA Technician(s) working on-site under direct supervision of the POR.

2. COMPACTED SOIL LAYER

2.1 Introduction

This section addresses the specifications and CQA requirements for the proposed compacted soil layer.

2.2 Compacted Soil Layer Specifications

2.2.1 Compacted Soil Layer Material Requirements

Material requirements for the physical properties of the compacted soil layer are presented in Table 7B-1.

2.2.2 Compacted Soil Layer Moisture-Density Target Compaction Requirements

Each lift of the compacted soil layer shall be compacted to at least 85% of the standard Proctor maximum dry density. The recommended target standard Proctor moisture content is between 0% to 5% wet of the optimum moisture content, as determined by standard Proctor test results (ASTM D 698) conducted on similar representative material during the pre-construction testing program. However, moisture contents outside of this range may be accepted, provided that the minimum required hydraulic conductivity is achieved.

2.2.3 Compacted Soil Layer Construction Requirements

2.2.3.1 Subgrade Preparation

A. The term "subgrade" refers to the surface on which the compacted soil layer component of the final cover system will be constructed. The subgrade will be either weekly cover, intermediate cover, or structural fill described below in Item B of this section. The subgrade shall be graded to be relatively smooth, uniform, with positive drainage, and within general accordance of the specified lines and grades shown on the drawings. As shown on the final cover grading plan (Drawing 3-3 in Attachment 3A of the Site Development Plan), the landfill is designed with 3% top-deck slopes, and 4 horizontal to 1 vertical (4H:1V) (i.e., 25%) sideslopes. The subgrade shall be free of exposed waste, debris, organic matter (i.e., roots, vegetation), standing water, or excessive moisture. To achieve the lack of organic matter specified in the preceding sentence, the subgrade shall be cleared as necessary (e.g., using a bulldozer blade) to remove roots and vegetation from the subgrade surface.

B. For areas requiring placement of additional fill to achieve the subgrade elevations for the compacted soil layer, structural fill shall be placed and compacted using the same soil material and placed in the same manner as is used for weekly and intermediate cover (e.g., tracked-in with a dozer, if that was the method for weekly/intermediate cover). The purpose of this provision is to result in the entire subgrade being on a consistently firm layer (i.e., minimize the potential for differential conditions due to overly firm areas).

C. For areas requiring cut to achieve the subgrade elevations for the compacted soil layer, once design elevations are reached the subgrade surface shall be proof-rolled and observed by CQA personnel for evidence that the surface provides support to adequately place and compact subsequent lifts of the overlying compacted soil layer (e.g., lack of excessive pumping, rutting, deflection of ground surface, etc.).

D. Soft, excessively wet, or otherwise deleterious subgrade areas as identified by CQA personnel shall be removed (over-excavated) and replaced with structural fill meeting the material and compaction requirements described above, to achieve the design elevations and to provide sufficient foundation support to adequately place and compact subsequent overlying lifts of the compacted soil layer. The extent of over-excavation shall be identified by CQA personnel so that the affected area provides a firm foundation and ties in to surrounding areas with acceptable proof-roll results or properly placed structural fill.

2.2.3.2 Standing Water Considerations

A. Compacted soil layer construction shall not take place in standing (ponded) water.

B. Completed compacted soil layer areas, both during ongoing construction and after submittal of the Final Cover System Evaluation Report (FCSER), shall have sufficient surface-water drainage controls to prevent the accumulation of water. Any ponded water that accumulates on newly constructed compacted soil layer surfaces shall be promptly removed.

2.2.3.3 Placement and Compaction

A. Scarification. Prior to placing a lift, the existing surface (i.e., top of subgrade or previous lifts) shall be scarified by tracking with a dozer, making a pass with the compactor, or similar as approved by the POR to promote bonding between the top of final cover subgrade and the first lift, and between adjacent lifts.

B. Lift Thickness. Compacted soil layer material shall be placed in loose lifts of uniform thickness generally not exceeding 8-inches thick after spreading and leveling, resulting in a compacted thickness of approximately 6-inches thick.

C. Soil Processing. Compacted soil layer material shall be processed as needed either in-place on the loose lift, or in a separate processing area, to yield a relatively uniform soil matrix devoid of large clods or macrostructural features. Clod size in the compacted soil layer should not exceed approximately 1-inch. Processing may be achieved by disking, grading, compacting, or pulverizing.

D. Moisture Conditioning. Moisture conditioning (either adding water to the soil or drying the soil) of the compacted soil layer shall be performed as needed to adjust the in-place moisture content to within the specified range of allowable moistures and densities. If water addition is required, the water shall be as uniformly distributed over the lift using water trucks with pressure-spray capabilities or similar. Proper hydration time, as evaluated by CQA personnel, shall be allowed so the added water blends and mixes with the soil. Care shall be taken to prevent over-watering and ponding of water within the loose lift, as this excess water is difficult to redistribute. If drying is necessary, it shall be accomplished by disking or similar techniques to lower the moisture content to the required range in a relatively uniform and controlled manner.

E. Moisture Content and Density. Each lift of compacted soil shall be compacted to meet the required range of moisture contents and densities as described in Section 2.2.2.

F. Non-Conforming Tests. Should the CQA field tests (described subsequently in this FCQCP) indicate that the moisture content or density of any layer of compacted soil material, or portion thereof, is not within the range of allowable moistures and densities, the representative portions of that particular layer shall be reworked and retested.

2.2.3.4 Compacted Soil Layer Tie In

A. Tie in of a new section of compacted soil layer to an old section of compacted soil layer shall be accomplished by either: (i) stair-step method; or (ii) slope method.

1) For the stair-step method, the old compacted soil layer shall be cut back at least 2.5-ft on 6-inch thick offset layers and the surface scarified so that the edge of each lift of the existing soil layer is tied in to new construction without superimposed construction joints.

2) For the slope method, the old section of compacted soil layer shall be cut back at a 5H:1V (horizontal:vertical) slope and the surface scarified, so that the edge of the existing soil layer is tied in to new construction without superimposed construction joints.

2.2.3.5 Sideslope Construction Considerations

A. The side slopes at this site are proposed to be 4H:1V (nominal).

B. The compacted soil layer on the side slopes may be constructed using either lifts parallel to the slope or horizontal lifts placed against the slope. However, the typical construction method for 4H:1V slopes is parallel lifts.

2.2.3.6 Top of Compacted Soil Layer Preparation and Maintenance

A. The top surface of the compacted soil layer shall be relatively smooth and uniform and free of irregularities, dimples, loose soil, or abrupt changes in grade.

B. The top surface of the compacted soil layer shall not exhibit excessive desiccation prior to placement of the overlying topsoil layer and shall be maintained (e.g., kept moist) as needed to prevent formation of excessive desiccation cracks.

C. The surface of the compacted soil layer shall also be kept free of standing water from rainfall events. Damage caused by precipitation shall be repaired, and if the lift must be reworked as determined by CQA personnel, then appropriate retesting of the lift shall be performed.

2.3 Compacted Soil Layer CQA

2.3.1 General

This section of the FCQCP addresses the CQA program to be implemented with regard to the compacted soil layer component of the final cover system. The following CQA activities are discussed in the remainder of this section:

- Pre-Construction Evaluation of Material Sources;
- Material Conformance Testing During Construction;
- Field Evaluation/Monitoring During Construction;
- Field Testing of Work Product;
- Deficiencies, Problems, and Repairs;
- Thickness Verification; and

- Compacted Soil Layer Documentation.

2.3.2 Pre-Construction Evaluation of Material Sources

Prior to construction of the compacted soil layer, CQA personnel shall obtain a soil sample from the proposed source(s). Each source shall be evaluated for potential use as compacted soil layer by performing the pre-construction laboratory tests presented in Table 7B-2.

2.3.3 Material Conformance Testing During Construction

When soil from the borrow/stockpile area is easily distinguished and consistent with the soil characterized during pre-construction testing, additional ongoing laboratory conformance testing beyond the initial pre-construction tests is not required. Any time the compacted soil material being used becomes variable, or soils vary or appear inappropriate or questionable compared to the results from the initial pre-construction test program, additional material conformance testing of the tests and methods outlined in Table 7B-2 should be performed at a frequency of one series of tests per 20,000 cubic yards of compacted soil layer material or until a consistent soil type is easily distinguished.

2.3.4 Field Evaluation/Monitoring During Construction

CQA personnel will be on-site at all times when final cover compacted soil layer construction is ongoing, so that all relevant activities can be observed and documented. The POR will visit the site periodically as construction progress warrants. Such visits will be frequent enough so that the POR is fully knowledgeable of the construction methods and performance, so that the POR can determine that quality control monitoring and testing activities are adequate to meet the terms and intent of this FCQCP. CQA personnel shall visually monitor and document that construction of the compacted soil layer is in accordance with the specifications and requirements set forth previously in this FCQCP. These observations shall include, but not be limited to, monitoring of:

- moisture content and distribution, particle size, and other physical properties of the soil during processing, placement, and compaction;
- type and level of compactive effort, including equipment type and number of passes;
- action of compaction equipment on soil surface (i.e. foot penetration, rolling, pumping, or shearing);

- maximum clod size and breakdown of soil structure;
- method of bonding lifts together and making final cover tie ins;
- stones or other inclusions which may adversely affect compaction, lift bonding, and in-place testing/sampling; and
- areas where damage due to excess moisture, insufficient moisture, or freezing may have occurred.

2.3.5 Field Testing of Work Product

2.3.5.1 Routine Field Testing

Field testing (e.g., density and moisture content testing and undisturbed tube sampling) of placed compacted soil layer materials will be performed by CQA personnel during construction to evaluate the Contractor's work product with respect to the requirements of the specifications as set forth in this FCQCP. The test methods and frequencies for routine CQA field testing of the compacted soil layer are given in Table 7B-3. Sampling and test locations shall be selected by CQA personnel.

2.3.5.2 Special Testing

A special testing frequency shall be implemented at the discretion of CQA personnel when observations indicate potential problems, or as requested by the Owner. Additional testing for suspected areas shall be considered when:

- the equipment slips during placement operations;
- the lift thickness is greater than specified;
- the material is at improper and/or highly variable moisture content;
- fewer than the anticipated number of roller passes are made;
- dirt-clogged rollers are used to compact the material;
- the fill materials differ substantially from those specified; or
- the degree of compaction is doubtful.

During construction, the frequency of testing may also be increased in the following situations:

- adverse weather conditions;

- breakdown of equipment;
- at the start and finish of grading;
- if the material fails to meet specification requirements;
- the work area is reduced; or
- as otherwise requested by the Owner.

2.3.5.3 Perforations

Perforations are holes in the compacted soil layer that must be filled, and may include, but are limited to, the following:

- nuclear density test probe locations; and
- sand cone test locations or other density verification test methods.

All perforations in the compacted soil layer created during any sampling or testing shall be backfilled using a mixture of at least 20% bentonite mixed with soil layer material and compacted in place with a tamping rod, or using an appropriate bentonite grout.

2.3.5.4 Placement of Overlying Soil Layers

All testing and evaluation of the compacted soil layer shall be complete prior to installing the overlying topsoil layer.

2.3.6 Deficiencies, Problems, and Repairs

If a deficiency or noncompliance in the compacted soil layer is discovered, CQA personnel shall promptly evaluate the extent and nature of the defect. The extent of the deficient area shall be evaluated by additional tests, observations, a review of records, or other means deemed appropriate.

Sections of compacted soil layer that do not pass the required field tests (including failures due to not meeting the required hydraulic conductivity) shall be reworked as appropriate (e.g., water added, additional compaction passes, etc.) and retested until the section in question does pass. If a failure occurs, the failing area shall be defined. This shall be accomplished by performing additional tests between the failed test and the nearest adjacent passing test locations. If those additional tests pass, then the area between the failed test and the additional passing tests must be reworked and retested until passing. If the additional tests fail, then additional tests must be performed halfway between the initial additional tests and the adjacent passing tests to further

define the failing area. This procedure must be repeated until the failing area is defined, reworked, and retested with passing results. All field moisture-density results shall be reported in the FCSER whether they indicate passing or failing values.

2.3.7 Thickness Verification

Compacted soil layer thickness verification will be performed at a frequency of one measurement per acre, coinciding with the locations where the thin-walled tube samples of the compacted soil layer (see Table 7B-3) are taken for laboratory testing. The location and top of compacted clay layer elevation of the verification points will be determined surveying methods. The tube sample specimen obtained (or the borehole from which the tube was taken) will be used to measure the thickness of the compacted soil layer at the verification point to determine if the minimum layer thickness has been provided.

2.3.8 Compacted Soil Layer Documentation

Documentation of the compacted soil layer shall be included in the FCSER. The required FCSER contents are described subsequently in Section 4 of this FCQCP.

TABLE 7B-1
MATERIAL SPECIFICATIONS FOR COMPACTED SOIL LAYER

PROPERTY	QUALIFIER	UNITS	SPECIFIED VALUES	TEST METHOD[1]
Maximum Particle Size	Maximum	Inch	1.5	ASTM D 422
Soil Classification	Meets Category	USCS Category	SC, CL, or CH	ASTM D 2487 (classified based on results from ASTM D 1140/422 and ASTM D 4318 tests)
Hydraulic Conductivity	Maximum	cm/s	1×10^{-5}	ASTM D 5084[3]

Notes:

(1) CQA testing frequencies are provided in Tables 7B-2 and 7B-3 of this FCQCP.

TABLE 7B-2
PRE-CONSTRUCTION TESTING REQUIREMENTS FOR COMPACTED SOIL LAYER

TEST	METHOD	MINIMUM FREQUENCY OF TESTING[1]	PASSING CRITERIA
Particle Size (Sieve) Analysis	ASTM D 422	1 per source	≤ 1.5 in. max particle size
Atterberg Limits	ASTM D 4318	1 per source	None
Soil Classification	ASTM D 2487	1 per source	SC, CL, or CH
Natural (as-received) Moisture Content	ASTM D 2216	1 per source	None
Standard Compaction	ASTM D 698	1 per source	None
Remolded Hydraulic Conductivity[2]	ASTM D 5084[3]	1 per moisture/density relationship	≤ 1×10^{-5} cm/s

Notes:

(1) The testing frequency of one per source refers to a relatively consistent and distinguishable soil type at a borrow source location based on visual observations and field classification procedures. If the same borrow source is utilized for the soil supply of more than one project, results from previous pre-construction tests may continue to be used.

(2) Hydraulic conductivity testing shall be performed using tap water or a 0.05N solution of $CaSO_4$. Use effective stress of 5 psi. Distilled or deionized water shall not be used. The permeant should be deaired. All hydraulic conductivity test data shall be submitted with the FCSER.

(3) Perform remolded hydraulic conductivity test on a remolded sample that is compacted greater than or equal to 95% of the maximum dry density and at the optimum moisture content as determined from the Standard Proctor test.

TABLE 7B-3
FIELD TESTING AND ONGOING CONFORMANCE TESTING REQUIREMENTS FOR COMPACTED SOIL LAYER

TEST	METHOD	MINIMUM FREQUENCY OF TESTING	PASSING CRITERIA
In-Place Density and In-Place Moisture Content (Nuclear Gauge)	ASTM D 6938	1 per acre per lift	See Section 2.2.2
Particle Size Analysis	ASTM D 422	1 per acre(2)	$\leq$ 1.5 in. max particle size
Atterberg Limits	ASTM D 4318	1 per acre(2)	None
Soil Classification	ASTM D 2487	1 per acre(2)	SC, CL, or CH
Undisturbed Hydraulic Conductivity	ASTM D 5084(1)	1 per acre(2)	$\leq 1 \times 10^{-5}$ cm/s
Layer Thickness Verification	See Note 2	1 per acre(2)	$\geq$ 1.5 ft thick

Note:

(1) Undisturbed hydraulic conductivity tests shall be obtained using thin-walled push tube sampler (e.g., Shelby tube), and shall be tested using tap water or a 0.05N solution of $CaSO_4$. Use effective stress of 5 psi. Distilled or deionized water shall not be used. The permeant should be deaired. All hydraulic conductivity test data shall be submitted with the FCSER.

(2) Soil samples for particle size analysis, Atterberg limits, classification, and hydraulic conductivity testing will be collected by pushing a 3-inch (nominal) diameter thin-walled tube sampler into the materials using a drill rig hydraulic system, a bulldozer, an excavator, or other appropriate equipment. The location and the elevation of the sample locations will be determined using surveying methods. The samples will then be sealed and placed in protective core boxes for transport to the independent soils laboratory for testing. The sample location boreholes will be backfilled with wetted bentonite or a cement-bentonite grout tremied into the borehole from the bottom to the top of the compacted soil layer. The specified laboratory soil testing will be performed at a frequency of one set of tests per acre, and the tests specimens will be evenly distributed through the lifts. The tube sample specimen obtained (or the borehole from which the tube was taken) will be used to measure the thickness of the compacted soil layer to determine if the minimum layer thickness has been provided.

3. TOPSOIL LAYER

3.1 Introduction

This section addresses the specifications and CQA requirements for the topsoil layer proposed for placement above the compacted soil layer component of the final cover system.

3.2 Topsoil Layer Specifications

3.2.1 Topsoil Layer Material Requirements

The topsoil layer material shall be earthen material with a 3-in. diameter maximum particle size, and without deleterious materials. In addition, the topsoil layer soil shall have suitable properties that provide a layer capable of sustaining native vegetation. The vegetative soil from the site that has been stripped from the natural ground surface (i.e., topsoil) has been determined to support site vegetation through adequate performance of previously installed final cover system areas, and is considered to have suitable properties.

If an alternate source of vegetative layer soil is proposed (besides the topsoil stripped from on-site areas), or if the owner or POR question the ability of the soil to perform, agronomic tests can be performed to evaluate the soil.

3.2.2 Topsoil Layer Placement Requirements

Topsoil layer placement does not require compaction control. Instead, to enhance vegetative growth, the material should be given relatively low compactive effort through placement and spreading using low-ground pressure bulldozers or similar equipment.

3.3 Topsoil Layer CQA

3.3.1 General

This section of the FCQCP addresses the CQA program to be implemented with regard to the topsoil layer. The following CQA activities are discussed in the remainder of this section:

- Field Evaluation/Monitoring During Construction;
- Thickness Verification; and

- Topsoil Layer Documentation.

Pre-construction evaluation of material sources, material conformance testing during construction, and field testing of the topsoil layer is not required.

3.3.2 Field Evaluation/Monitoring During Construction

CQA personnel will be on-site at all times when topsoil layer construction is ongoing, so that all relevant activities can be observed and documented. CQA personnel shall visually monitor and document that construction of the topsoil layer is in accordance with the specifications and requirements set forth previously in this FCQCP. These observations shall include, but not be limited to visual monitoring and documentation of:

- the topsoil layer soil material to evaluate the visual material classification and check for the presence of deleterious materials; and
- the thickness and dimensions of the material as spread for compliance with the drawings and engineering details; and
- the construction equipment used during placement of the material to verify that only low-ground pressure equipment traverses over the topsoil layer.

3.3.3 Thickness Verification

Topsoil layer thickness verification will be performed at a frequency of one measurement per acre, coinciding with the locations where the thin-walled tube samples of the compacted soil layer (see Table 7B-3) were taken. The location and ground surface elevation of the verification points will be determined surveying methods. The thickness verification will be made by first hand-excavating a small hole from the ground surface down to the bottom of the topsoil layer (i.e., top of the compacted soil layer). The thickness at that location may be measured using either surveying instruments to take the elevation of the top and bottom of the hole, or by hand measurements (e.g., ruler or tape). After the measurement is taken, the small hole will be re-filled with topsoil and lightly tamped back into place.

3.3.4 Topsoil Layer Documentation

Upon completion of all required construction and evaluation of the final cover system, the POR shall prepare and submit a FCSER to TCEQ containing a construction report along with relevant test data and related documentation. The required FCSER contents are described subsequently in Section 4 of this FCQCP.

4. DOCUMENTATION

Upon completion of all required final cover system construction and evaluation, the POR shall prepare and submit a FCSER to TCEQ for review and approval. The construction documentation will contain a narrative report describing the conduct of work and testing programs required by the FCQCP, "as-built" record drawings, and appendices of field and laboratory data. The FCSER shall include the following items at a minimum:

- narrative report summarizing construction activities;
- a figure or drawing showing the location of the subject final cover system evaluation area in relation to the overall final cover system layout, and showing previously final capped areas;
- as-built record drawing(s) showing confirmation of the compacted soil layer and topsoil layer elevations and thicknesses;
- a statement of compliance with the FCSER, signed and sealed by the POR performing the evaluation and counter-signed by the site operator's authorized representative (using the latest versions of any applicable TCEQ final cover system evaluation report forms); and
- supporting documentation, including the following items addressed either through the narrative construction report or as attachments/appendices to the construction report:
    - provision of full-time CQA by the POR or their representative during final cover system construction;
    - preconstruction soil test results, including hydraulic conductivity results; and
    - construction field testing and laboratory soil test results including hydraulic conductivity results.

ATTACHMENT 9

COST ESTIMATES FOR CLOSURE AND POST-CLOSURE CARE

Prepared for:
USA Waste of Texas Landfills, Inc.

PERMIT AMENDMENT APPLICATION

PART III – SITE DEVELOPMENT PLAN
ATTACHMENT 9

COST ESTIMATE FOR CLOSURE AND POST-CLOSURE CARE

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

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FOR PERMIT PURPOSES ONLY

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ATTACHMENT

Attachment 9A Current Financial Assurance Documentation



FOR PERMIT PURPOSES ONLY

1. INTRODUCTION

This Cost Estimate for Closure and Post-Closure Care (Cost Estimate) for the Fairbanks Landfill (facility) was prepared to meet the requirements of 30 TAC §330.63(j) and 30 TAC §330.501, §330.503, and §330.507. The Cost Estimate presents the estimated costs for:

- closure of the landfill when the largest waste fill area that could potentially be open would require closure (and closure costs would be the greatest) and closure activities implemented in accordance with the Closure Plan presented in Part III, Attachment 7 of this permit application; and

- post-closure care for the largest waste fill area that could possibly require post-closure care (and post-closure costs would be the greatest) and post-closure care activities implemented in accordance with the Post-Closure Plan presented in Part III, Attachment 8 of this permit application.

The Cost Estimate also presents information on the financial assurance currently established for the facility in accordance with 30 TAC Chapter 37, Subchapter R.

2. CLOSURE COST ESTIMATE

2.1 Cost Estimate

The closure cost estimate, in current dollars, has been developed in accordance with 30 TAC §330.503. The cost estimate accounts for closure of the landfill when the when the largest waste fill area that could potentially be open would require closure. Drawing 7-1 showing the largest area that could potentially require closure (i.e., 52.2 acres) is presented in Part III, Attachment 7 (Closure Plan) of this Permit Amendment Application. The following conditions were used in preparing the closure cost estimate:

- all groundwater monitoring wells, landfill gas probes, and passive landfill gas vents will be in place before final closure is initiated;
- the site perimeter fence will be in place prior to initiating final closure;
- all required permits will be obtained prior to initiating final closure;
- all closure activities will be performed by a third party engineer or contractor;
- the Staging Area for Large/Heavy/Bulky Items (i.e., White Goods/Appliances), the Wood Recycling Area, and C&D Recycling Area are assumed to each have their maximum inventories of processed and unprocessed combustible materials present; and the closure activities will include disposition of all such processed and unprocessed combustible materials on-site;
- a topographic survey of the site will be conducted as part of closure, prior to installation of the final cover;
- a boundary survey will be conducted as part of final closure;
- a pre-design site evaluation will be performed to determine if the facility systems and features, including the environmental monitoring systems and operations records, are adequate for the post-closure care period;
- closure activities will be performed in accordance with Part III, Attachment 7 (Closure Plan) of the permit application;

- a contingency has been added to the cost, calculated as 10% of the engineering and construction costs;
- contract payment and performance bonds for closure activities that will be obtained are estimated at 1.5% of the engineering and construction costs; and
- TCEQ administration and legal fee costs are estimated at 1% of the engineering and construction costs.

The estimated cost for final facility closure is given in Table 9-1. This cost estimate is presented in current dollars and is based on unit costs from recent bids obtained for similar landfill construction projects, site-specific cost information obtained from the applicant, vendor quotes, and engineering judgment.

An annual review process will be performed to evaluate whether the cost estimates (both closure costs, and post-closure costs) are sufficient, and adjustments will be made accordingly, as discussed in Section 4.

2.2 Financial Assurance for Final Closure

Evidence of the facility's current financial assurance that is in-place is provided in Attachment 9A. It is noted that this documentation has been previously provided to TCEQ as indicated on the cover letter that accompanies Attachment 9A; and that this documentation also covers a number of other facilities in Texas owned/operated by USA Waste of Texas Landfills, Inc. or its parent company, Waste Management of Texas, Inc. Once Permit MSW-1565B is issued, the facility will need to update the financial assurance amount to that presented herein for closure costs (as well as to include post-closure care costs, discussed subsequently in Section 3).

The updated documentation of financial assurance for the facility will be provided to TCEQ within 60 days of approval of issuance of Permit MSW-1565B. The financial assurance for closure will be maintained continuously until the facility is officially placed under the post-closure maintenance period and all requirements of the Closure Plan have been met as evidenced in writing by the TCEQ Executive Director.

Cost estimate and financial assurance adjustments will be made as described in Section 4.

TABLE 9-1
FAIRBANKS LANDFILL
CLOSURE COST ESTIMATE[1]
LARGEST AND MOST EXPENSIVE AREA REQUIRING CLOSURE
Total surface area to be closed and capped = 52.2 Acres
Approx. permit boundary area = 189 Acres

ITEM NO.	DESCRIPTION	UNIT[2]	UNIT COST	QUANTITY	TOTAL COST
1	**Engineering**				
1.1	Topographic Survey	LS	$10,000	1	$10,000
1.2	Boundary Survey for Affidavit	LS	$5,000	1	$5,000
1.3	Pre-Design Site Evaluation	LS	$55,000	1	$55,000
1.4	Development of Engineering Plans and Documents	LS	$30,000	1	$30,000
1.5	Administration	LS	$10,000	1	$10,000
1.6	QA/QC, CQA Surveying, and Cert. (Final Report)	AC	$3,000	52.2	$156,600
				ENGINEERING SUBTOTAL	$266,600
2	**Closure Construction**				
2.1	Final Cover System				
2.1.1	1.5-ft-thick Compacted Soil Layer	CY	$5.00	126,324	$631,620
2.1.2	1-ft-thick Topsoil Layer	CY	$4.00	84,216	$336,864
2.1.3	Cover Vegetation (fertilizing, seeding, and mulching)	AC	$2,500	52.2	$130,500
2.1.4	Grading and Drainage	AC	$6,000	52.2	$313,200
2.2.1	Closure of Wood Recycling Area - grading & revegetating	LS	$8,000	1	$8,000
2.2.2	Closure of Wood Recycling Area - unprocessed mat'l	CY	$2.00	5,000	$10,000
2.2.3	Closure of Wood Recycling Area - processed mat'l	CY	$0.50	2,000	$1,000
2.3.1	Closure of Large/Heavy/Bulky Item Area - grading & reveg.	LS	$8,000	1	$8,000
2.3.2	Closure of Large/Heavy/Bulky Item Area - mat'l disposition	CY	$2.00	0	$0
2.4.1	Closure of C&D Recycling Area - grading & revegetation	LS	$8,000	1	$8,000
2.4.2	Closure of C&D Recycling Area - material disposition	CY	$2.00	1,000	$2,000
				CLOSURE CONSTRUCTION SUBTOTAL	$1,449,184
				ENGINEERING AND CONSTRUCTION SUBTOTAL	$1,715,784
				10% CONTINGENCY	$171,578
3	**Administrative and Legal**				
3.1	Contract Performance Bonds (1.5% of Eng/Constr Subtotal)				$25,737
3.2	TCEQ Contract Admin & Legal Fees (1% of Eng/Constr Subtotal)				$17,158
				TOTAL CLOSURE COST	**$1,930,257**

[1] This closure cost estimate was developed in 2013 dollars.

[2] LS = Lump Sum; AC = Acres; CY = Cubic Yards.

[3] Closure of recycling areas includes disposition of the maximum inventory of unprocessed and processed combustible materials (maximum quantities are per Part III Report, Section 2.3.3).



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3. POST-CLOSURE CARE COST ESTIMATE

3.1 Cost Estimate

A post-closure care cost estimate, in current dollars, has been developed in accordance with 30 TAC §330.507 for the 5-year post-closure period for the entire facility and using the Post-Closure Plan (Part III, Attachment 8). The following conditions were used in preparing the post-closure cost estimates:

- costs are based on post-closure activities being performed by a third-party;
- inspection, maintenance, and monitoring will be conducted in accordance with the schedule of post-closure care activities presented in Table 8-1 of Part III, Attachment 8 (Post-Closure Plan);
- a 10% contingency has been added to the cost of post-closure activities; and
- TCEQ post-closure care administration costs are estimated at 5% of the pre-contingency total post-closure care cost.

The estimated cost for post-closure care is given below in Table 9-2. This cost estimate is presented in current dollars and is based on unit costs from recent bids obtained for similar landfill projects, site-specific cost information obtained from the applicant, vendor quotes, and engineering judgment.

TABLE 9-2
FAIRBANKS LANDFILL
POST-CLOSURE CARE COST ESTIMATE
Approx. permit boundary area = 189 Acres

ITEM No.	DESCRIPTION	UNIT	UNIT COST	QUANTITY	TOTAL
1	Facility Inspections	YR	$6,200	5	$31,000
2	Facility Maintenance	YR	$31,700	5	$158,500
3	Groundwater Monitoring (8 wells)	YR	$4,500	5	$22,500
4	Landfill Gas Monitoring (14 probes)	YR	$2,000	5	$10,000
5	Groundwater Monitoring Well Maint/Repair	WELL	$1,500	8	$12,000
6	Landfill Gas Probe Maint/Repair	PROBE	$1,500	14	$21,000
7	Landfill Gas Vent Maint/Repair	VENT	$1,000	18	$18,000
	Subtotal Post-Closure Cost				$273,000
	10% CONTINGENCY				$27,300
8	TCEQ Administration Cost (5% of total post-closure cost)				$13,650
	Total Post-Closure Care Cost				**$313,950**

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3.2 Financial Assurance for Post-Closure

As mentioned, evidence of the facility's current financial assurance that is in-place is provided in Attachment 9A. Once Permit MSW-1565B is issued, the facility will need to update the financial assurance amount to that presented herein for post-closure care costs (as well as to include the closure costs, discussed previously in Section 2).

The updated documentation of financial assurance for the facility will be provided to TCEQ within 60 days of issuance of Permit MSW-1565B. The financial assurance will be maintained continuously until the facility is officially released in writing by the TCEQ Executive Director from the post-closure period in accordance with all requirements of the Post-Closure Closure Plan.

Cost estimate and financial assurance adjustments will be made as described in Section 4.

4. COST ESTIMATE AND FINANCIAL ASSURANCE ADJUSTMENTS

4.1 Annual Inflation Adjustments

During the active life of the facility, the permittee will annually adjust the current cost estimates for inflation within 60 days prior to the anniversary date of the first establishment of the financial assurance mechanism. The adjustment may be made by recalculating the maximum costs of closure and post-closure care in current dollars, or by using an inflation factor derived from the most recent annual *Implicit Price Deflator for Gross National Product* published by the United States Department of Commerce in its Survey of Current Business. The inflation factor is the result of dividing the latest published annual deflator by the deflator for the previous year. The first adjustment is made by multiplying the current cost estimate by the inflation factor. The result is the adjusted current cost estimate. Subsequent adjustments are made by multiplying the latest adjusted cost estimate by the latest inflation factor.

4.2 Cost Estimate and Financial Assurance Increases

The permittee will evaluate the closure cost and post-closure cost annually, to determine whether an increase in the closure or post-closure cost is required as a result of continued facility development or otherwise changed facility conditions. This will include a review the facility's permit conditions on an annual basis to verify that the current active areas match the areas on which closure cost estimates are based. An increase in the closure or post-closure cost estimate and the amount of financial assurance will be made if changes to the final Closure Plan or Post-Closure Plan or the facility conditions increase the maximum cost of closure or post-closure care.

4.3 Cost Estimate and Financial Assurance Decreases

A reduction in the closure or post-closure cost estimate and amount of financial assurance provided may be requested if the cost estimate exceeds the maximum costs of closure at any time during the remaining life of the facility or post-closure care remaining over the post-closure period. The permittee will provide written notice to the TCEQ Executive Director of the detailed justification for the reduction of the closure cost estimate or the post-closure cost estimate and the amount of financial assurance. The permittee may request a reduction in the cost estimate and the financial assurance as a permit modification.

Prepared for:
USA Waste of Texas Landfills, Inc.

PERMIT AMENDMENT APPLICATION

PART IV – SITE OPERATING PLAN (SOP)

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

Prepared by:

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3/3/2014

SEALED FOR THIS PART IV SITE OPERATING PLAN, AND FOR PERMITTING PURPOSES ONLY.

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CONTENTS OF THE APPENDICES ARE SIGNED, SEALED, AND DATED, AS APPROPRIATE, BY THE RESPONSIBLE PROFESSIONAL.

FIGURE

Figure IV-1 Organizational Chart

APPENDICES

Appendix IV-A Contaminated Water Management Plan
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SITE OPERATING PLAN (SOP)

1. INTRODUCTION

1.1 Terms of Reference

The Fairbanks Landfill (hereafter referred to as the "facility" or "site") is a Type IV municipal solid waste (MSW) facility, owned and operated by USA Waste of Texas Landfills, Inc. This Site Operating Plan (SOP) provides general instructions for site management and personnel to operate the facility in a manner consistent with the design of the facility and with the Texas Commission on Environmental Quality's (TCEQ's) rules to protect human health and the environment. This SOP complies with the requirements of 30 TAC Chapter 330 Subchapter D of the TCEQ Municipal Solid Waste Management Regulations (MSWMR) "Operational Standards for Solid Waste Land Disposal Sites" for Type IV landfills.

The specific procedures outlined in this SOP are operational requirements and must be understood, acknowledged, and followed by the site personnel. This SOP will be maintained at the site as part of the Site Operating Record in an easily accessible location to allow the site operating personnel to review the SOP as needed. This SOP will be retained during the active life of the site and throughout the site's post-closure care maintenance period.

References to the terms "Executive Director" or "TCEQ" used in this SOP shall refer to the Executive Director of the TCEQ or the designated representative of the TCEQ. References to information in the permit or "permit application" for this facility shall refer to the most current version of these documents, including any amendments, modifications, or revisions as approved.

The Site Manager has overall responsibility for implementation and adherence to this SOP. Wherever this SOP describes procedures or requirements without naming a specific individual or position responsible for those requirements, the Site Manager shall have primary responsibility for those requirements. Where a specific position is responsible for a particular task, that responsibility is described. Otherwise, the Site Manager may assign any qualified personnel to accomplish the requirements of this SOP.

1.2 Facilities Addressed by this SOP

As mentioned in Section 1.1, this SOP has been prepared to address 30 TAC Chapter 330 Subchapter D for Type IV landfills. Disposal of waste in the landfill is the primary site activity. Additionally, the following recycling areas will be established on-site: (i) a staging area to collect large/heavy/bulky items (e.g., appliances) for recycling or salvaging; (ii) a wood recycling area; and (iii) a construction and demolition (C&D) waste recycling area. This SOP

also addresses the relevant operational requirements and activities associated with these on-site recycling areas, as well as waste disposal operations.

1.3 Sequence of Landfill Operations

The facility is designed to operate as a multi-level, modified aerial fill landfill, with above and below-grade filling. The general sequence of anticipated landfill operations is shown on the drawings presented in Part II, Appendix IIA of the Permit Amendment Application (see Drawings IIA-12 through IIA-17).

- inert material (both natural and man-made);
- Class 2 industrial solid waste that is free of putrescible waste;
- Class 3 industrial solid waste;
- special wastes as allowed by 30 TAC §330.171(a), including non-regulated asbestos-containing materials (non-RACM) and empty containers that meet the requirements of 30 TAC §330.171(c)(5) and which have been used for pesticides, herbicides, fungicides, or rodenticides;
- soils contaminated by petroleum products with concentrations of less than 1,500 milligrams per kilogram total petroleum hydrocarbons;
- trash;
- yard waste that is free of putrescible and household waste; and
- scrap tires that have been slit and quartered or shredded and do not come from a tire disposer/recycler who is reimbursed from the State Waste Tire Recycling Fund.

Prohibited Wastes: The facility may not accept the following wastes:

- putrescible wastes;
- conditionally exempt small-quantity generator waste;
- household wastes;
- regulated hazardous waste;
- Class 1 nonhazardous industrial waste;
- special wastes (with the exception of those allowable special wastes noted in the above list of wastes that may be accepted);
- regulated asbestos-containing materials (RACM);
- radioactive waste;
- prohibited polychlorinated biphenyls (PCB) waste;
- liquid waste;
- water and wastewater treatment sludges;
- grease/grit trap waste;
- lead acid storage batteries;
- used motor vehicle oil;
- used oil filters from internal combustion engines;
- whole tires;
- wastes incompatible with landfilling activities.

5.6 Methods for Detection and Prevention of Disposal of Prohibited Waste

This section describes the program that the facility will implement to detect and prevent the disposal of prohibited wastes. A list of prohibited wastes is presented above in the previous section of this SOP.

6. FIRE PROTECTION PLAN

6.1 Fire Protection Training

Facility operations personnel, (not including personnel with administrative duties only) will receive annual training in fire protection and fire-fighting. The training will include:

- review and discussion of this Fire Protection Plan;
- fire prevention and hazard awareness;
- location of fire-fighting equipment and materials;
- operation of fire extinguishers;
- alternate fire-fighting methods, including use of soil stockpile and water truck;
- appropriate personnel protective equipment;
- properties of methane gas and proper safety procedures;
- facility evacuation procedures; and
- coordination with the local fire department.

Administrative personnel will receive annual training relating to fire prevention and hazard awareness and facility evacuation procedures. Records of training will be kept in the Site Operating Record.

6.2 Fire Prevention

The main potential fire hazard at this facility is operations associated with waste disposal (disposal truck traffic on-site, off-loading of waste at working face, handling waste during compaction for disposal), since some wastes are potentially combustible materials. Other site activities involving potentially combustible materials are vehicle fuel storage and dispensing, wood recycling, and landfill gas monitoring/management.

In order to minimize fire hazards at the site, the following standards are in effect.

- Smoking is allowed only in designated areas. Smoking is specifically prohibited:
    - on any area of the landfill waste footprint;
    - at fuel storage and dispensing areas;
    - at material recycling areas; and
    - near landfill gas management system features (gas monitoring probes);
- "No Smoking" signs will be posted at appropriate locations.

above methods, the local fire department will be contacted immediately at 911. Facility personnel will use reasonable measures to contain the fire until the fire department arrives.

6.4.4 Structures

Personnel will follow the general procedures outlined in Section 6.3 of this SOP for fires occurring in on-site structures. The potential for fires will be minimized by employing routine maintenance and cleanup. Fire extinguishers will be provided in structures. No site personnel will enter a structure that is on fire.

6.4.5 Other Areas

Fire-fighting procedures at the large/heavy/bulky item area, the wood recycling area, and the C&D recycling area will be the same as for the working face, as described in Section 6.4.1.

6.5 Notification of TCEQ

If a fire is not extinguished within 10 minutes of detection, the facility will contact the TCEQ Region 12 Office by phone immediately, but no later than four hours after detection. The facility will provide the Region 12 Office with a written description of the fire and response within 14 days of the event. TCEQ Region 12 contact information is as follows:

TCEQ Region 12 Office
5425 Polk St., Ste. H
Houston, TX 77023-1452
Ph. (713) 767-3500
Fax (713) 767-3646

8. UNLOADING AREAS

8.1 Unloading at Working Face

Unloading of waste to be placed in the landfill will only take place at the designated working face or recycling area under the supervision of trained site personnel. A maximum of two working faces at a time may be used for the receipt and disposal of waste. The maximum size of the working face(s) will be in accordance with the fire-fighting/soil spreading capabilities of the equipment (see Section 6.4.1). Equipment Operators will maintain the daily working face(s) at the smallest safe and practical size. Signs and barricades may be used in addition to instructions from site personnel to direct incoming loads to the designated unloading area.

Equipment Operators and other staff with responsibility for the working face operations will be appropriately trained as specified in Section 5.4 of this SOP with regard to approved waste acceptance procedures and requirements. This will include an understanding of prohibited waste (e.g., putrescible, hazardous, PCB, etc.) recognition and incident management methods. One or more of these trained employees will direct and visually monitor disposal of incoming loads of waste at the working face. Trained personnel will be on duty at all times when wastes are being discharged at the working face, and will have the authority and responsibility to reject unauthorized loads, to assess appropriate surcharges, and to have unauthorized material removed by the transporter or on-site personnel or otherwise properly managed by the facility. A sign at the site entrance will display the rules regarding authorized and prohibited waste restrictions for the facility. Additionally, as previously mentioned in Section 5.6, the Scale Clerks will be trained to be on alert for signs of unauthorized waste in incoming loads.

8.2 Unloading Unauthorized and Prohibited Wastes

Unloading of waste in unauthorized areas is prohibited. Waste deposited in an unauthorized area will be removed immediately and disposed of properly.

The methods employed at the site to detect and prevent the disposal of prohibited wastes were discussed in Section 5.6 and will be followed during waste unloading. If unauthorized or prohibited waste is detected by site personnel after it has been discharged, the procedures, notifications, and recordkeeping outlined in Sections 5.6.2 and 5.6.3 will be followed for the type of waste involved in the incident.

8.3 Large/Heavy/Bulky Item Unloading and Collection Area

A staging area to unload and store received/salvaged large/heavy/bulky items (e.g., appliances, white goods) may be maintained at the site, either located on waste within the current landfill

footprint, or in areas within the future landfill footprint. The unloading of such items will be supervised by site personnel and the large/heavy/bulky item area will be policed regularly to insure that any noncompliant materials are removed and deposited in the landfill.

8.4 Wood Recycling Area

An unloading and stockpile area associated with the wood recycling area may be maintained at the site to facilitate segregation of wood materials (e.g., brush, leaves, grass clippings, other wood materials)) and subsequent on-site grinding/chipping/mulching. The wood recycling area will be either located on waste within the current landfill footprint, or will be located in areas within the future landfill footprint. The unloading of brush and wood will be supervised by site personnel and the storage area for these materials will be inspected monthly to insure that any non-brush/wood materials are removed and deposited in the landfill.

8.5 C&D Waste Recycling Area

A special area to stage and store potentially-recyclable C&D materials received/salvaged at the facility may be maintained at the site, either located on waste within the current landfill footprint, or in areas within the future landfill footprint. The unloading of such items will be supervised by site personnel and the C&D recycling area will be inspected monthly to insure that any noncompliant materials are removed and deposited in the landfill.

15. LARGE, HEAVY, OR BULKY ITEMS

Large, heavy or bulky items received at the site may have a designated collection and staging area and may be salvaged/recycled as described in Section 19.1 of this SOP, or may be disposed of at the working face.

Large appliances, brush, and other bulky items will not be placed within 5-ft of the top of the clay liner system. Items classified as large, heavy, or bulky may include, but are not limited to white goods (appliances), air conditioner units, and large metal pieces. No chlorofluorocarbon (CFC)-containing appliances, or electrical equipment containing prohibited PCBs, will be accepted for disposal. Appliances that have had CFCs removed and have certification of removal in accordance with Chapter 40 to the Code of Federal Regulations (40 CFR) 82.156(f)(2) may be accepted. In accordance with 40 CFR 82.156(f)(3), signs will be posted indicating that appliances containing CFCs will not be accepted for disposal.

CFC-containing appliances such as refrigerators, freezers, and air conditioning units that are accepted for recycling will have a licensed CFC recovery technician come on-site to recover the CFCs, or will be sent to an off-site facility for CFC recovery, in accordance with 40 CFR 82.156(f). These items may be stored as potentially recyclable materials as described in Section 19.1 of this SOP prior to CFC recovery or shipment to an off-site facility.

19. SALVAGING AND SCAVENGING

19.1 Salvaging

Salvaging, defined as the "controlled removal of waste materials for utilization, recycling or sale," may be performed at the facility. If so, salvaging will not be allowed to interfere with prompt disposal of solid waste or otherwise create unsafe operating conditions or a public health nuisance. No items will be salvaged from the working face if the salvaging would endanger site personnel. Also, salvaging may not occur in areas that have already received weekly or intermediate cover.

Salvaged items, including potentially recyclable items such as shingles, sheetrock, tires, land clearing debris, metal, concrete, bricks, large/heavy/bulky items, or other inert materials, will be temporarily stored in a designated area(s) at the landfill located within the current or future waste footprint. Due to the location of access roads and waste placement, the location of this designated area may vary over time. Concrete, bricks, or other inert materials may be used for erosion control, road base materials, or other similar uses. Salvaged items will be removed often enough to prevent them from becoming a nuisance, to preclude the discharge of any pollutants from the area, and to prevent an excessive accumulation of the material at the site. Potentially recyclable materials will not be stored at the facility for more than 180 days.

Additional information on C&D waste recycling at the facility can be found in Section 31 of this SOP.

19.2 Scavenging

Scavenging, defined as the "uncontrolled and unauthorized removal of materials at any point in the solid waste management system," will not be allowed at the facility. Scavenging will be prevented through the following controls:

- Access control measures such as fencing, gates, and facility personnel duties (described in Section 7.1);
- Access control inspections and maintenance (e.g., fence inspection and repair as described in Section 7.2);
- Litter control and pickup (described in Section 11);
- Vector control actions (described in Section 17); and
- Application of weekly cover, and inspection/repairs to cover (described in Section 24).

24. LANDFILL COVER

This section contains the general provisions for weekly, intermediate, and final cover for the facility. The Executive Director may grant a temporary waiver from the requirements for weekly and intermediate cover if site management demonstrates that there are extreme seasonal climatic conditions that make meeting such requirements impractical.

24.1 Soil Management

Soil will be obtained from on-site and off-site soil borrow sources and will be maintained in a soil stockpile as needed for facility operations, including application of cover, and fire protection. The earthen material will consist of soil that has not previously come in contact with waste and will be of sufficient volume to meet the fire protection requirements specified in Section 6.4 of this SOP. As this earthen material is used, it will be replenished and/or located as soon as practical but shall at all times be maintained to meet the aforementioned fire protection requirements. The soil material will be located as not to interfere with vehicular traffic or impede drainage.

24.2 Weekly Cover

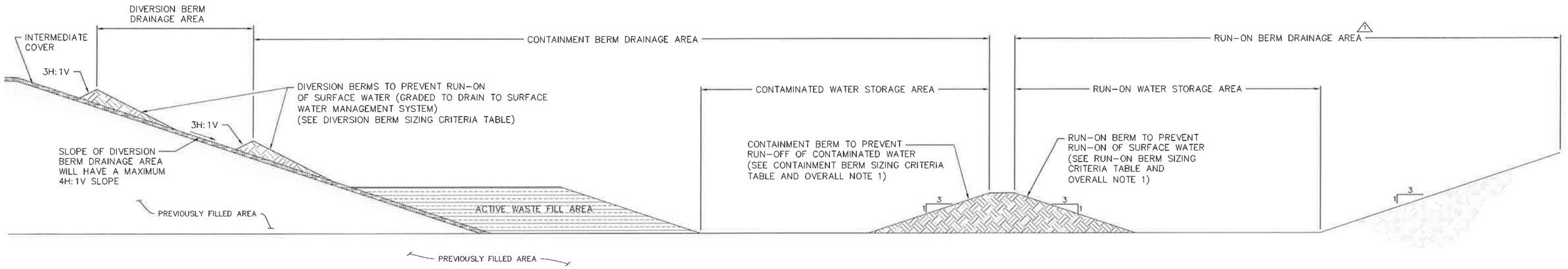
Cover will be placed weekly on all solid waste received during that week, by placing a layer of cover soil after the last load of waste from an operational week has been placed. The purposes of weekly cover include minimization of fire hazards, odors, blowing litter, vector food and harborage, and infiltration of precipitation. In addition, cover materials should discourage scavenging, limit erosion, and improve the aesthetic appearance of the facility.

A minimum compacted thickness of six inches of soil will be placed in one lift and compacted. Scrapers or dump trucks will transport cover soil to the working face. A bulldozer or compactor will spread and compact the soil cover. Soil cover will be clean soil material that has not been mixed with or in previous contact with solid waste. Care will be taken to avoid mixing the landfilled waste with the soil cover material. Storm water runoff from areas that have intact weekly cover is not considered as having come in contact with waste, and accordingly this water will remain uncontaminated.

The Site Manager or designated alternate will document the weekly cover placement and indicate that he/she has visually verified the thickness and condition of the cover in a Cover Application Log (see Section 24.6 of this SOP).

24.3 Intermediate Cover

All areas that will receive additional waste but have been inactive for longer than 180 days will be covered with intermediate cover. This intermediate cover will consist of an additional 6 inches of soil cover material applied over the weekly cover, for a total of at least 12 inches of



DIVERSION BERM SIZING CRITERIA			
BERM HEIGHT	FLOW LINE SLOPE	MAXIMUM DRAINAGE AREA	MAXIMUM FLOW VELOCITY
(FT)	(%)	(AC)	(FT/S)
2.5	0.5	9.2	3.0
	1.0	13.0	4.2
	1.5	16.0	5.2
	2.0	18.4	6.0

NOTES:
1. THE DIVERSION BERMS ARE SIZED TO CONTAIN SURFACE WATER FROM THE 25-YEAR, 24-HOUR RAINFALL EVENT.
2. OPERATOR WILL USE THIS TABLE AND THE ACTUAL BERM SLOPE TO DETERMINE THE MAXIMUM ALLOWABLE DRAINAGE AREA CONTRIBUTING RUNOFF TO A GIVEN BERM.

CONTAINMENT BERM SIZING CRITERIA		
CONTAINMENT BERM DRAINAGE AREA	CONTAMINATED WATER STORAGE AREA	MINIMUM REQUIRED BERM HEIGHT
(AC)	(AC)	(FT)
0.50	0.10	5.0
	0.25	2.6
	0.50	1.8
1.0	0.10	9.0
	0.25	4.2
	0.50	2.6
1.5	0.25	5.8
	0.50	3.4
	0.75	2.6
2.0	0.25	7.4
	0.50	4.2
	0.75	3.1
3.0	0.40	7.0
	0.75	4.2
	1.00	3.4
4.0	0.50	7.4
	0.75	5.3
	1.00	4.2

NOTES:
1. THE CONTAINMENT BERM HEIGHT INCLUDES 1.0 FT OF FREEBOARD AND BERMS ARE SIZED TO CONTAIN SURFACE WATER FROM THE 25-YEAR, 24-HOUR RAINFALL EVENT.
2. OPERATOR WILL USE THIS TABLE AND ACTUAL WORKING FACE/DRAINAGE AREA SIZE AND STORAGE AREA SIZE TO DETERMINE THE APPROPRIATE MINIMUM CONTAINMENT BERM SIZE.

⚠1 RUN-ON BERM SIZING CRITERIA		
RUN-ON BERM DRAINAGE AREA	RUN-ON WATER STORAGE AREA	MINIMUM REQUIRED BERM HEIGHT
(AC)	(AC)	(FT)
2.0	0.25	7.40
	0.50	4.20
	0.75	3.13
4.0	0.50	7.40
	0.75	5.27
	1.0	4.2
10.0	1.0	9.0
	2.0	5.0
	3.0	3.7
15.0	2.0	7.0
	3.0	5.0
	4.0	4.0
20.0	2.0	9.0
	3.0	6.3
	4.0	5.0
25.0	3.0	7.7
	4.0	6.0
	5.0	5.0
30.0	3.0	9.0
	4.0	7.0
	5.0	5.8

NOTES:
1. THE RUN-ON BERM HEIGHT INCLUDES 1.0 FT OF FREEBOARD AND BERMS ARE SIZED TO CONTAIN SURFACE WATER FROM THE 25-YEAR, 24-HOUR RAINFALL EVENT.
2. OPERATOR WILL USE THIS TABLE AND ACTUAL DRAINAGE AREA SIZE AND STORAGE AREA SIZE TO DETERMINE THE APPROPRIATE MINIMUM RUN-ON BERM SIZE.

⚠1 OVERALL NOTE:
1. ONE BERM MAY PROVIDE BOTH FUNCTIONS (CONTAINMENT ON ONE SIDE AND RUN-ON STORAGE/PROTECTION ON THE OTHER SIDE) PROVIDED IT IS SIZED TO THE LARGER OF THE APPLICABLE CRITERIA IN THE TABLES ON THIS DRAWING.

STATE OF TEXAS
SCOTT M. GRAVES
86557
LICENSED
PROFESSIONAL ENGINEER
3/3/2014

FOR PERMIT PURPOSES ONLY

SCALE: N.T.S.

REV	DATE	DESCRIPTION	DRN	APP
⚠1	MAR. 2014	REVISED, RESPONSE TO NOD 1	JJV/KH	SMG
–	AUG. 2013	INITIAL SUBMITTAL TO TCEQ	JJV	SMG

USA WASTE OF TEXAS LANDFILLS, INC.
LANDFILL SITE ADDRESS:
8205 FAIRBANKS N HOUSTON RD
HOUSTON, TEXAS 77064
PHONE: 713.824.6867

Geosyntec consultants
GEOSYNTEC CONSULTANTS, INC.
TEXAS ENG. FIRM REGISTRATION NO. 1182
8217 SHOAL CREEK BLVD, SUITE 200
AUSTIN, TEXAS 78757
PHONE: 512.451.4003

TITLE:
CONTAMINATED RUN-ON AND RUNOFF DETAILS

PROJECT:
FAIRBANKS LANDFILL
PERMIT AMENDMENT APPLICATION – PERMIT NO. MSW-1565B

PROJECT NO.: TXL0263	DESIGN BY: LOL	REVIEWED BY: SMG	PART NO.: IV	DRAWING: IV-A-1
FILE: 0263P3E-1	DRAWN BY: JJV	APPROVED BY: SMG		

PERMIT DRAWING

DRAWING: Austin P:\CADD\Projects\F\Fairbanks Landfill\Permit\Expansion (TXL0263)\Drawings\Dwgs-RevO\0263P3E-1.dwg PLOTTED: Feb 28, 2014 - 11:20am

CONSTRUCTION AND DEMOLITION (C&D) MATERIAL RECYCLING PLAN



3/3/2014

FOR PERMIT PURPOSES ONLY;
PAGES IV-B-1 THROUGH 3

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

B1. INTRODUCTION AND OVERVIEW

A C&D recycling program will be implemented at the facility to collect and process (segregate) C&D materials into separate material streams for recycling. The program will include various C&D materials that are potentially-recyclable items, such as, metal, cardboard, plastic, concrete, bricks, shingles, sheetrock, tires, land clearing debris, wood pallets, or other inert materials. A special area to stage, store, and process potentially-recyclable C&D materials received/salvaged at the facility will be established in an area of the site separate from the active working face to provide convenient access to users, without interrupting landfill operations. It is anticipated that the area will move as landfill development progresses, but in all cases the area will either be located on waste within the current landfill footprint, or in areas within the future landfill footprint.

Separated materials will be stockpiled either in piles (e.g., for shingles and yard waste), or in roll-off box containers (e.g., for sheetrock). The incoming loads of C&D will be weighed at the facility's scales, and then will be visually observed by facility personnel to decide whether the material is clean and composed of material(s) that is suitable to be diverted to the C&D recycling area instead of disposal at the working face.

Some of the processed C&D materials may be diverted for other use (e.g., grinding/wood-chipping to create mulch) or be used at the facility (e.g., concrete debris for road base). Other separated materials will be sent off-site for beneficial use where possible as described herein, or landfilled on-site.

Consistent with 30 TAC §328.4, the materials removed for recycling shall not be considered to be accumulated, but shall be considered to be recycled, since they have been contained, covered,

that separates metals. The facility may also use a magnet attached to a piece of heavy equipment such as a track-hoe for separating metals from stockpiles of mixed materials. Metals will be collected and stockpiled, and transferred off-site to a TCEQ-approved recycling facility.

- Wood and Wood Pallets. Those loads deemed by facility personnel as suitable for wood recycling will be unloaded and stockpiled in the recycling area. Clean wood and wood pallets will then be separated by hand-sorting and mechanical means. The wood will then be ground/chipped/mulched on-site.

- Plastics/Cardboard. Those loads deemed by facility personnel as suitable for plastics and cardboard recycling will be unloaded and stockpiled in the recycling area. The plastics and cardboard will then be hand-sorted and stored in dumpsters until full loads of each material are available for transportation to an off-site TCEQ-approved recycling facility.

Material Unloading. The unloading of C&D materials in the recycling area shall be confined to as small an area as practical. The unloading of such items will be supervised by site personnel and the C&D recycling area will be policed regularly to insure that any noncompliant materials are removed and deposited in the landfill.

Access Control. Since the C&D recycling area will be located within the limit of landfill footprint inside the permit boundary, access will be through the main landfill entrance, and access control will be accomplished through the overall facility access controls described in Section 7 of the SOP.

Surface Water Management and Other Environmental Controls. To prevent surface water runoff onto and off of the recycling area, this area will be operated and maintained to manage runon and runoff during peak discharge from the 25-year, 24-hour storm event and to prevent the potential for off-site discharge of waste and contaminated water. This will be accomplished through the installation of runon diversion berms up-gradient from the recycling area in the same manner as for the active working face – in accordance with the Contaminated Water Management Plan (Appendix IV-A to the SOP). This will prevent excessive surface water from passing through the area and potentially causing any washouts, etc. The recycling area will also be operated in a manner that prevents it from becoming a nuisance or fire hazard. Dust control will be performed. Fire protection requirements for the area are provided in Section 6 of the SOP (in particular see Section 6.4.5).