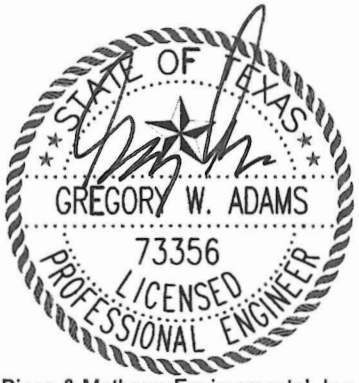
WASTE MANAGEMENT SKYLINE LANDFILL
DALLAS AND ELLIS COUNTIES, TEXAS
PERMIT AMENDMENT APPLICATION NO. MSW 42E

VOLUME 2 OF 4

Prepared for

WASTE MANAGEMENT OF TEXAS, INC.

March 2026



Biggs & Mathews Environmental, Inc.
Firm Registration No. F-256
3/31/2026

Prepared by

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

TEXAS BOARD OF PROFESSIONAL ENGINEERS AND LAND SURVEYORS
FIRM REGISTRATION NO. F-256 AND NO. 10194895

TEXAS BOARD OF PROFESSIONAL GEOSCIENTISTS
FIRM REGISTRATION NO. 50222

WASTE MANAGEMENT SKYLINE LANDFILL
DALLAS AND ELLIS COUNTIES, TEXAS
PERMIT AMENDMENT APPLICATION NO. MSW 42E

VOLUME 2 OF 4 CONTENTS

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Attachment B – General Facility Design
Attachment C – Facility Surface Water Drainage Report
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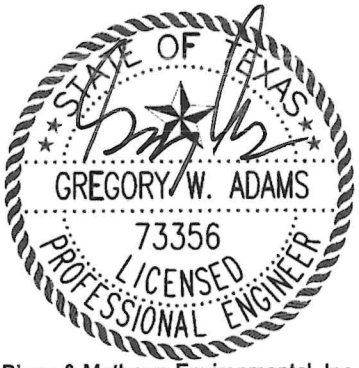
Attachment D6 – Leachate and Contaminated Water Management Plan
Attachment D7 – Liner Quality Control Plan
Attachment D8 – Final Cover Quality Control Plan
Attachment D9 – Alternate Final Cover Demonstration



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WASTE MANAGEMENT SKYLINE LANDFILL
DALLAS AND ELLIS COUNTIES, TEXAS
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PART III – FACILITY INVESTIGATION AND DESIGN

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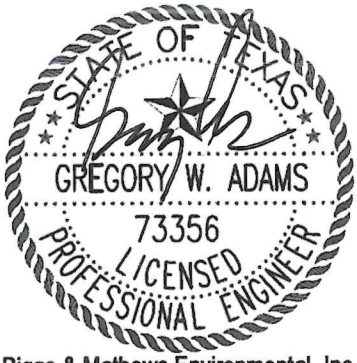
WASTE MANAGEMENT OF TEXAS, INC.

March 2026



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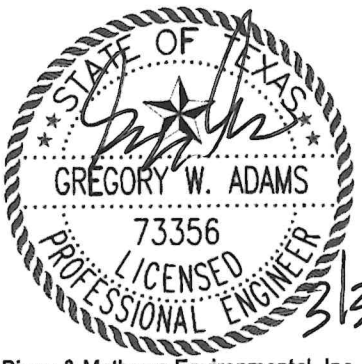

3/31/2026

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WASTE MANAGEMENT SKYLINE LANDFILL
DALLAS AND ELLIS COUNTIES, TEXAS
PERMIT AMENDMENT APPLICATION NO. MSW 42E

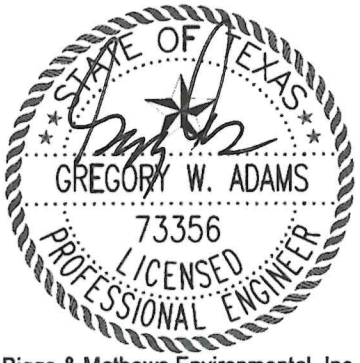
PART III – FACILITY INVESTIGATION AND DESIGN

ATTACHMENT A
SITE DEVELOPMENT PLAN NARRATIVE

Prepared for

WASTE MANAGEMENT OF TEXAS, INC.

March 2026



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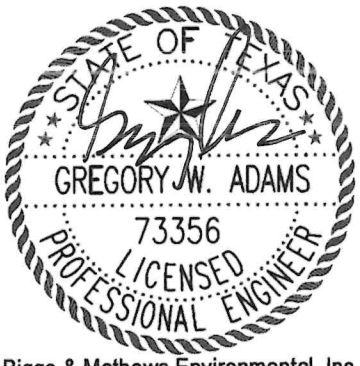

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1 INTRODUCTION

30 TAC §330.63(a)

This site development plan provides the criteria used in the selection and design of this facility for the safeguarding of the health, welfare, and physical property of the public and environment through consideration of the geology, soil conditions, drainage, land use, zoning, adequacy of access roads and highways, and other considerations specific to this facility.

2 GENERAL FACILITY DESIGN

30 TAC §330.63(b)

The general facility design information is included in Attachment B. Attachment B provides details about facility access control as required by §330.63(b)(1), a generalized process design and working plan of the facility that describes waste movement as required by §330.63(b)(2), a description of how solid waste processing facilities will be designed to facilitate proper cleaning as required by §330.63(b)(3), a description of how all liquids resulting from the operation of solid waste processing facilities will be disposed of in a manner that will not cause surface water or groundwater pollution as well as the treatment of wastewaters resulting from the process or from cleaning and washing as required by §330.63(b)(4), and a general discussion of endangered and threatened species as required by §330.63(b)(5).

3 FACILITY SURFACE WATER DRAINAGE DESIGN

30 TAC §330.63(c)

The facility surface water drainage design report is included in Attachment C. Attachment C demonstrates how the facility is designed to meet the drainage and flood control requirements of §330.63(c) and §§330.303, 330.305, and 330.307. The surface water drainage design report includes analyses of the existing conditions, postdevelopment conditions, and design of the surface water management system, including final cover drainage facilities, perimeter drainage channels, and ponds, and also includes an erosion and sediment control plan for all phases of landfill development. The facility surface water drainage design report demonstrates that current drainage patterns will not be adversely altered and that the facility is not located within the 100-year floodplain.

4 WASTE MANAGEMENT UNIT DESIGN

30 TAC §330.63(d)

The waste management unit design information is included in Attachment D. Attachment D demonstrates how the facility was designed to meet §330.63(d)(4) for landfill units. The waste management unit design includes provisions for all-weather operations, proposed landfill method, elevation of deepest excavation, maximum elevation of waste and final cover, waste disposal rate and operating life of the landfill, landfill unit cross sections, construction and design details of the landfill unit, and the liner quality control plan. The landfill liner system has been designed to meet the requirements of §330.331(d) and the requirements of §330.337 for special liner design constraints as related to construction of a passive dewatering system to reduce hydrostatic forces on the liner during construction. In addition, Attachment D includes the geotechnical design report for the facility, the liner quality control plan, final cover quality control plan, and contaminated water management plan.

5 GEOLOGY REPORT

30 TAC §330.63(e)

The geology and soil information is included in Attachment E. Attachment E provides the descriptions of the regional geology and hydrogeology, geologic process, regional aquifers, subsurface investigations, geotechnical properties of subsurface soils, and fault and seismic conditions.

6 GROUNDWATER SAMPLING AND ANALYSIS PLAN

30 TAC §330.63(f)

The groundwater sampling and analysis plan is included as Attachment F. Attachment F provides the information required by §330.63(f) and §§330.401 through 330.421. The groundwater monitoring plan includes the point of compliance, contaminant pathway analysis, groundwater monitoring program, detection monitoring program, and groundwater sampling and analysis plan.

7 LANDFILL GAS MANAGEMENT PLAN

30 TAC §330.63(g)

The landfill gas management plan is included as Attachment G. Attachment G provides the information required by §330.63(g) and §330.371. The landfill gas management plan includes the requirements for landfill gas monitoring at the landfill perimeter and in on-site structures, and procedures to be implemented in the event that concentrations of methane in excess of the regulatory limits are measured at the facility permit boundary or in on-site structures.

8 CLOSURE PLAN

30 TAC §330.63(g)

The closure plan is included as Attachment H. Attachment H provides the information required by §330.63(h), §330.453, and §330.457. The closure plan includes the procedures for closure of the facility following final acceptance of waste and certification of final closure. The closure plan describes the final cover system, closure procedures, final cover quality control plan, and a closure schedule.

9 POSTCLOSURE PLAN

30 TAC §330.63(i)

The postclosure plan is included as Attachment I. Attachment I provides the information required by §330.63(i), §330.463, and §330.465. The postclosure plan includes the procedures for postclosure care maintenance and postclosure care certification. The postclosure plan describes the postclosure care activities, persons responsible for conducting postclosure care activities, and postclosure land use.

10 COST ESTIMATES FOR CLOSURE AND POSTCLOSURE CARE

30 TAC §330.63(j)

The cost estimates for closure and postclosure care are included as Attachment J. Attachment J provides the information required by §330.63(j). The detailed cost estimate for closure meets the requirements of §330.503. The detailed cost estimate for postclosure care meets the requirements of §330.507. This plan also provides procedures to adjust the cost estimates during the life of the facility and provides the evidence of financial assurance.

WASTE MANAGEMENT SKYLINE LANDFILL
DALLAS AND ELLIS COUNTIES, TEXAS
PERMIT AMENDMENT APPLICATION NO. MSW 42E

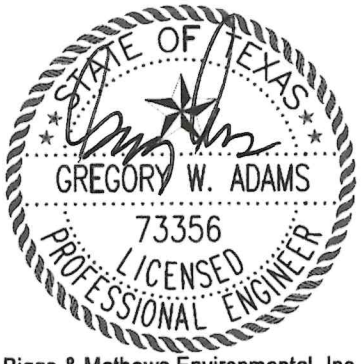
PART III – FACILITY INVESTIGATION AND DESIGN

ATTACHMENT B
GENERAL FACILITY DESIGN

Prepared for

WASTE MANAGEMENT OF TEXAS, INC.

March 2026



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TEXAS BOARD OF PROFESSIONAL GEOSCIENTISTS
FIRM REGISTRATION NO. 50222

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1 FACILITY ACCESS 1

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3 SANITATION 4

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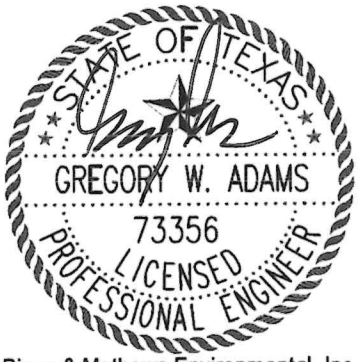
5 ENDANGERED SPECIES PROTECTION 6



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Firm Registration No. F-256

3/31/2026

1 FACILITY ACCESS

30 TAC §330.63(b)(1)

Access to the Skyline Landfill is provided by an entrance road from Business U.S. 45. Access to the facility is controlled by a perimeter fence along the permit boundary and locking gate at the site entrance. The fence and gate will prevent the entry of livestock, protect the public from exposure to potential health and safety hazards, and discourage unauthorized entry or uncontrolled disposal of solid waste or prohibited materials.

Entry to the active portion of the site is restricted to designated personnel, approved waste haulers, properly identified persons whose entry is authorized by site management, and TCEQ personnel. Visitors may be allowed on the active area only when accompanied by a site representative. Signs are located along the entrance road directing traffic to the gatehouse. The gate attendant restricts site access to authorized vehicles and directs these vehicles appropriately. Waste hauling vehicles are directed to appropriate fill areas by signs located along the landfill haul road and access road. These vehicles will deposit their loads and depart the site. Private, commercial, or public solid waste vehicles are not allowed access to any areas other than the active portion of the landfill. Site personnel provide traffic directions as necessary to facilitate safe movement of vehicles. Within the site, signs are placed along the landfill haul road and access road at a frequency adequate for users to be able to determine where the disposal area locations are, and which roads are to be used. Roads not being used for access to disposal areas will be blocked or otherwise marked for no entry.

2 WASTE MOVEMENT

30 TAC §330.63(b)(2)

Waste disposal facilities include a waste disposal area, large item staging area, reusable materials staging area, citizen's convenience area, liquid stabilization area, and wood waste mulching area. Appendix B1 includes a waste flow diagram, schematic drawings, and details that depict disposal and materials staging activities.

Waste movement through the facility is depicted on Drawing B.1 and a waste disposal material staging plan is provided on Drawing B.2. As waste enters the facility via the entrance road, the attendant observes the incoming waste, conducts waste screening and weighing, and documents incoming waste. The attendant is familiar with the rules and regulations governing the various types of waste that can or cannot be accepted into this facility and directs the waste hauler to the appropriate waste disposal or material staging area. The site personnel have the authority to reject prohibited wastes and have the rejected waste removed by the waste haul vehicle or transporter immediately upon discovery. Trained personnel observe waste unloading at the active working face and large item staging area and will have the authority and responsibility to reject loads which contain prohibited wastes. The working face personnel also have the authority to have unauthorized and prohibited waste removed by the waste haul vehicle or transporter immediately upon discovery.

The waste disposal area will have a constructed liner system as described in Attachment D. A staging area for large items and white goods and a wood waste mulching area may be provided over lined areas near the active working face. Large items and white goods include items such as ovens, dishwashers, freezers, air conditioners, and other large items. Runon or runoff from the area will be contained within the active area and handled as contaminated water, as discussed in Part IV. These items will be disposed of after CFCs have been removed in accordance with all applicable regulatory requirements and within 10 days of acceptance at the facility. The wood waste mulching area will include source-separated yard trimmings, brush, and clean wood materials. Materials will be chipped and mulched in small piles and will be managed to prevent fire, safety, or health hazards in accordance 30 TAC §330.209(a). Periodically, a third party contractor will be called to the site to grind and transport the wood waste material off-site for re-use. Wood waste mulch will be re-used within the facility or transported for off-site re-use within 90 days of acceptance at the facility.

Source-separated inert materials such as brick, concrete, rubble, aggregate, and reclaimed asphalt pavement may be staged at the facility for use on facility access roads, staging areas, and drainage structures. The reusable materials staging area will be located above existing lined areas and will be relocated periodically as the active working face moves. The size of the stockpiles will vary depending on the amount of materials received. Since brick, concrete, rubble, aggregate materials, and reclaimed asphalt pavement are inert, their staging will not create a public health hazard or nuisance, and separate management of runon and runoff from rainfall in this area will not

be required. Since these inert materials will continuously be reused for site operations, there is no time limit on the staging of these materials. Reclaimed asphalt pavement that contains asbestos will not be used and will not be accepted.

The current and future Citizen's Convenience Area will be located within limits of the waste management unit beside the access road. The Citizen's Convenience Area will consist of 30 cy roll off boxes as depicted on Drawing B.4. The roll off boxes will be emptied at the working face.

3 SANITATION

30 TAC §330.63(b)(3)

The solid waste material staging areas include the large item staging area, reusable materials staging area, and wood waste mulching area. Each of these facilities is designed to facilitate proper cleaning and comply with the surface water drainage requirements of §330.303.

Runoff of contaminated water from the large item staging area will be prevented by containment berms as shown on Drawing B.3. Contaminated water will be disposed of in accordance with Attachment D6. Surface water runon and runoff controls are not required for inert materials in the reusable materials staging area. The wood waste mulching area will consist of small piles managed to prevent litter and control fire, health hazards, and safety in accordance with §330.209(a). There are no water runon and runoff control, or additional sanitation controls required.

4 WATER POLLUTION CONTROL

30 TAC §330.63(b)(4)

The material staging areas will be maintained and operated to manage runon and runoff during the peak discharge from the 25-year storm event and will prevent the off-site discharge of waste material. Surface water in and around each material staging area, as applicable, will be controlled to minimize surface water running onto, into, and off these areas. Since all contaminated water will be managed in a controlled manner, as discussed above, surface water and groundwater will be protected. The landfill will not discharge contaminated water off-site or into waters of the United States without obtaining specific written authorization from the TCEQ, prior to any discharge. The landfill and its material staging areas will be operated consistent with §330.15(h)(1)-(4) regarding discharge of solid wastes or pollutants into waters of the United States.

The design of the landfill and the surface water management system for the facility will prevent the discharge of solid waste, pollutants, dredged, or fill material and non-point source pollution that would violate any of the provisions referenced in §330.15(h). The facility has been designed to keep contaminated surface water separated from uncontaminated stormwater runoff. The contaminated water will not be discharged to the surface water management system to be constructed at the site.

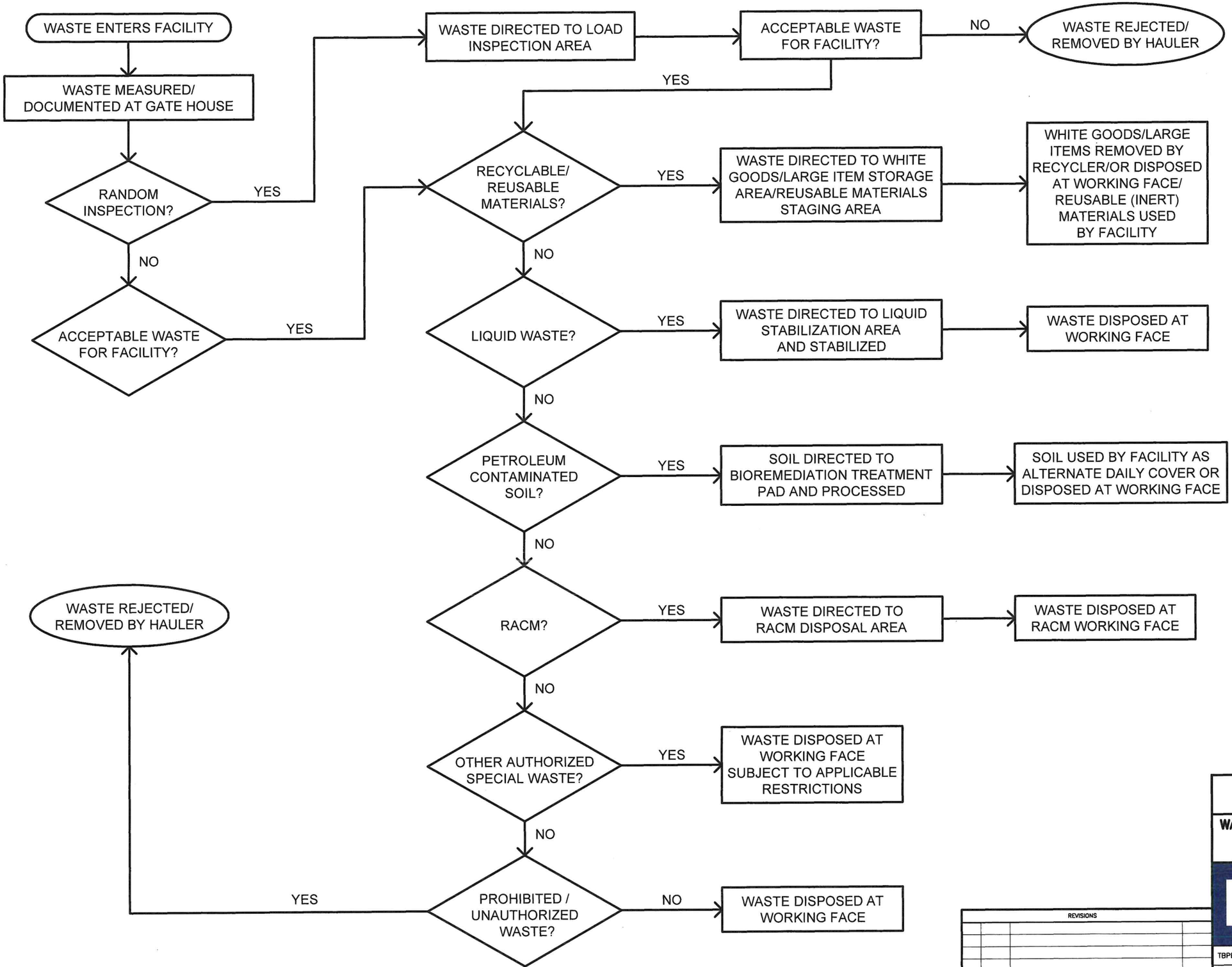
5 ENDANGERED SPECIES PROTECTION

30 TAC §330.63(b)(5)

An evaluation of endangered or threatened species at the site was conducted by Integrated Environmental Solutions, LLC and is provided in Part II, Appendix IIE. Based on the evaluation the facility and operation of the facility will not result in the destruction or adverse modification of the critical habitat of endangered or threatened species and will not cause or contribute to the taking of any endangered or threatened species.

SKYLINE LANDFILL

APPENDIX B1
DRAWINGS



STATE OF TEXAS
GREGORY W. ADAMS
73356
LICENSED PROFESSIONAL ENGINEER

3/31/2026

WASTE MOVEMENT FLOW DIAGRAM

WASTE MANAGEMENT OF TEXAS, INC. SKYLINE LANDFILL

BME
BIGGS & MATHEWS ENVIRONMENTAL
1700 ROBERT ROAD, STE. 100
MANSFIELD, TEXAS 76063
817-563-1144

TBPELS FIRM NO. F-256 AND NO. 10194895
TBPG FIRM NO. 50222

DRAWING B.1

REVISIONS			
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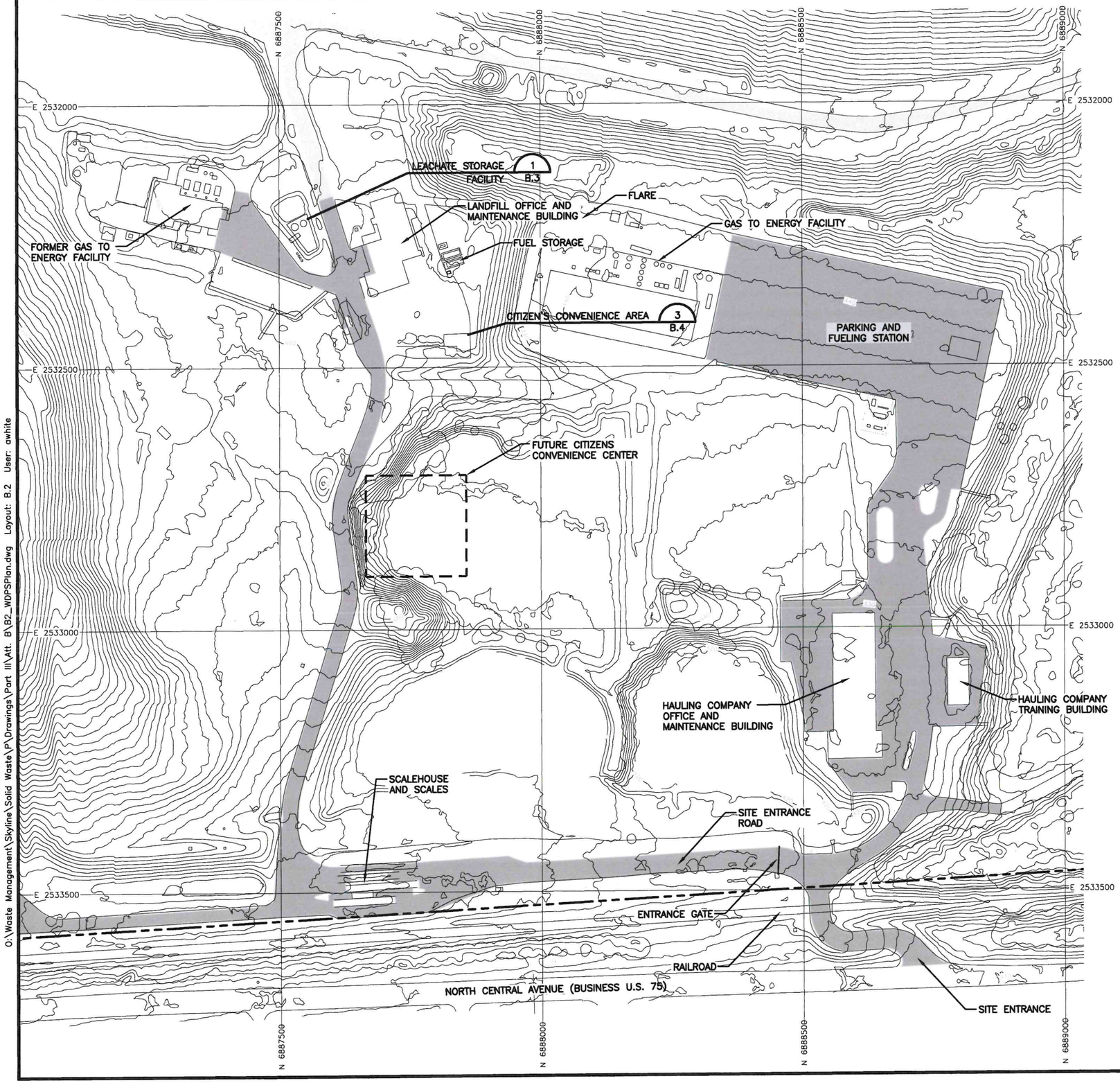

0 100 200
SCALE IN FEET

LEGEND

- PERMIT BOUNDARY
- EXISTING 2' GROUND CONTOUR
- E 2532500 — STATE PLANE GRID (NAD 83)
- CONCRETE PAVEMENT
- AGGREGATE PAVEMENT

NOTES:

1. EXISTING CONTOURS COMPILED BY HYDREX DRONE DIVISION FROM AERIAL PHOTOGRAPHY. FLOWN MARCH 5, 2025. COORDINATE SYSTEM IS BASED ON TEXAS STATE PLANE NAD 83 (2011), TEXAS NORTH CENTRAL ZONE, US FEET.
2. THE LANDFILL GAS TO ENERGY FACILITY, CITIZEN'S CONVENIENCE AREA, LEACHATE STORAGE FACILITY, MUD GRATE FACILITY, LANDFILL OFFICE AND MAINTENANCE FACILITY, AND SCALE HOUSE AND SCALES ARE EXISTING.

STATE OF TEXAS
GREGORY W. ADAMS
73356
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PROFESSIONAL ENGINEER

3/31/2026

WASTE PROCESSING AND STORAGE FACILITIES SCHEMATIC PLAN

WASTE MANAGEMENT OF TEXAS, INC. SKYLINE LANDFILL

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DRAWING B.2

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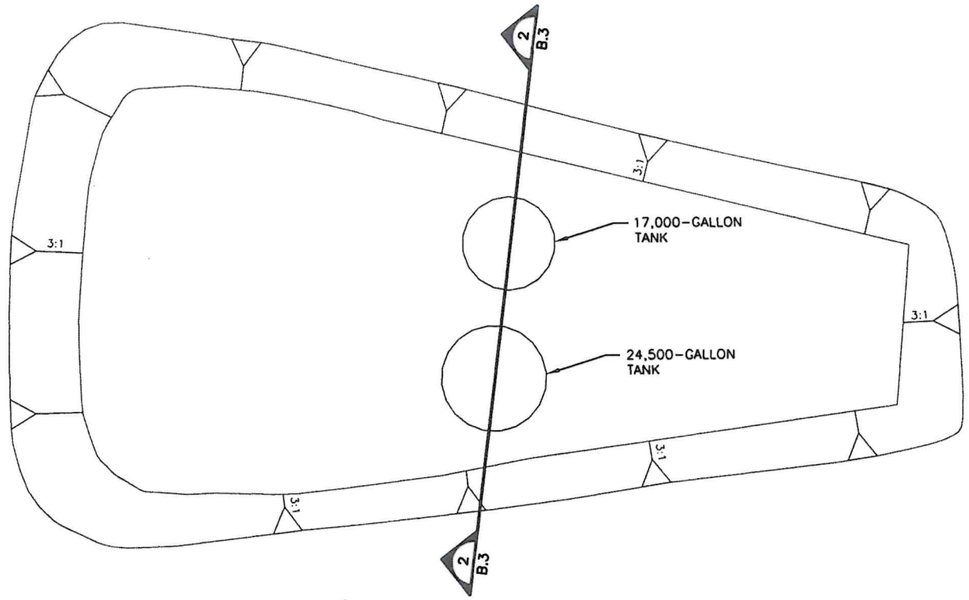

LEACHATE STORAGE FACILITY 1 B.3

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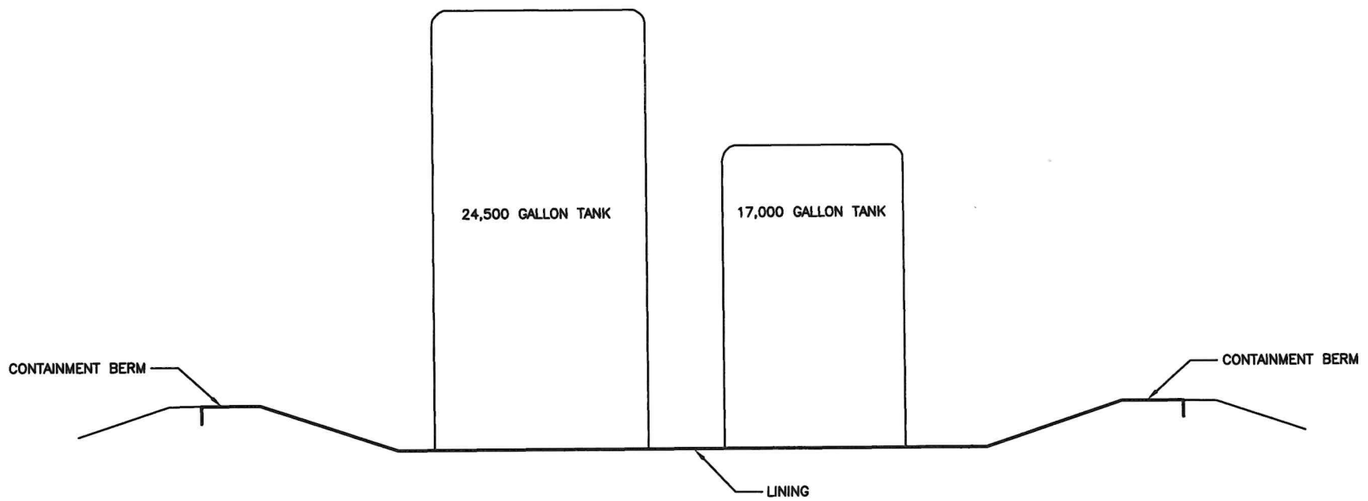

LEACHATE STORAGE FACILITY SECTION 2 B.3

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MUD GRATE AND LEACHATE STORAGE FACILITY

WASTE MANAGEMENT OF TEXAS, INC.
SKYLINE LANDFILL

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TBPG FIRM NO. 50222

DRAWING B.3

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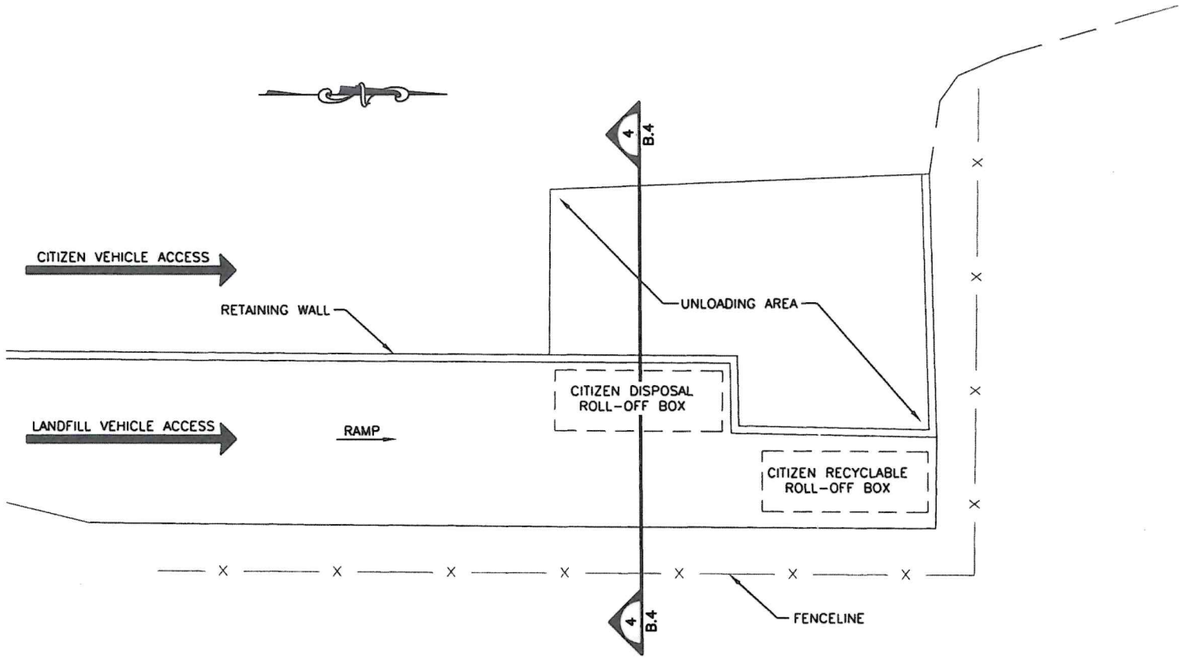

CITIZEN'S CONVENIENCE AREA (4 / B.4)

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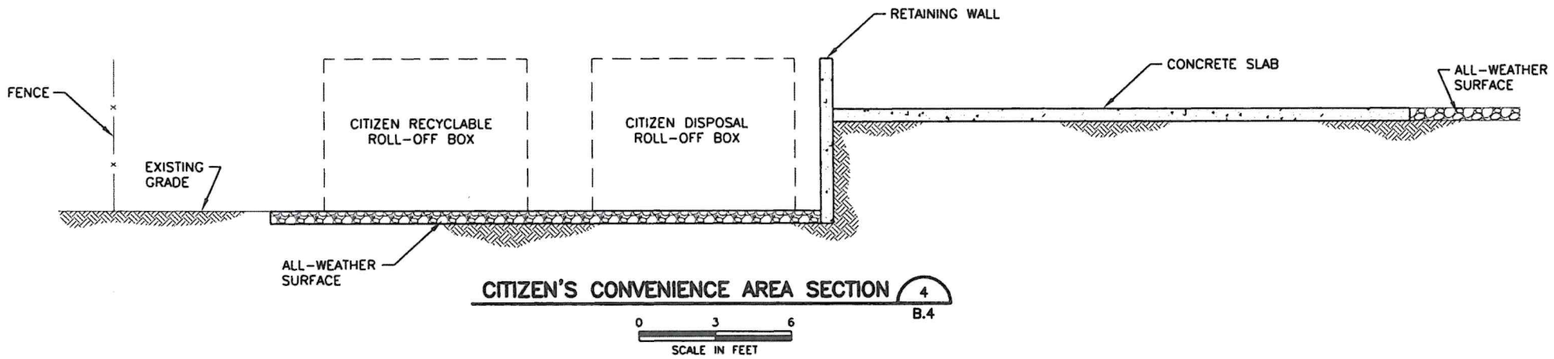

CITIZEN'S CONVENIENCE AREA SECTION (4 / B.4)

0 3 6
SCALE IN FEET

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PROFESSIONAL ENGINEER

3/31/2026

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REV	DATE	DESCRIPTION	DWN BY

CITIZEN'S CONVENIENCE AREA

WASTE MANAGEMENT OF TEXAS, INC. SKYLINE LANDFILL

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1700 ROBERT ROAD, STE. 100
MANSFIELD, TEXAS 76063
817-563-1144

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TBPG FIRM NO. 50222

DRAWING
B.4

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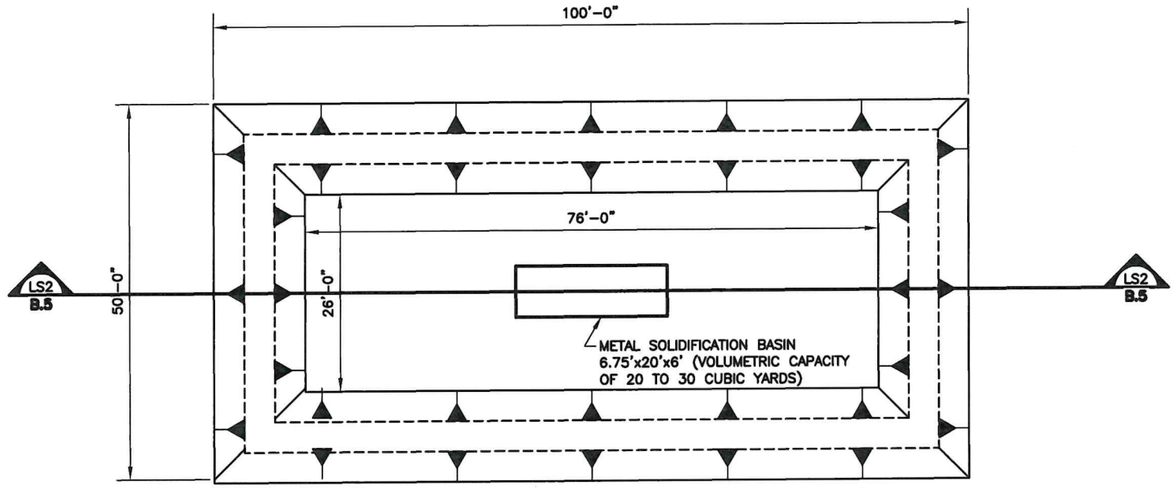
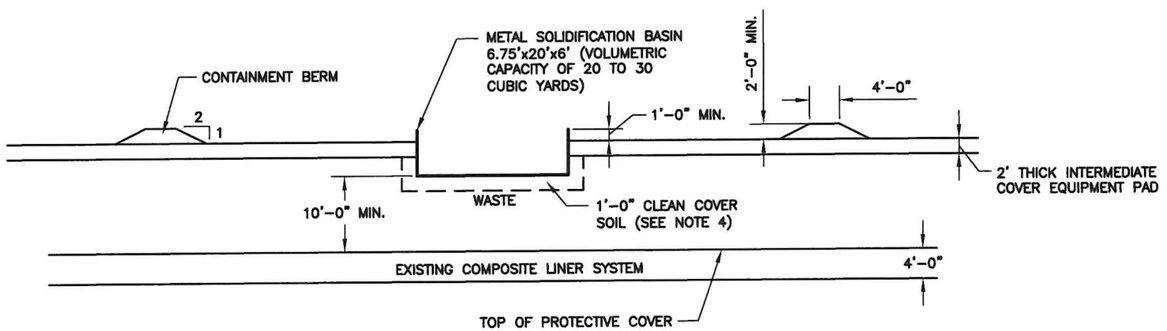


LIQUID STABILAZATION AREA PLAN LS1 B.5

(SEE NOTE 2)



LIQUID STABILAZATION AREA PLAN LS2 B.5

(SEE NOTE 2)

0 10 20

SCALE IN FEET

NOTES:

1. THE LIQUID STABILIZATION AREA WILL BE LOCATED ABOVE EXISTING LINED AREAS AND WILL BE RELOCATED PERIODICALLY AS THE ACTIVE WORKING FACE MOVES.
2. DIMENSIONS OF THE LIQUID STABILIZATION AREA AND STABILIZATION BASIN MAY VARY.
3. DISCUSSION ON THE LIQUID STABILIZATION FACILITY IS PROVIDED IN ATTACHMENT B.
4. THE SOLIDIFICATION BASIN WILL BE SEPARATED FROM WASTE BY 12 INCHES OF CLEAN COVER SOIL ON BOTTOM AND SIDES OF BASIN.

STATE OF TEXAS
GREGORY W. ADAMS
73356
LICENSED
PROFESSIONAL ENGINEER

3/31/2026

REVISIONS			
REV	DATE	DESCRIPTION	DWN BY

LIQUID STABILIZATION AREA

WASTE MANAGEMENT OF TEXAS, INC.
SKYLINE LANDFILL

BIGGS & MATHEWS ENVIRONMENTAL
1700 ROBERT ROAD, STE. 100
MANSFIELD, TEXAS 76063
817–563–1144

TBPELS FIRM NO. F–256 AND NO. 10194895

TBPG FIRM NO. 50222

DRAWING B.5

O:\Waste Management\Skyline\Solid Waste\P\Drawings\Part III\Att. B\B5_SolidDtls.dwg Layout: B.5 User: awhite

WASTE MANAGEMENT SKYLINE LANDFILL
DALLAS AND ELLIS COUNTIES, TEXAS
TCEQ PERMIT APPLICATION NO. MSW 42E

PERMIT AMENDMENT APPLICATION

PART III – FACILITY INVESTIGATION AND DESIGN
ATTACHMENT C
FACILITY SURFACE WATER DRAINAGE REPORT

Prepared for

WASTE MANAGEMENT

Waste Management of Texas, Inc.

March 2026

STATE OF TEXAS
FELIPE ANTONIO WESCOUP
103826
LICENSED
PROFESSIONAL ENGINEER
3/31/2026

Biggs & Mathews Environmental, Inc.
Firm Registration No. F-256

Prepared by

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TEXAS BOARD OF PROFESSIONAL ENGINEERS AND LAND SURVEYORS
FIRM REGISTRATION NO. F-256 AND NO. 10194895

TEXAS BOARD OF PROFESSIONAL GEOSCIENTISTS
FIRM REGISTRATION NO. 50222

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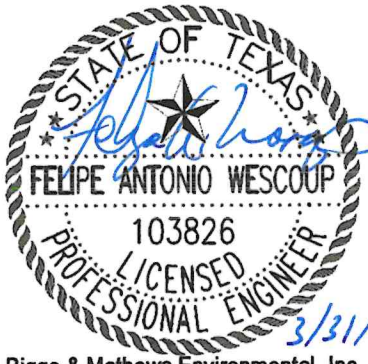
Attachment C2 – Flood Control Analysis

Attachment C3 – Drainage System Plans and Details



Biggs & Mathews Environmental, Inc.
Firm Registration No. F-256

1 NARRATIVE

30 TAC §330.63(c) and §§330.301-330.307

The facility surface water drainage report is prepared as part of a permit application for the Skyline Landfill, consistent with 30 TAC Chapter 330. This facility surface water drainage report has been prepared consistent with the requirements of §330.63(c) and §§330.301 through 330.307. Attachment C – Facility Surface Water Drainage Report is organized to include the drainage analysis and design, flood control and analysis, and drainage system plans and details. The facility design complies with the requirements of §330.303(a)-(b) concerning the management of runon and runoff during peak discharge of a 25-year rainfall event, the prevention of off-site discharge of waste and feedstock materials, and the control of surface water discharge in and around the facility. The following is a brief description of each of the attachments.

Attachment C1 –Drainage Analysis and Design

Attachment C1 is the drainage analysis and design of the facility, which includes calculations and demonstrations consistent with the requirements of §330.63(c), and §§330.301-330.305. This attachment includes a comparison of surface water runoff from the current permitted condition to the postdevelopment condition at each location where surface water enters or exits the permit boundary for the 25-year, 24-hour rainfall event. The current permitted condition for this evaluation is defined as the permitted landfill completion plan for the Skyline Landfill MSW Permit No. 42D (42D). The postdevelopment condition for this evaluation is defined as the landfill completion plan for the Skyline Landfill MSW Permit No. 42E (42E). The comparison between the current permitted condition and the postdeveloped condition demonstrates that the proposed expansion (42E) of the Skyline Landfill will not adversely alter the current permitted (42D) drainage patterns. In addition, this attachment includes the drainage design for the final cover system, drainage swales, chutes, perimeter channels, and detention ponds.

Attachment C2 – Flood Control Analysis

Attachment C2 is the flood control analysis, which includes calculations and demonstrations consistent with the requirements of §330.63(c)(2) and §§330.301-330.307. The flood control analysis demonstrates that the proposed expansion of the Skyline Landfill will not adversely impact the flooding conditions of the receiving channel and that the landfill footprint will not be located within the 100-year floodplain. Since the landfill footprint will not be located within the 100-year floodplain, the levees required by §330.307 are not necessary to protect the facility from a 100-year frequency flood or to otherwise prevent the washout of solid waste from the facility.

Attachment C3 – Drainage System Plans and Details

This attachment includes the permit level site plans and details for the drainage system consistent with §330.63(c) and §§330.301-330.305.

WASTE MANAGEMENT SKYLINE LANDFILL
DALLAS AND ELLIS COUNTIES, TEXAS
TCEQ PERMIT APPLICATION NO. MSW 42E

PERMIT AMENDMENT APPLICATION

PART III – FACILITY INVESTIGATION AND DESIGN
ATTACHMENT C1
DRAINAGE ANALYSIS AND DESIGN

Prepared for

WASTE MANAGEMENT

Waste Management of Texas, Inc.

March 2026

STATE OF TEXAS
FELIPE ANTONIO WESCOUP
103826
LICENSED
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FIRM REGISTRATION NO. F-256 AND NO. 10194895

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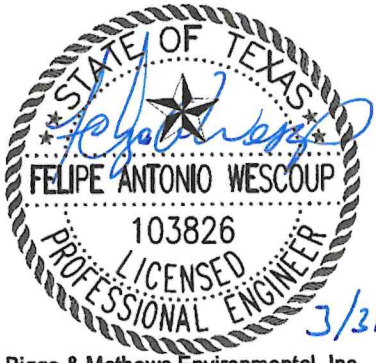
FIRM REGISTRATION NO. 50222



3/31/2026

Biggs & Mathews Environmental, Inc.
Firm Registration No. F-256

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APPENDIX C1G – INTERMEDIATE COVER EROSION CONTROL STRUCTURE DESIGN

1 INTRODUCTION

30 TAC §330.63(c) and §§330.301-330.305

1.1 Purpose

The drainage analysis and design is prepared as part of a permit amendment application for the Skyline Lanfilll and includes the demonstrations consistent with the requirements of 30 TAC Chapter 330, §330.63(c) and §§330.301-305. The drainage analysis and design is organized to include a narrative description of the current permitted (42D) and postdevelopment (42E) conditions, the proposed drainage system design, the erosion and sedimentation control plan, and a discussion of the current permitted/postdevelopment comparison at the permit boundary. Drainage calculations are included in the appendices. Drainage design plans and details are included in Attachment C3. The following is a brief description of each of the appendices.

Appendix C1A – Current Permitted/Postdevelopment Comparison

Appendix C1A includes drainage area maps that delineate the drainage areas that contribute surface water runon and runoff at the permit boundary and provide a summary of the peak flow rate, volume of runoff, and runoff velocity at locations along the permit boundary for the current permitted and postdevelopment conditions. Appendix C1A also includes a table summarizing the current permitted/postdevelopment boundary analysis comparison.

Appendix C1B – Current Permitted Hydrologic Calculations

The current permitted hydrologic and hydraulic evaluation included in Appendix C1B represents the current permitted final closure configuration. The current permitted analysis includes delineations of drainage areas that contribute surface water runon and runoff at comparison locations along the current permit boundary. The current permitted hydrologic analysis represents the hydrologic calculations as defined by the landfill completion plan for the Skyline Landfill MSW Permit No. 42D (42D).

The results of the current permitted hydrologic evaluation are provided on the current permitted boundary analysis summary, which shows the 25-year peak flow rate, volume of runoff, and runoff velocity at comparison locations along the current permit boundary.

Appendix C1C – Postdevelopment Hydrologic Calculations

The postdevelopment hydrologic and hydraulic evaluation included in Appendix C1C represents the proposed final closure landfill configuration. The postdevelopment analysis includes delineations of drainage areas that contribute surface water runon and runoff at comparison points along the proposed permit boundary. The postdevelopment hydrologic analysis represents the hydrologic calculations as defined by the landfill completion plan for the Skyline Landfill Permit No. 42E (42E).

The results of the postdevelopment hydrologic evaluation are provided on the postdevelopment boundary analysis summary, which shows the 25-year peak flow rate, volume of runoff, and runoff velocity at the comparison locations along the proposed permit boundary.

Appendix C1D – Perimeter Drainage System Design

Appendix C1D presents the hydraulic design of the perimeter drainage system. The perimeter drainage plan shows the locations of the perimeter drainage channels, detention ponds, and surface water impoundments. The detention ponds are designed to provide the necessary storage and outlet control to mitigate impacts to the receiving channels downstream of the Skyline Landfill. The retention ponds and surface water impoundments are existing and have been incorporated into the MSW (42E) surface water drainage system design. The perimeter channels are designed for the 25-year, 24-hour storm event.

Appendix C1E – Final Cover Drainage Structure Design

Appendix C1E is limited to the design of the permanent final cover drainage structures (i.e., chute and swale system). The calculations demonstrate that the structures are designed to convey runoff produced from the 25-year storms, to provide erosion protection, and to minimize sediment loss from the final cover condition.

Appendix C1F – Intermediate Cover Erosion and Sedimentation Control Plan

Appendix C1F provides a detailed erosion and sediment control plan during the intermediate cover phase of development.

Appendix C1G – Intermediate Cover Erosion Control Structure Design

Appendix C1G provides the supporting documentation to evaluate and design temporary erosion and sediment control structures for the intermediate cover phase of landfill development.

2 METHODOLOGY

30 TAC §330.305(f) and §330.305

2.1 Concepts and Methods

The hydrologic and hydraulic methods employed in this study are consistent with the TCEQ regulations. The United States Army Corps of Engineers (COE) HEC-HMS computer program was used to compute peak flow rates and to determine water surface profiles. The Rational Method and the methods defined in the TxDOT *Hydraulic Design Manual*, September 2019, were used to design the final cover drainage system and erosion control features. Analyses of the peak flow rates, water surface profiles, and drainage design for these conditions proceeded in the following sequence:

- Maps were prepared that provided information about the surface water runoff characteristics of the current permitted final cover drainage conditions and contributing drainage areas. These maps are included in Appendix C1B.

- Surface water runoff hydrographs for the current permitted condition, including the perimeter drainage channels, detention ponds, and surface water impoundments, were developed using HEC-HMS. The current permitted HEC-HMS evaluation is included in Appendix C1B.

- Maps were prepared that provide information about the surface water runoff characteristics of the postdeveloped final cover drainage conditions for the expansion of the TASWA DRF. These maps are included in Appendix C1C.

- Surface water hydrographs for the postdeveloped condition, including the perimeter drainage channels, detention ponds, and surface water impoundments, were evaluated using HEC-HMS. The postdeveloped evaluation is included in Appendix C1C.

- Perimeter channels were modeled using HEC-HMS and Manning's Equation. Runoff hydrographs from drainage areas that contribute surface water runoff to the perimeter drainage system were routed through the perimeter drainage system, which include ponds and surface water impoundments, using HEC-HMS. Peak flow rates at specific stations were taken directly from HEC-HMS. Narrative discussing the perimeter drainage system design, which includes the evaluation of the existing and proposed surface water drainage features, is included in Appendix C1D.

- Final cover drainage systems were evaluated for capacity and erosion loss using the Rational Method and the methods defined in the TxDOT *Hydraulic Design Manual*, September 2019. Final cover drainage systems calculations are included in Appendix C1E.

- Intermediate cover erosion and sediment control plan and structure design were evaluated for capacity and erosion loss using the Rational Method and the methods defined in the TxDOT *Hydraulic Design Manual*, September 2019. Intermediate cover erosion and sediment control plans are included in Appendix C1F and C1G.

2.2 Hydrologic and Hydraulic Modeling

2.2.1 HEC-HMS

The COE HEC-HMS program was developed to simulate the surface water runoff response of a watershed. The HEC-HMS model represents a watershed as a network of hydrologic and hydraulic components. The modeling process results in the computation of stream-flow hydrographs at desired locations in the watershed. The following assumptions were made as part of the hydrologic modeling process:

- Precipitation is distributed uniformly and with constant intensity over the watershed.

- The watershed is divided into three separate processes: loss, transform, and baseflow. Part of the precipitation falling on the land surface is lost due to infiltration and is represented with a loss method. Rainfall that does not infiltrate becomes direct runoff and moves across the watershed surface or through the upper soil horizons and eventually reaches the watershed outlet. All runoff processes are represented as pure surface routing using a transform method. Groundwater contributions to channel flow are called baseflow and are not considered due to the brief duration of the hydrologic modeling simulation.

- The Espey "10-Minute Method" was used to estimate Snyder Parameters for watershed areas within the permit boundary and off-site areas with characteristics similar to watershed areas within the permit boundary.

2.3 Hydrologic Elements Naming Convention

The following naming convention was used in the current permitted and postdevelopment hydrologic evaluations:

CA – drainage area within the current permit boundary, current permitted condition

DA – drainage area within the proposed permit boundary, postdeveloped condition

OS – drainage area outside of the permit boundary

R – designates a reach that conveys runoff through a given drainage area (examples: R3 conveys runoff through drainage area CA3)

CP – comparison point where surface water runoff enters or exits the permit boundary

J – junction

POND – designates a pond (example: Pond 01 is within drainage area CA02 in the current permitted condition and within drainage area P1P in the postdeveloped condition.)

I – designates a drainage control structure (example: I-08 is a drainage control structure within drainage area I-08A in the postdeveloped condition.)

3 CURRENT PERMITTED CONDITIONS

The Skyline Landfill is an existing 662-acre, Type I Municipal Solid Waste Disposal Facility operated by Waste Management of Texas, Inc. The Skyline Landfill is located in Dallas and Ellis Counties, Texas, immediately north of the City of Ferris and west of Old U.S. Highway 75 (also referred to as Business 45).

The Skyline Landfill is located along Ten Mile Creek (or Tenmile Creek), which is part of the Trinity River Basin. The north permit boundary of the Skyline Landfill generally coincides with the centerline meanders of the channel of Ten Mile Creek.

The proposed permit boundary, as shown in Appendix C1A on Drawing C1A.1, will be used to evaluate the current permitted and postdeveloped runoff conditions. Refer to Appendix C1B for the current permitted hydrology calculations. Peak discharges at the comparison points along the permit boundary, as shown on Drawing C1A.1, were determined for the current permitted condition. These peak discharges were then used to design and evaluate the postdeveloped condition.

The major portion of the stormwater runoff from the Skyline Landfill enters Ten Mile Creek at eleven locations along the northern permit boundary. A minor portion of the stormwater runoff exits at six locations along the western permit boundary and five locations along the southern permit boundary, which flows through existing culverts under Ferris Avenue. Another minor portion of the stormwater runoff exists at four locations along the southeastern permit boundary and flows through existing culverts under the T&HC Line of the Union Pacific Railroad and Old U.S. Highway 75 (OH75). A fifth potential point listed in Table 1 for runoff along the eastern permit boundary, however, as shown in modeling, does not receive any flow contributing to runoff. OH75.1, OH75.2, and OH75.3 represent existing culvert discharge locations east of Old U.S. Highway 75. These have been included to confirm the capacity of the culverts conveying stormwater runoff from the permit boundary under the UPR and OH75.

4 POSTDEVELOPMENT CONDITIONS

Drawing C1A.2 of Appendix C1A delineates the postdevelopment drainage areas that contribute runoff to the proposed permit boundary. Peak discharges at the comparison points along the proposed permit boundary, as shown on Drawing C1A.2, were determined for the postdevelopment condition. Refer to Appendix C1C for postdevelopment hydrology calculations.

The major portion of the stormwater runoff from the Skyline Landfill enters Ten Mile Creek at eleven locations along the northern permit boundary. A minor portion of the stormwater runoff exists at six locations along the western permit boundary and five locations along the southern permit boundary and flows through the existing culverts under Ferris Avenue.

Another minor portion of the stormwater runoff exits at four locations along the southeastern permit boundary and flows through existing culverts under the T&HC Line of the Union Pacific Railroad and Old State Highway 75 (OH75). A fifth potential point is listed in Table 2 for runoff along the easter permit boundary, however, as shown in modeling, does not receive any flow contributing to runoff. OH75.1, OH75.2, and OH75.3 represent existing culvert discharge locations east of Old U.S. Highway 75. These have been included to confirm the capacity of the culverts conveying stormwater runoff from the permit boundary under the UPR and OH75.

5 PROPOSED DRAINAGE SYSTEM DESIGN

30 TAC §330.63(c)(1), §330.303 and §330.305(a)–(f)

The proposed drainage system for the Skyline Landfill will consist of drainage swales, downchutes, perimeter channels, detention ponds, and outlet structures.

The facility has been designed to prevent discharge of pollutants into waters in the state or waters of the United States, as defined by the Texas Water Code and the Federal Clean Water Act, respectively. WMTX has been authorized by the TCEQ to discharge stormwater runoff consistent with Texas Pollutant Discharge Elimination System (TPDES) Permit No. TXR05U147, consistent with General Permit No. TXR050000 relating to stormwater discharges associated with industrial activity. Landfills are authorized under the General Permit.

5.1 Perimeter Drainage System Design

The perimeter drainage system is designed to convey the 25-year runoff from the developed landfill consistent with TCEQ regulations. The perimeter channel system design calculations are referenced in Appendix C1D. The perimeter drainage structure plans are included in Attachment C3.

The detention ponds are designed to provide the necessary storage and outlet control to mitigate impacts to the receiving channels downstream of the Skyline Landfill. Detention pond design parameters are referenced in Appendix C1D, as included in the hydraulic modeling for postdeveloped conditions in Appendix C1C. The detention pond details are shown in Attachment C3.

5.2 Final Cover Drainage Structure Design

Stormwater runoff will be collected in swales, located near the upper grade break on the landfill and on the 4:1 (horizontal to vertical) side slopes, leading to drainage letdown structures or chutes on the 4:1 side slopes and to the perimeter drainage system. The perimeter drainage system will be constructed as each sector is developed.

The final cover drainage system swales and chutes are designed to convey the 25-year peak flow rate. These swales, channels, and chutes will also reduce maintenance at the site after closure by minimizing erosion. The final cover erosion control design calculations are included in Appendix C1E. The final cover design, showing the locations of the drainage swales, downchutes, and final cover drainage structure details, is illustrated in Appendix C1E.

The chute/letdown structures are designed to convey the 25-year, 24-hour peak flow rate. The chutes are designed with 40-mil textured FML to minimize erosive conditions along the chute and at swale/chute confluences. There is a slope transition between the chute and perimeter road low water crossing. A hydraulic jump occurs at the chute/low water crossing transition that

dissipates the energy and reduces the velocity across the perimeter road. Concrete is used at the chute/low water crossing transitions to minimize erosion. The letdown structures continue and convey stormwater into the perimeter channels or directly into the detention ponds. The chute design calculations are included in Appendix C1E. Final cover drainage system details including the chute details are shown in Attachment C3. A typical detail of the low water crossing depicting where the chute crosses the perimeter road is also shown in Attachment C3.

5.3 Surface Water Runon Controls

There are no locations along the permit boundary where surface water enters the permit boundary. Surface water drainage in and around the facility will be controlled by the perimeter drainage system described in Section 5.1 and will be prevented from entering the landfill footprint and waste disposal area. The landfill perimeter road, berm, and perimeter drainage channels and detention ponds will be constructed as the landfill is developed as depicted in Attachment D1 and Attachment D3.

Temporary berms will be constructed around the active working face to divert uncontaminated surface water away from the active working face. Temporary containment berms will be constructed around the active working face to collect and contain surface water that has come in contact with the waste. These run-on and runoff controls around the active working face are designed to collect and control surface water generated from a 25-year, 24-hour storm event. Refer to Attachment D6 for these calculations.

6 EROSION AND SEDIMENTATION CONTROL

30 TAC §330.305

6.1 Final Cover Stormwater System Control Plan

Perimeter drainage channels and detention ponds will be constructed as the subsequent phased development of the landfill progresses. Erosion will be minimized in these structures by establishment of vegetation or with rock riprap, gabions, or other materials as provided for in the drainage design calculations.

Swales and chutes will be constructed upon placement of the final cover. The final cover includes, among other things, an erosion layer that is a minimum of 24 inches of earthen material with the top 6 inches capable of sustaining native plant life and will be seeded with native and introduced grasses immediately following the application of final cover in order to minimize erosion. A soil loss demonstration for the erosion layer is included in Appendix C1E of this attachment. The swales and chutes include establishment of vegetation, rock riprap, gabions, and other materials as provided in the drainage calculations.

6.2 Final Cover Stormwater System Maintenance Plan

Landfill personnel will inspect, restore, and repair constructed permanent stormwater systems such as channels, drainage swales, chutes, and flood control structures in the event of wash-out or failure from extreme storm events. Excessive sediment will be removed, as needed, so that the drainage structures, such as the perimeter channels and detention ponds, function as designed. Site inspections by landfill personnel will be performed weekly or within 48 hours of a rainfall event of 0.5 inches or more. Documentation of the inspection will be included in the site operating record.

The following items will be evaluated during the inspections:

- Erosion of final cover areas, perimeter ditches, chutes, swales, detention ponds, berms, and other drainage features
- Settlement of final cover areas, perimeter ditches, chutes, swales, and other drainage features
- Silt and sediment build-up in perimeter ditches, chutes, swales, and detention ponds
- Obstructions in drainage features
- Presence of erosion or sediment discharge at perimeter stormwater discharge locations

- Presence of sediment discharges along the site boundary in areas that have been disturbed by site activities

Maintenance activities will be performed to correct damaged or deficient items noted during the site inspections. These activities will be performed as soon as reasonably possible after the inspection. The time frame for correction of damaged or deficient items will vary based on weather, ground conditions, and other site-specific conditions.

Maintenance activities will consist of the following, as needed:

- Placement of additional temporary or permanent vegetation
- Placement, grading, and stabilization of additional soils in eroded areas or in areas that have experienced settlement
- Replacement of riprap or other structural lining
- Placement of additional riprap in eroded areas or in areas that have experienced settlement
- Removal of obstructions from drainage features
- Removal of silt and sediment build-up in perimeter ditches, chutes, swales, detention ponds, retention ponds, and other surface water drainage structures.
- Repairs to erosion and sedimentation controls
- Installation of additional erosion and sedimentation controls

6.3 Intermediate Cover Erosion and Sedimentation Control Plan

Erosion and sediment controls have been designed for the intermediate cover phase of landfill development. The intermediate cover erosion and sedimentation control plan includes temporary structures and establishment of vegetation to minimize erosion of the intermediate cover and documentation requirements. Refer to Appendix C1F and Appendix C1G.

6.4 Daily Cover Erosion and Sedimentation Control Plan

Erosion and sediment controls for the daily cover phase of landfill development will be consistent with the requirements of Part IV. Daily cover will be placed over all solid waste at the end of each operating day as required by Part IV. The daily cover will be sloped to drain. Runoff from areas that have intact daily cover is considered uncontaminated stormwater runoff. Erosion and sediment controls for daily cover will include the following procedures:

- Areas with daily cover will be inspected daily for erosion that may cause contaminated runoff from the daily cover.

- After each rainfall event all daily cover areas will be inspected for erosion or other damage and repaired as necessary. Runoff from damaged or eroded areas will be handled as contaminated water until repairs are completed.

- Daily cover will be compacted and sloped to drain.

- Should erosion of daily cover be observed, the daily cover will be replaced so that no solid waste is exposed at the end of the operating day. In the event that additional soil stabilization or erosion control measures are deemed necessary, one or more of the following measures will be constructed: temporary sediment control fence, silt fence, swales, or filter berms.

7 CURRENT PERMITTED/POSTDEVELOPMENT COMPARISON

30 TAC §330.63(c)(1)(D)(iii) and §330.305(a)

Consistent with 30 TAC §330.63(c)(1)(D)(iii) and §330.305(a), the proposed landfill development will not adversely alter existing or permitted drainage patterns. A summary of the current permitted and postdevelopment drainage conditions analyzed is included in Appendix C1A. Supporting calculations are presented in Appendix C1B and C1C. As required by the regulations, a summary of drainage patterns and flows produced by the 25-year storm event is presented on the following drawings.

- Drawing C1B.2: Current Permitted Boundary Analysis Summary: This drawing included in Appendix C1B, depicted the current permitted stormwater runon and runoff locations along the MSW (42D) permit boundary. Each location identified with flows, velocities, and volume of runoff as appropriate in the summary table

- Drawing C1C.2: Postdeveloped Boundary Analysis Summary: This drawing, included in Appendix C1C, depicts the postdevelopment stormwater runon and runoff locations along the proposed MSW (42E) permit boundary. Each postdevelopment discharge point is at the same location as the current permitted discharge point and is identified in the summary table.

For the postdevelopment site configuration shown on Drawing C1C.2, the stormwater outfall locations along the proposed permit boundary remain consistent with the current permitted outfall locations shown on Drawing C1B.2.

The current permitted and postdevelopment surface water runoff has been evaluated for the peak flow rate, volume of runoff, and velocity at each comparison point. A comparison table is included in Appendix C1A.

Conclusion

Given that: (1) drainage from the permit boundary or property boundary does not adversely alter the peak flow rate, velocity, or runoff volumes at the permit boundary and receiving channels, and (2) the stormwater discharge outfalls are consistent with the current permitted site configuration, except as noted, it is concluded that the proposed landfill development will not adversely alter existing or permitted drainage patterns consistent with §330.305(a).

8 CONCLUSIONS

The following conclusions summarize the results of the drainage analysis and design:

- The drainage design criteria and analyses used for these drainage calculations satisfy the requirements of 30 TAC Chapter 330.
- The final cover drainage structures (swales, chutes) are designed in accordance with the rules to convey peak flow rates from the 25-year rainfall event.
- Perimeter channels are designed in accordance with the rules for the 25-year rainfall event.
- Detention pond capacities and outlets are designed in accordance with the rules for the 25-year rainfall event.
- Erosion will be minimized by using Best Management Practices.
- The proposed landfill development will not adversely alter existing or current permitted drainage patterns.

ATTACHMENT C1
APPENDIX C1A

CURRENT PERMITTED/POSTDEVELOPMENT COMPARISON

CONTENTS

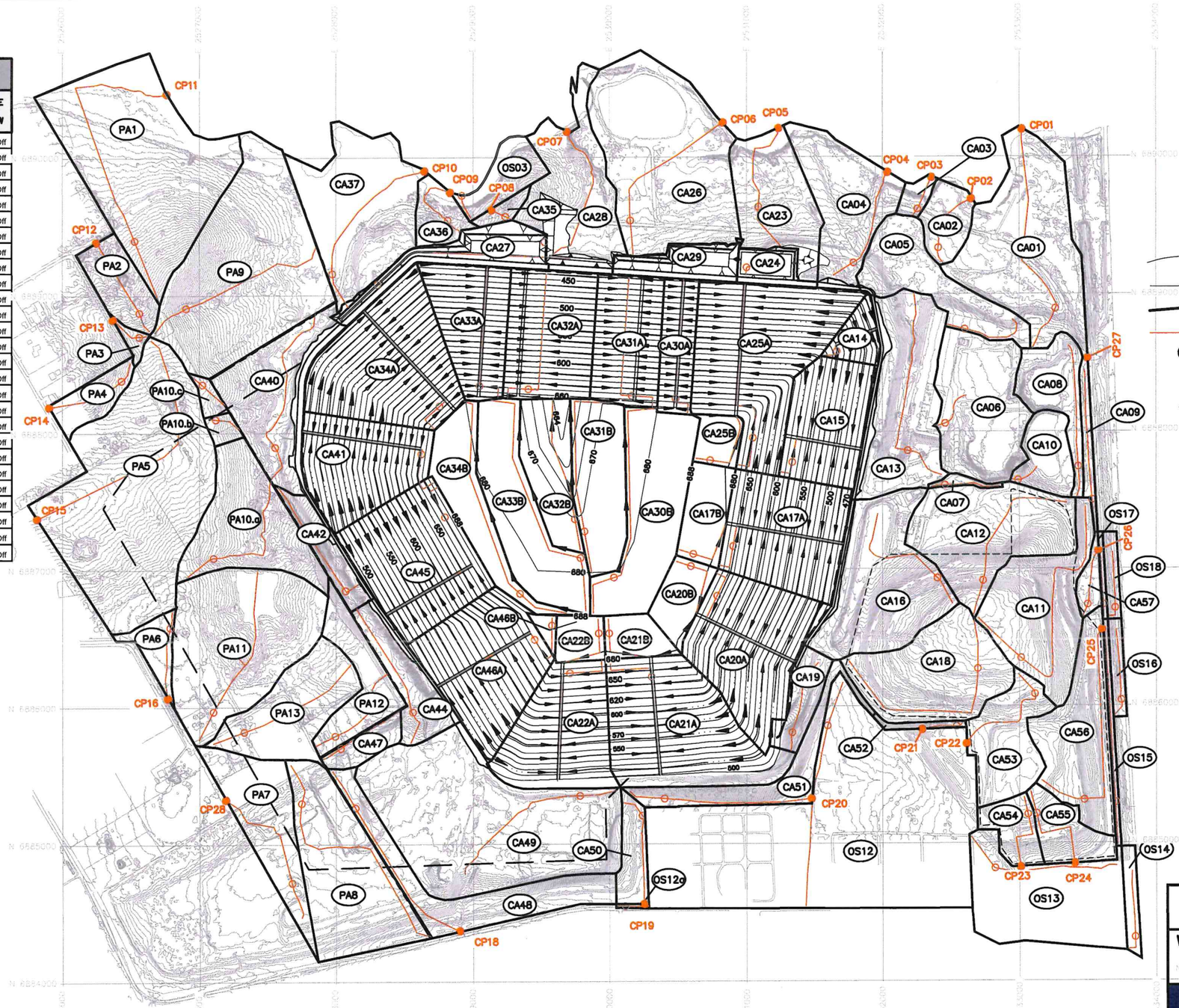
Current Permitted Boundary Analysis Summary C1A.1

Postdeveloped Boundary Analysis Summary C1A.2

Current Permitted/Postdeveloped Boundary Analysis Summary Table C1A.3

CURRENT PERMITTED BOUNDARY ANALYSIS SUMMARY

BOUNDARY COMPARISON POINT	Total Contributing Drainage Area (mi2)	25-YEAR FLOW RATE (cfs)	25-YEAR VOLUME (ac-ft)	25-YEAR VELOCITY (fps)	TYPE OF FLOW
CP1	0.0341	61.9	10.2	2.26	Run Off
CP2	0.0062	15.1	1.9	2.52	Run Off
CP3	0.0019	5.8	0.6	1.34	Run Off
CP4	0.3674	325.3	93.8	17.53	Run Off
CP5	0.0630	88.6	19.7	2.39	Run Off
CP6	0.0417	89.9	13.3	1.84	Run Off
CP7	0.2245	198.8	69.7	10.50	Run Off
CP8	0.0018	5.8	0.5	1.56	Run Off
CP9	0.0052	13.8	1.6	4.28	Run Off
CP10	0.3	337.9	80.5	6.61	Run Off
CP11	0.0471	97.4	14.1	1.42	Run Off
CP12	0.0083	21.2	2.5	1.20	Run Off
CP13	0.0014	3.8	0.4	0.92	Run Off
CP14	0.0054	13.4	1.6	2.09	Run Off
CP15	0.0596	121.3	18.6	4.24	Run Off
CP16	0.0043	8.3	1.3	0.51	Run Off
CP18	0.1011	120.5	31.0	4.83	Run Off
CP19	0.0054	12.4	1.6	3.17	Run Off
CP20	0.0112	24.2	3.4	1.80	Run Off
CP21	0.0012	3.3	0.4	1.43	Run Off
CP22	0.0139	32.1	4.2	1.13	Run Off
CP23	0.0058	14.5	1.7	5.47	Run Off
CP24	0.0076	18.6	2.3	6.00	Run Off
CP25	0.0203	40.3	6.1	7.89	Run Off
CP26	0.0025	5.4	0.7	2.50	Run Off
CP27	0.0000	0.3	0.0	0.44	Run Off
CP28	0.0167	33.5	5.0	0.89	Run Off



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SCALE IN FEET

LEGEND

- 460 — EXISTING 10' GROUND CONTOUR
- 500 — PROPOSED 10' FINAL COVER CONTOUR
- DRAINAGE AREA BOUNDARY
- DRAINAGE AREA REACH
- DA18 — DRAINAGE AREA DESIGNATION
- COMPARISON POINT-POINT DISCHARGE
- COMPARISON POINT-SHEET FLOW (NON-POINT DISCHARGE)

NOTES:

1. EXISTING CONTOURS 2019 LIDAR.
2. CONTOURS WITHIN THE LANDFILL FOOTPRINT DEPICT POSTDEVELOPED FINAL CONTOURS.
3. DRAINAGE AREA BOUNDARY NOT SHOWN WHERE COINCIDENTAL WITH PERMIT BOUNDARY.

STATE OF TEXAS
FELIPE ANTONIO WESCOUP
103826
LICENSED
PROFESSIONAL ENGINEER

3/31/2026

CURRENT PERMITTED BOUNDARY ANALYSIS SUMMARY

WASTE MANAGEMENT OF TEXAS, INC.
SKYLINE LANDFILL

REVISIONS			
REV	DATE	DESCRIPTION	DWN BY

BIGGS & MATHEWS ENVIRONMENTAL
1700 ROBERT ROAD, STE. 100
MANSFIELD, TEXAS 76063
817-563-1144

TBPELS FIRM NO. F-256 AND NO. 10194895
TBPG FIRM NO. 50222

DRAWING C1A.1

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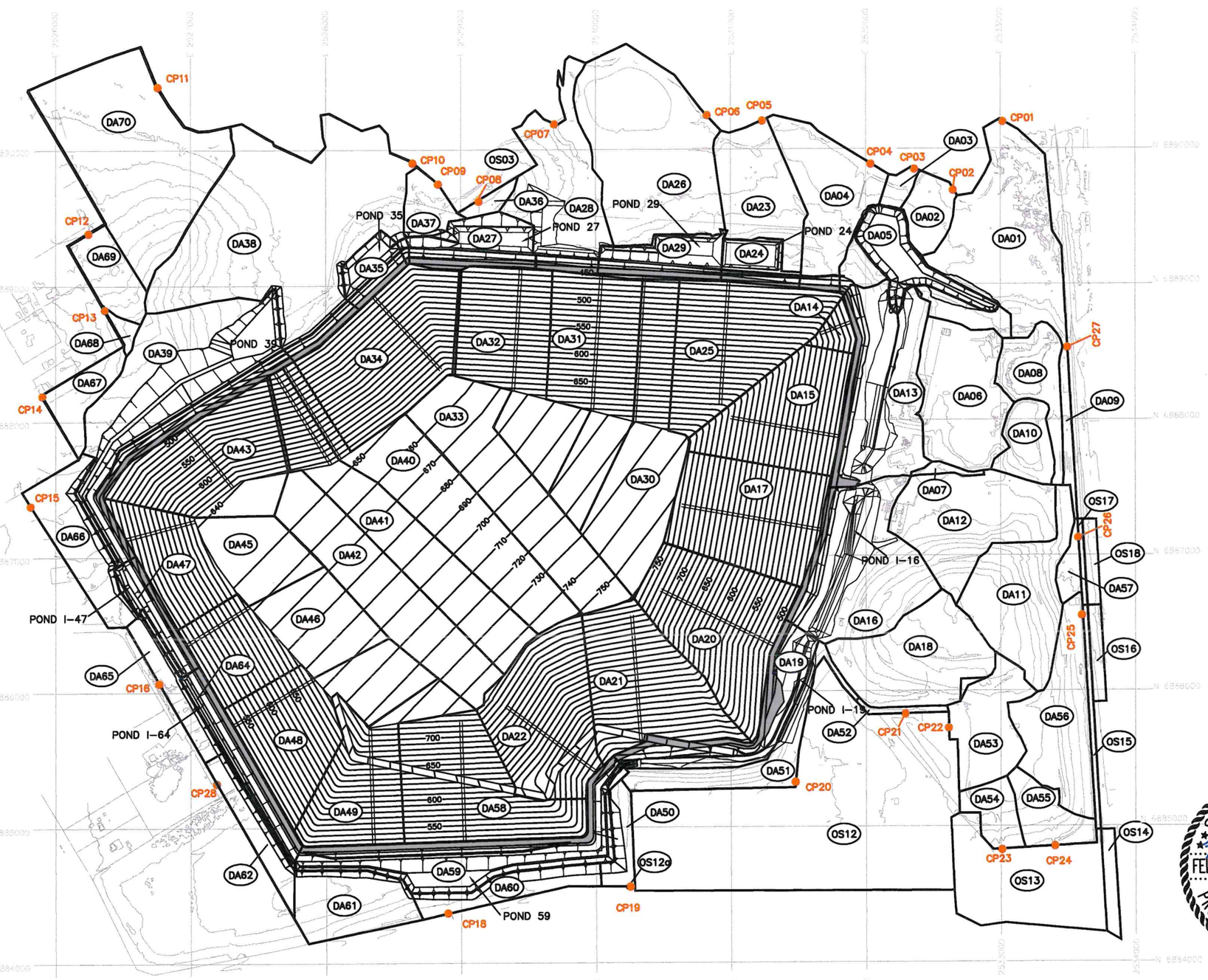

0 400 800
SCALE IN FEET

LEGEND

- 460 — EXISTING 10' GROUND CONTOUR
- 500 — PROPOSED 10' FINAL COVER CONTOUR
- DRAINAGE AREA BOUNDARY
- DA18 — DRAINAGE AREA DESIGNATION
- COMPARISON POINT–POINT DISCHARGE
- COMPARISON POINT–SHEET FLOW (NON–POINT DISCHARGE)

NOTE:

1. EXISTING CONTOURS COMPILED BY HYDREX DRONE DIVISION, FROM AERIAL SURVEY FLOWN MARCH 5, 2025.
2. CONTOURS WITHIN WASTE DISPOSAL FOOTPRINT DEPICT PROPOSED FINAL CONTOURS.
3. REFER TO FINAL COVER DRAINAGE STRUCTURE CALLOUTS FOR TYPICAL DETAILS FOR CHUTES, SWALES, AND LOW–WATER CROSSING.

POSTDEVELOPED BOUNDARY ANALYSIS SUMMARY

BOUNDARY COMPARISON POINT	TOTAL CONTRIBUTING DRAINAGE AREA	25–YEAR FLOWRATE (cfs)	25–YEAR VOLUME (ac–ft)	25–YEAR VELOCITY (fps)
CP1	0.0341	61.9	10.2	2.3
CP2	0.0062	15.1	1.9	2.5
CP3	0.0019	5.8	0.6	1.3
CP4	0.3782	316.2	94.3	8.0
CP5	0.0547	85.0	17.2	2.3
CP6	0.0417	82.2	12.5	1.8
CP7	0.2136	191.0	66.8	6.6
CP8	0.0018	5.6	0.5	1.5
CP9	0.0051	13.1	1.5	4.2
CP10	0.2671	320.5	82.0	6.5
CP11	0.0471	97.4	14.1	1.4
CP12	0.0083	21.2	2.5	1.2
CP13	0.0013	3.6	0.4	0.9
CP14	0.0068	16.8	2.0	2.3
CP15	0.0855	130.6	20.3	4.4
CP16	0.0063	12.3	1.9	0.6
CP18	0.1029	110.6	32.2	4.7
CP19	0.0047	10.4	1.4	3.0
CP20	0.0117	25.3	3.5	1.8
CP21	0.0012	3.1	0.4	1.4
CP22	0.0139	37.6	4.2	1.2
CP23	0.0058	14.5	1.7	5.5
CP24	0.0075	18.4	2.2	6.0
CP25	0.0203	40.3	6.1	7.9
CP26	0.0025	5.6	0.7	2.5
CP27	0.0000	0.3	0.0	0.4
CP28	0.0070	26.7	8.3	0.8

STATE OF TEXAS
FELIPE ANTONIO WESCOUP
103826
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REVISIONS			
REV	DATE	DESCRIPTION	DWN BY

POSTDEVELOPED BOUNDARY ANALYSIS SUMMARY

WASTE MANAGEMENT OF TEXAS, INC. SKYLINE LANDFILL

BIGGS & MATHEWS ENVIRONMENTAL
1700 ROBERT ROAD, STE. 100
MANSFIELD, TEXAS 76063
817–563–1144

TBPELS FIRM NO. F–256 AND NO. 10194895
TBPG FIRM NO. 50222

DRAWING C1A.2

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CURRENT PERMITTED/POSTDEVELOPED BOUNDARY ANALYSIS SUMMARY TABLE

WASTE MANAGEMENT OF TEXAS, INC.
SKYLINE LANDFILL
CURRENT PERMITTED/POSTDEVELOPED BOUNDARY ANALYSIS SUMMARY TABLE

Discharge Point	Total Contributing Drainage Area (ac)				25-Year Flow Rate (cfs)				25-Year Volume (Ac-ft)				25-Year Velocity (fps)			
	Current Permitted (mi2)	Post-Developed (mi2)	Difference	Percent Difference	Current Permitted	Post-Developed	Difference	Percent Difference	Current Permitted	Post-Developed	Difference	Percent Difference	Current Permitted	Post-Developed	Difference	Percent Difference
CP1	0.0341	0.0341	0.0000	0%	61.9	61.9	0.0	0%	10.2	10.2	0.0	0%	2.3	2.3	0.0	0%
CP2	0.0062	0.0062	0.0000	0%	15.1	15.1	0.0	0%	1.9	1.9	0.0	0%	2.5	2.5	0.0	0%
CP3	0.0019	0.0019	0.0000	0%	5.8	5.8	0.0	0%	0.6	0.6	0.0	0%	1.3	1.3	0.0	0%
CP4	0.3674	0.3782	0.0108	3%	325.3	316.2	-9.1	-3%	93.8	94.3	0.5	1%	17.5	8.0	-9.6	-55%
CP5	0.0630	0.0547	-0.0083	-13%	88.6	85.0	-3.6	-4%	19.7	17.2	-2.5	-13%	2.4	2.3	0.0	-2%
CP6	0.0417	0.0417	0.0000	0%	89.9	82.2	-7.7	-9%	13.3	12.5	-0.8	-6%	1.8	1.8	-0.1	-4%
CP7	0.2245	0.2136	-0.0109	-5%	198.8	191.0	-7.8	-4%	69.7	66.8	-2.9	-4%	10.5	6.6	-3.9	-37%
CP8	0.0018	0.0018	0.0000	0%	5.8	5.6	-0.2	-3%	0.5	0.5	0.0	0%	1.6	1.5	0.0	-2%
CP9	0.0052	0.0051	-0.0001	-2%	13.8	13.1	-0.7	-5%	1.6	1.5	-0.1	-6%	4.3	4.2	-0.1	-2%
CP10	0.2840	0.2671	-0.0169	-6%	337.9	320.5	-17.4	-5%	80.5	82.0	1.5	2%	6.6	6.5	-0.1	-2%
CP11	0.0471	0.0471	0.0000	0%	97.4	97.4	0.0	0%	14.1	14.1	0.0	0%	1.4	1.4	0.0	0%
CP12	0.0083	0.0083	0.0000	0%	21.2	21.2	0.0	0%	2.5	2.5	0.0	0%	1.2	1.2	0.0	0%
CP13	0.0014	0.0013	-0.0001	-7%	3.8	3.6	-0.2	-5%	0.4	0.4	0.0	0%	0.9	0.9	0.0	-3%
CP14	0.0054	0.0068	0.0014	26%	13.4	16.8	3.4	25%	1.6	2.0	0.4	25%	2.1	2.3	0.2	10%
CP15	0.0596	0.0907	0.0311	52%	121.3	122.1	0.8	1%	18.6	22.3	3.7	20%	4.2	4.3	0.0	0%
CP16	0.0043	0.0063	0.0020	47%	8.3	12.3	4.0	48%	1.3	1.9	0.6	46%	0.5	0.6	0.1	16%
CP18	0.1011	0.1029	0.0018	2%	120.5	110.6	-9.9	-8%	31.0	32.2	1.2	4%	4.8	4.7	-0.1	-3%
CP19	0.0054	0.0047	-0.0007	-13%	12.4	10.4	-2.0	-16%	1.6	1.4	-0.2	-13%	3.2	3.0	-0.2	-6%
CP20	0.0112	0.0117	0.0005	4%	24.2	25.3	1.1	5%	3.4	3.5	0.1	3%	1.8	1.8	0.0	2%
CP21	0.0012	0.0012	0.0000	0%	3.3	3.1	-0.2	-6%	0.4	0.4	0.0	0%	1.4	1.4	0.0	-3%
CP22	0.0139	0.0139	0.0000	0%	32.1	37.6	5.5	17%	4.2	4.2	0.0	0%	1.1	1.2	0.1	6%
CP23	0.0058	0.0058	0.0000	0%	14.5	14.5	0.0	0%	1.7	1.7	0.0	0%	5.5	5.5	0.0	0%
CP24	0.0076	0.0075	-0.0001	-1%	18.6	18.4	-0.2	-1%	2.3	2.2	-0.1	-4%	6.0	6.0	0.0	0%
CP25	0.0203	0.0203	0.0000	0%	40.3	40.3	0.0	0%	6.1	6.1	0.0	0%	7.9	7.9	0.0	0%
CP26	0.0025	0.0025	0.0000	0%	5.4	5.6	0.2	4%	0.7	0.7	0.0	0%	2.5	2.5	0.0	1%
CP27	0.0000	0.0000	0.0000	0%	0.3	0.3	0.0	0%	0.0	0.0	0.0	0%	0.4	0.4	0.0	1%
CP28	0.0167	0.0070	-0.0097	-58%	33.5	26.7	-6.8	-20%	5.0	8.3	3.3	66%	0.9	0.8	-0.1	-9%

ATTACHMENT C1
APPENDIX C1B

CURRENT PERMITTED HYDROLOGIC CALCULATIONS

CONTENTS

Current Permitted Narrative C1B.1

Current Permitted Drainage Area Drawings C1B.4

Current Permitted Watershed Characteristics C1B.8

Rainfall Data C1B.15

Current Permitted Drainage Structure Design Parameters C1B.17

Current Permitted Hydrologic Analysis C1B.42

Current Permitted Velocity Summary C1B.78

Current Permitted Flow and Boundary Analysis Summary C1B.80

CURRENT PERMITTED NARRATIVE

30 TAC §330.305

This current permitted hydrologic analysis represents the hydrologic calculations as defined by the landfill completion plan for the Skyline Landfill MSW Permit No. 42D in accordance with §330.305.

CURRENT PERMITTED DRAINAGE AREA DRAWINGS

The current permitted drainage area summary (Drawing C1B.1 and C1B.2) delineates the drainage areas that contribute stormwater runon or runoff to the proposed permit boundary. Drainage areas within the proposed permit boundary are designated by the prefix "CA". Refer to Drawing C1B.1 for the current permitted boundary drainage area summary.

Drawing C1B.3 is the soil map that depicts the Skyline Landfill permit boundary and the existing soil types. The Soil Survey of Dallas and Ellis, Texas, published by the Soil Conservation Service, is the reference for the base map and soils information.

METHODS USED TO EVALUATE THE CURRENT PERMITTED CONDITION

The US Army Corps of Engineers Hydraulic Engineering Center's Hydraulic Modeling System (HEC-HMS) program was used to perform the hydrologic modeling of the Skyline landfill. HEC-HMS is designed to simulate the precipitation-runoff processes of dendritic watershed systems.

Espey's "10-Minute" Method for estimating Snyder parameters was used to calculate peak discharge for each drainage area for the current permitted final closure configuration. The method is applicable for the steep terrain associated with final cover and for the increased imperviousness related to other landfill improvements.

CURRENT PERMITTED WATERSHED CHARACTERISTICS

Watershed characteristics have been developed for the current permitted hydrologic evaluation. The watershed characteristics address drainage area runoff characteristics, unit hydrograph data, and reach characteristics. This information is included on pages C1B.9 and C1B.14.

The first table, titled Current Permitted Watershed Characteristics, page C1B.9, provides the summary of drainage areas, soil types, Curve Numbers (CN) values, initial loss, reach slope calculations, and determination of Manning's n value. The Soil Conservation Service (SCS) CN were derived from watershed characteristic tables from the SCS Technical Report 55 (TR-55), which included evaluation of soil and surface cover/condition characteristics. The second table, titled Unit Hydrograph Data –

Snyder's Hydrograph Coefficients, page C1B.13, provides the determination of the Snyder's Unit Hydrograph parameters.

RAINFALL DATA

The hypothetical precipitation for the storm event for the facility was taken from the National Oceanic and Atmospheric Administration (NOAA) Point Precipitation Frequency Estimates (Atlas 14, Volume 11, Version 2). A return period of 25 years and a duration of 24 hours was used for the design storm. The rainfall data for the facility located in Dallas and Ellisa Counties, Texas is depicted in the table on page C1B.16.

HYDROLOGIC ANALYSIS

For the hydrologic evaluation, HEC-HMS was used for the precipitation-runoff simulation for the current permitted condition. The following describes the various modeling components. The HEC-HMS hydrologic analysis results begin on page C1B.43.

Watershed Subareas and Schematization

The drainage areas that contribute flow to the permit boundary were delineated into subareas to derive peak flows to determine current permitted runon and runoff flows. Hydrographs are developed for each subarea and appropriately combined and routed through existing surface drainage features. The subareas are shown on Drawing C1B.1-Current permitted Drainage Area Summary, and pages C1B.43 for the HEC-HMS schematic of the current permitted condition.

Time Step

The time step, or the program computation interval, is the duration of the unit hydrograph. The time step selected is 5 minutes, which results in 289 hydrograph ordinates in 24 hours.

Hypothetical Precipitation

A return period of 25 years and a duration of 24 hours was used for the design storm. The rainfall data used is shown in the rainfall data table on page C1B.16. The precipitation is assumed to be evenly distributed over the entire landfill for each time interval.

Precipitation Losses

Precipitation losses (the precipitation that does not contribute to the runoff) are calculated using the Soil Conservation Service (SCS) Curve Number (CN) method. CN is a function of soil cover, land use, and antecedent moisture conditions. The CN values used for each drainage area are shown in the Watershed Characteristics tables on pages C1B.9 and C1B.14.

Synthetic Unit Hydrographs and Flow Routing

The rainfall/runoff transformation was performed with the Unit Hydrograph Method. The synthetic unit hydrographs for each watershed were derived by the Snyder Method and Espey, "10-Minute Method" for estimating Snyder Parameters for the landfill permit boundary. The parameters and input values for this model are included in the Watershed Characteristics tables on pages C1B.9 and C1B.14.

The Kinematic Wave Method was used for routing of the flood wave through the existing drainage channels. This method is capable of accounting for hydrograph attenuation based on physical channel properties such as length, bottom slope, channel shape, bottom width, and channel roughness.

CURRENT PERMITTED VELOCITY SUMMARY

Surface water velocities were determined for each discharge point where the surface water exits the permit boundary. The 25-year, 24-hour peak flow rate was used to determine the velocity at the permit boundary. Manning's Equation was used to evaluate the velocities at the discharge points. Refer to Drawing C1B-.11 for the locations of the discharge points and peak flow rate. Refer to page C1B.79 for the current permitted velocity calculations.

CURRENT PERMITTED FLOW AND BOUNDARY ANALYSIS SUMMARY

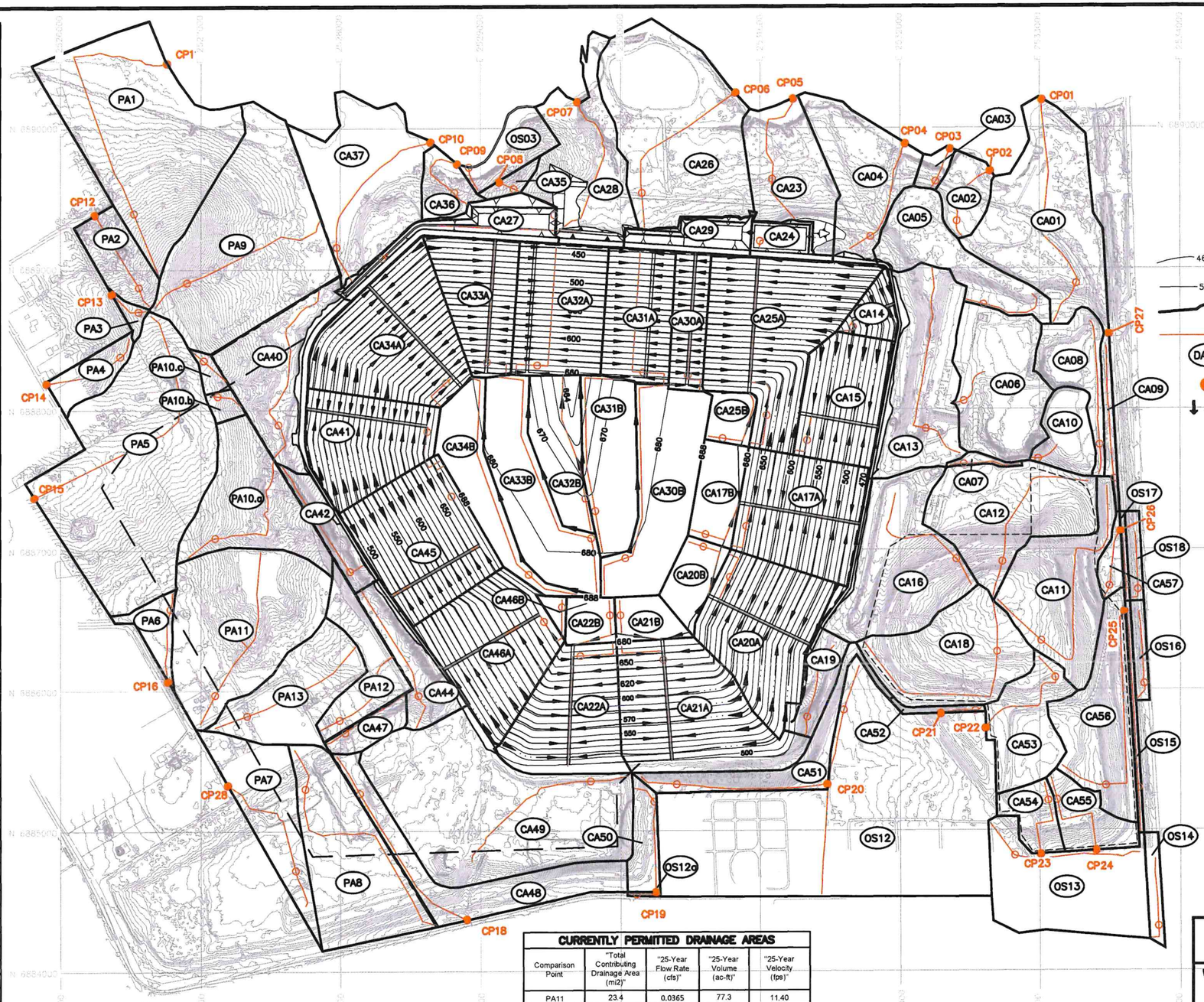
The current permitted flow summary table on page C1B.81 lists the peak flow rate for each drainage area for the 25-year rainfall event. This table summarizes the results of the hydrologic evaluation.

The boundary analysis summary for the current permitted conditions is provided on page C1B.83. The table provides for each comparison point (CP01 through CP28) the peak flow rate, velocity, and volume resulting from the HEC-HMS evaluation for the 25-year, 24 hour rainfall.

CURRENT PERMITTED DRAINAGE AREA DRAWINGS

CURRENTLY PERMITTED DRAINAGE AREAS

Comparison Point	"Total Contributing Drainage Area (mi2)"	"25-Year Flow Rate (cfs)"	"25-Year Volume (ac-ft)"	"25-Year Velocity (fps)"
CA1	21.8	0.0341	61.9	10.20
CA2	4.0	0.0062	15.1	1.90
CA3	1.2	0.0019	5.8	0.60
CA4	12.4	0.0194	47.1	5.80
CA5	10.3	0.0161	40.7	5.30
CA6	14.3	0.0224	57.3	7.30
CA7	0.7	0.0010	2.2	0.30
CA8	6.4	0.0100	20.6	3.20
CA9	1.9	0.0029	5.5	0.90
CA10	4.7	0.0073	24.2	2.50
CA11	14.5	0.0227	50.1	6.80
CA12	16.4	0.0257	62.5	7.70
CA13	17.3	0.0270	55.9	8.10
CA14	2.8	0.0044	13.6	1.40
CA15	11.6	0.0181	51.0	5.80
CA16	18.5	0.0289	67.6	8.70
CA17.A	16.0	0.0250	69.7	8.00
CA17.B	5.3	0.0082	16.1	2.50
CA18	15.4	0.0240	50.4	7.20
CA19	4.1	0.0064	14.6	1.90
CA20.A	17.2	0.0269	75.0	8.60
CA20.B	4.2	0.0066	13.0	2.00
CA21.A	21.0	0.0327	89.2	10.40
CA21.B	3.2	0.0050	10.0	1.50
CA22.A	14.4	0.0225	61.9	7.20
CA22.B	2.7	0.0042	8.4	1.30
CA23	11.2	0.0175	41.4	5.20
CA24	2.8	0.0044	12.2	1.50
CA25.A	23.6	0.0369	99.6	11.70
CA25.B	2.7	0.0042	8.1	1.30
CA26	26.7	0.0417	89.9	13.30
CA27	7.4	0.0115	18.7	3.70
CA28	14.7	0.0229	48.5	6.90
CA29	4.5	0.0071	10.5	2.20
CA30.A	5.6	0.0088	25.8	2.80
CA30.B	15.6	0.0244	38.5	7.50
CA31.A	10.5	0.0164	47.5	5.20
CA31.B	10.4	0.0163	30.3	5.00
CA32.A	13.7	0.0215	61.6	6.80
CA32.B	8.1	0.0126	24.0	3.90
CA33.A	10.8	0.0169	50.2	5.40
CA33.B	13.8	0.0215	36.0	6.60
CA34.A	19.5	0.0305	86.5	9.70
CA34.B	9.0	0.0141	20.7	4.30
CA36	3.3	0.0052	13.8	1.60
CA37	18.1	0.0283	54.6	8.50
CA40	13.6	0.0213	38.0	6.40
CA41	13.4	0.0209	59.8	6.60
CA42	4.4	0.0069	14.5	2.10
CA44	6.8	0.0106	26.4	3.60
CA45	17.5	0.0273	72.9	8.70
CA46.A	16.6	0.0259	72.3	8.20
CA46.B	0.8	0.0013	3.2	0.40
CA47	2.6	0.0041	8.6	1.20
CA48	11.5	0.0180	30.3	5.40
CA49	34.8	0.0544	88.8	17.00
CA50	3.5	0.0054	12.4	1.60
CA51	7.2	0.0112	24.2	3.40
CA52	0.7	0.0012	3.3	0.40
CA53	8.9	0.0139	32.1	4.20
CA54	3.7	0.0058	14.5	1.70
CA55	4.8	0.0076	18.6	2.30
CA56	13.0	0.0203	40.3	6.10
CA57	1.6	0.0025	5.4	0.70
PA1	30.2	0.0471	97.4	14.10
PA2	5.3	0.0083	21.2	2.50
PA3	0.9	0.0014	3.8	0.40
PA4	3.5	0.0054	13.4	1.60
PA5	38.2	0.0596	121.3	18.60
PA6	2.7	0.0043	8.3	1.30
PA7	10.7	0.0167	33.5	5.00
PA8	18.4	0.0287	48.3	8.60
PA9	30.0	0.0469	108.5	14.00
PA10.A	13.8	0.0215	49.2	6.40
PA10.B	1.0	0.0016	4.9	0.50
PA10.C	1.0	0.0016	4.6	0.50



LEGEND

- 460 — EXISTING 10' GROUND CONTOUR
- 500 — PROPOSED 10' FINAL COVER CONTOUR
- DRAINAGE AREA BOUNDARY
- DRAINAGE AREA REACH
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- COMPARISON POINT–POINT DISCHARGE
- COMPARISON POINT–SHEET FLOW (NON–POINT DISCHARGE)

NOTES:

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2. CONTOURS WITHIN THE LANDFILL FOOTPRINT DEPICT POSTDEVELOPED FINAL CONTOURS.
3. DRAINAGE AREA BOUNDARY NOT SHOWN WHERE COINCIDENTAL WITH PERMIT BOUNDARY.

CURRENTLY PERMITTED DRAINAGE AREAS

Comparison Point	"Total Contributing Drainage Area (mi2)"	"25-Year Flow Rate (cfs)"	"25-Year Volume (ac-ft)"	"25-Year Velocity (fps)"
PA11	23.4	0.0365	77.3	11.40
PA12	7.1	0.0111	24.6	3.30
PA13	11.6	0.0182	35.5	5.50
OS03	4.2	0.0066	16.0	2.00
OS12	57.8	0.0904	157.9	27.10
OS12.A	0.2	0.0003	0.7	0.10
OS13	16.2	0.0254	54.2	7.60
OS14	1.8	0.0028	5.6	0.80
OS15	1.4	0.0022	4.0	0.70
OS16	1.6	0.0025	5.2	0.70
OS17	0.5	0.0008	1.8	0.20
OS18	1.5	0.0023	4.7	0.70

STATE OF TEXAS
FELIPE ANTONIO WESCOUP
103826
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3/31/2026

REVISIONS			
REV	DATE	DESCRIPTION	DWN BY

CURRENT PERMITTED DRAINAGE AREA SUMMARY

WASTE MANAGEMENT OF TEXAS, INC. SKYLINE LANDFILL

BIGGS & MATHEWS ENVIRONMENTAL
1700 ROBERT ROAD, STE. 100
MANSFIELD, TEXAS 76063
817–563–1144

TBPELS FIRM NO. F–256 AND NO. 10194895
TBPG FIRM NO. 50222

DRAWING C1B.1

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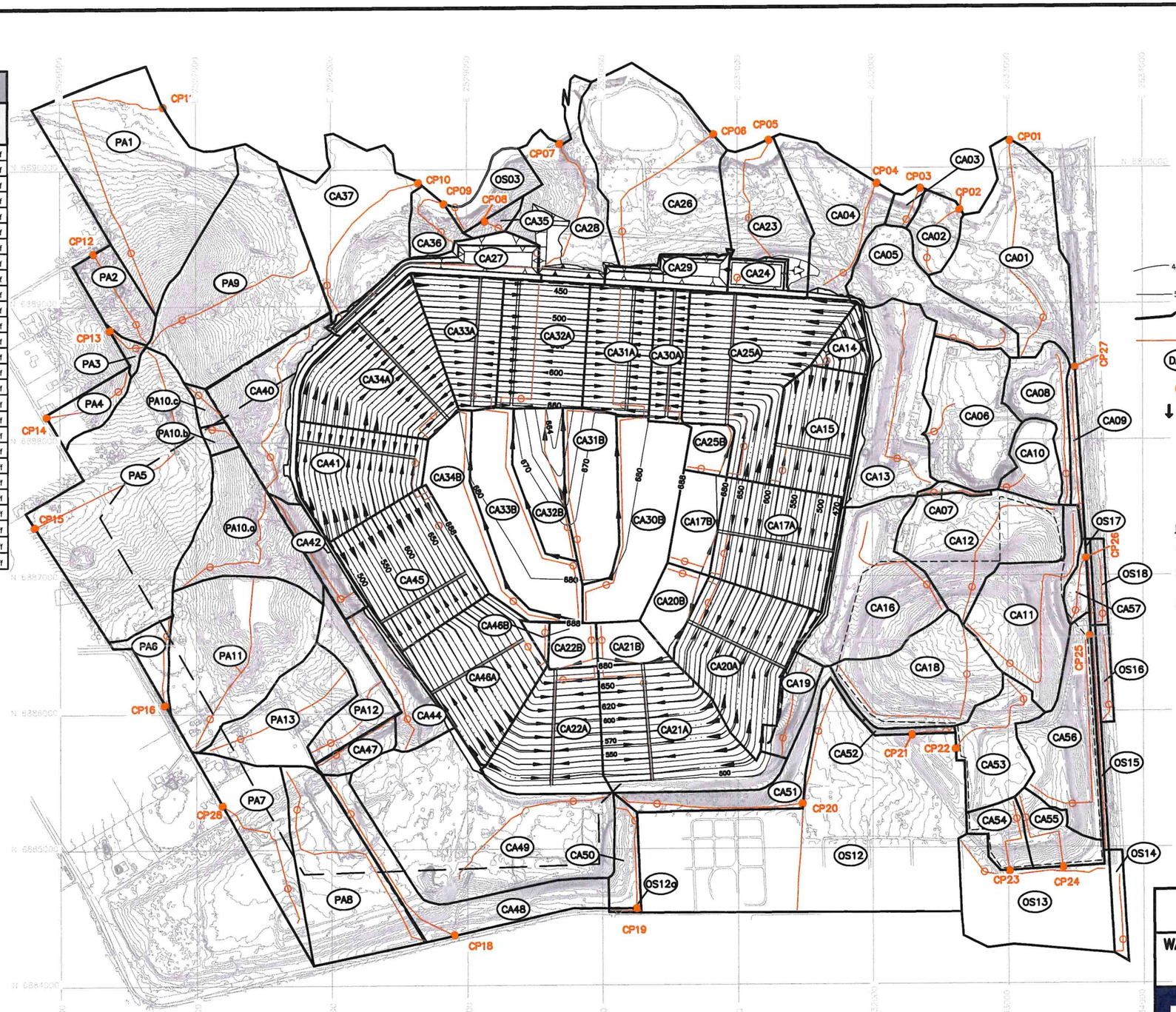
CURRENT PERMITTED BOUNDARY ANALYSIS SUMMARY

BOUNDARY COMPARISON POINT	Total Contributing Drainage Area (mi2)	25-YEAR FLOW RATE (cfs)	25-YEAR VOLUME (ac-ft)	25-YEAR VELOCITY (fps)	TYPE OF FLOW
CP1	0.0341	61.9	10.2	2.26	Run Off
CP2	0.0062	15.1	1.9	2.52	Run Off
CP3	0.0019	5.8	0.6	1.34	Run Off
CP4	0.3674	325.3	93.8	17.53	Run Off
CP5	0.0630	88.6	19.7	2.39	Run Off
CP6	0.0417	89.9	13.3	1.84	Run Off
CP7	0.2245	198.8	69.7	10.50	Run Off
CP8	0.0018	5.8	0.5	1.56	Run Off
CP9	0.0052	13.8	1.6	4.28	Run Off
CP10	0.3	337.9	80.5	6.61	Run Off
CP11	0.0471	97.4	14.1	1.42	Run Off
CP12	0.0083	21.2	2.5	1.20	Run Off
CP13	0.0014	3.8	0.4	0.92	Run Off
CP14	0.0054	13.4	1.6	2.09	Run Off
CP15	0.0596	121.3	18.6	4.24	Run Off
CP16	0.0043	8.3	1.3	0.51	Run Off
CP18	0.1011	120.5	31.0	4.83	Run Off
CP19	0.0054	12.4	1.6	3.17	Run Off
CP20	0.0112	24.2	3.4	1.80	Run Off
CP21	0.0012	3.3	0.4	1.43	Run Off
CP22	0.0139	32.1	4.2	1.13	Run Off
CP23	0.0058	14.5	1.7	5.47	Run Off
CP24	0.0076	18.6	2.3	6.00	Run Off
CP25	0.0203	40.3	6.1	7.89	Run Off
CP26	0.0025	5.4	0.7	2.50	Run Off
CP27	0.0000	0.3	0.0	0.44	Run Off
CP28	0.0167	33.5	5.0	0.89	Run Off



0 400 800
SCALE IN FEET

LEGEND

- 460 — EXISTING 10' GROUND CONTOUR
- 500 — PROPOSED 10' FINAL COVER CONTOUR
- DRAINAGE AREA BOUNDARY
- DRAINAGE AREA REACH
- DA18 — DRAINAGE AREA DESIGNATION
- COMPARISON POINT-POINT DISCHARGE
- COMPARISON POINT-SHEET FLOW (NON-POINT DISCHARGE)

NOTES:

1. EXISTING CONTOURS 2019 LIDAR.
2. CONTOURS WITHIN THE LANDFILL FOOTPRINT DEPICT POSTDEVELOPED FINAL CONTOURS.
3. DRAINAGE AREA BOUNDARY NOT SHOWN WHERE COINCIDENTAL WITH PERMIT BOUNDARY.

STATE OF TEXAS
FELIPE ANTONIO WESCOUP
103826
LICENSED
PROFESSIONAL ENGINEER

3/31/2026

REVISIONS			
REV	DATE	DESCRIPTION	DWN BY

CURRENT PERMITTED BOUNDARY ANALYSIS SUMMARY

WASTE MANAGEMENT OF TEXAS, INC. SKYLINE LANDFILL

BIGGS & MATHEWS ENVIRONMENTAL
1700 ROBERT ROAD, STE. 100
MANSFIELD, TEXAS 76063
817-563-1144

TBPELS FIRM NO. F-256 AND NO. 10194895
TBPG FIRM NO. 50222

DRAWING C1B.2

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0 1000 2000

SCALE IN FEET

LEGEND

- PERMIT BOUNDARY
- LANDFILL FOOTPRINT
- COUNTY LINE

NOTES:

1. AERIAL PHOTOGRAPH PROVIDED BY AERO-METRIC FROM AERIAL PHOTOGRAPHY FLOWN MARCH 6, 2011.
2. SOILS INFORMATION IS FROM THE SOIL SURVEY GEOGRAPHIC (SSURGO) DATABASE FOR ELLIS AND DALLAS COUNTIES TEXAS COMPILED BY THE UNITED STATES DEPARTMENT OF AGRIGULTURE (USDA) AND THE NATIONAL RESOURCE CONSERVATION SERVICE (NRCS).

SOIL SYMBOL	SOIL NAME	HYDROLOGIC SOIL GROUP
4	Arents loamy, gently undulating	C
34	Ferris-Heiden complex, 5 to 12% slopes	C
37	Frio silty clay, 0 to 1% slopes, frequently flooded	D
41	Heiden clay, 1 to 3% slopes	D
42	Heiden clay, 2 to 5% slopes	D
44	Houston Black clay, 1 to 3% slopes	D
Cp	Clay pits	
HaB	Houston Black clay, 1 to 3% slopes	D
HcC2	Heiden clay, 3 to 5% slopes	D
HcD2	Heiden clay, 5 to 8% slopes	D
SuE3	Ferris clay, 5 to 12% slopes, severely eroded	D
W	Water	

STATE OF TEXAS
FELIPE ANTONIO WESCOUP
103826
LICENSED
PROFESSIONAL ENGINEER

3/31/2026

REVISIONS			
REV	DATE	DESCRIPTION	DWN BY

SOILS MAP

WASTE MANAGEMENT OF TEXAS, INC. SKYLINE LANDFILL

BIGGS & MATHEWS ENVIRONMENTAL
1700 ROBERT ROAD, STE. 100
MANSFIELD, TEXAS 76063
817-563-1144

TBPELS FIRM NO. F-256 AND NO. 10194895
TBPG FIRM NO. 50222

DRAWING C1B.3

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CURRENT PERMITTED WATERSHED CHARACTERISTICS

Prep by:
Date:

Chkd by:
Date:

WASTE MANAGEMENT OF TEXAS, INC.
SKYLINE LANDFILL
UNIT HYDROGRAPH DATA

Current Permitted Watershed Characteristics

			CN Determination					Main Reach Slope Calculation (for Espey Method)					Mannings "n" Determination			
Watershed Name	Watershed Area (ac)	Watershed Area (sq mi)	Final Cover Topslope Area (ac) CN = 85	Final Cover Sideslope Area (ac) CN = 87	Non-Final Cover Area (ac) CN = 84	Pond Area (ac) CN = 98	CN	Longest Reach (ft)	20% of Reach Length (ft)	Elevation @ 20% Reach Length from Upstream	Downstream Elevation	Slope (ft/ft)	Sheet Flow % of n = 0.070	Shallow Concentrated or Swale Flow % of n = 0.050	Channelized Flow % of n = 0.035	Composite n
CA1	21.8	0.0341			21.7		84	1756	351	407.0	379.0	0.0199	20	30	50	0.047
CA2	4.0	0.0062			4.0		84	624	125	411.0	380.0	0.0621	50	50	0	0.060
CA3	1.2	0.0019			1.2		84	292	58	416.0	382.0	0.1455	100	0	0	0.070
CA4	12.4	0.0194			12.4		84	993	199	450.0	382.0	0.0856	30	60	10	0.055
CA5	10.3	0.0161			6.7	3.6	89	634	127	441.0	412.0	0.0572	50	50	0	0.060
CA6	14.3	0.0224			9.6	4.7	88	351	70	439.0	425.0	0.0499	90	10	0	0.068
CA7	0.7	0.0010			0.7		84	505	101	462.0	454.0	0.0198	60	40	0	0.062
CA8	6.4	0.0100			4.6	1.8	88	1109	222	436.0	420.0	0.0180	30	50	20	0.053
CA9	1.9	0.0029			1.9		84	1182	236	435.0	422.0	0.0137	30	50	20	0.053
CA10	4.7	0.0073			2.3	2.4	91	217	43	451.0	426.0	0.1440	100	0	0	0.070
CA11	14.5	0.0227			14.5		84	2133	427	544.0	429.0	0.0674	10	30	60	0.043
CA12	16.4	0.0257			16.4		84	1296	259	542.0	436.0	0.1022	20	50	30	0.050
CA13	17.3	0.0270			17.3		84	1567	313	461.0	413.0	0.0383	20	40	40	0.048
CA14	2.8	0.0044		2.8			87	492	98	511.0	449.0	0.1575	60	50	-10	0.064
CA15	11.6	0.0181		11.6			87	830	166	580.0	460.0	0.1807	40	60	0	0.058
CA16	18.5	0.0289			18.5		84	1083	217	500.0	430.0	0.0808	30	60	10	0.055
CA17.A	16.0	0.0250		16.0			87	1186	237	680.0	460.0	0.2319	30	50	20	0.053
CA17.B	5.3	0.0082	5.3				85	530	106	685.0	680.0	0.0118	60	40	0	0.062
CA18	15.4	0.0240			15.4		84	1781	356	544.0	475.0	0.0484	20	30	50	0.047
CA19	4.1	0.0064			4.1		84	697	139	479.0	458.0	0.0377	40	60	0	0.058
CA20.A	17.2	0.0269		17.2			87	1135	227	680.0	480.0	0.2203	30	50	20	0.053
CA20.B	4.2	0.0066	4.2				85	559	112	685.0	680.0	0.0112	50	50	0	0.060
CA21.A	21.0	0.0327		21.0			87	1159	232	680.0	500.0	0.1941	30	50	20	0.053

Prep by:
Date:

Chkd by:
Date:

WASTE MANAGEMENT OF TEXAS, INC.
SKYLINE LANDFILL
UNIT HYDROGRAPH DATA

Current Permitted Watershed Characteristics

			CN Determination					Main Reach Slope Calculation (for Espey Method)					Mannings "n" Determination			
Watershed Name	Watershed Area (ac)	Watershed Area (sq mi)	Final Cover Topslope Area (ac) CN = 85	Final Cover Sideslope Area (ac) CN = 87	Non-Final Cover Area (ac) CN = 84	Pond Area (ac) CN = 98	CN	Longest Reach (ft)	20% of Reach Length (ft)	Elevation @ 20% Reach Length from Upstream	Downstream Elevation	Slope (ft/ft)	Sheet Flow % of n = 0.070	Shallow Concentrated or Swale Flow % of n = 0.050	Channelized Flow % of n = 0.035	Composite n
CA21.B	3.2	0.0050	3.2				85	532	106	685.0	680.0	0.0117	60	40	0	0.062
CA22.A	14.4	0.0225		14.4			87	1156	231	680.0	504.0	0.1903	30	50	20	0.053
CA22.B	2.7	0.0042	2.7				85	530	106	685.0	680.0	0.0118	60	40	0	0.062
CA23	11.2	0.0175			11.2		84	1046	209	444.0	383.0	0.0729	30	60	10	0.055
CA24	2.8	0.0044			1.4	1.4	91	300	60	450.0	439.0	0.0458	100	30	-30	0.075
CA25.A	23.6	0.0369		23.6			87	1537	307	680.0	437.0	0.1976	20	40	40	0.048
CA25.B	2.7	0.0042	2.7				85	606	121	685.0	680.0	0.0103	50	50	0	0.060
CA26	26.7	0.0417			21.1	5.6	87	1310	262	420.0	384.0	0.0344	20	50	30	0.050
CA27	7.4	0.0115			6.0	1.4	87	1656	331	423.0	415.0	0.0060	20	40	40	0.048
CA28	14.7	0.0229			14.7		84	1300	260	431.0	392.0	0.0375	20	50	30	0.050
CA29	4.5	0.0071			3.5	1.0	86	602	120	413.0	412.0	0.0021	50	50	0	0.060
CA30.A	5.6	0.0088		5.6			87	1074	215	655.0	450.0	0.2386	30	60	10	0.055
CA30.B	15.6	0.0244	15.6				85	1836	367	681.0	670.0	0.0075	20	30	50	0.047
CA31.A	10.5	0.0164		10.5			87	1161	232	670.0	440.0	0.2476	30	50	20	0.053
CA31.B	10.4	0.0163	10.4				85	1538	308	680.0	660.0	0.0163	20	40	40	0.048
CA32.A	13.7	0.0215		13.7			87	1148	230	665.0	440.0	0.2450	30	50	20	0.053
CA32.B	8.1	0.0126	8.1				85	1139	228	675.0	660.0	0.0165	30	50	20	0.053
CA33.A	10.8	0.0169		10.8			87	1094	219	670.0	430.0	0.2742	30	50	20	0.053
CA33.B	13.8	0.0215	13.8				85	1930	386	688.0	670.0	0.0117	20	30	50	0.047
CA34.A	19.5	0.0305		19.5			87	1184	237	670.0	440.0	0.2428	30	50	20	0.053
CA34.B	9.0	0.0141	9.0				85	1923	385	687.0	680.0	0.0046	20	30	50	0.047
CA35	1.1	0.0018			1.1		84	175	35	462.0	443.0	0.1357	70	0	30	0.060
CA36	3.3	0.0052			3.3		84	616	123	436.0	391.0	0.0913	50	10	40	0.054

Prep by:
Date:

Chkd by:
Date:

WASTE MANAGEMENT OF TEXAS, INC.
SKYLINE LANDFILL
UNIT HYDROGRAPH DATA

Current Permitted Watershed Characteristics

			CN Determination					Main Reach Slope Calculation (for Espey Method)					Mannings "n" Determination			
Watershed Name	Watershed Area (ac)	Watershed Area (sq mi)	Final Cover Topslope Area (ac) CN = 85	Final Cover Sideslope Area (ac) CN = 87	Non-Final Cover Area (ac) CN = 84	Pond Area (ac) CN = 98	CN	Longest Reach (ft)	20% of Reach Length (ft)	Elevation @ 20% Reach Length from Upstream	Downstream Elevation	Slope (ft/ft)	Sheet Flow % of n = 0.070	Shallow Concentrated or Swale Flow % of n = 0.050	Channelized Flow % of n = 0.035	Composite n
CA37	18.1	0.0283			18.1		84	1326	265	414.0	394.0	0.0189	20	10	70	0.044
CA40	13.6	0.0213			13.6		84	1444	289	432.0	416.0	0.0139	20	40	40	0.048
CA41	13.4	0.0209		13.4			87	1268	254	670.0	441.0	0.2257	20	50	30	0.050
CA42	4.4	0.0069			4.4		84	1061	212	460.0	434.0	0.0306	30	60	10	0.055
CA44	6.8	0.0106			3.8	3.0	90	1109	222	521.0	467.0	0.0609	30	50	20	0.053
CA45	17.5	0.0273		17.5			87	1409	282	671.0	490.0	0.1606	20	40	40	0.048
CA46.A	16.6	0.0259		16.6			87	1062	212	670.0	510.0	0.1883	30	60	10	0.055
CA46.B	0.8	0.0013	0.8				85	272	54	686.0	680.0	0.0276	100	0	0	0.070
CA47	2.6	0.0041			2.6		84	662	132	491.0	480.0	0.0208	50	50	0	0.060
CA48	11.5	0.0180			11.5		84	1566	313	490.0	474.0	0.0128	20	40	40	0.048
CA49	34.8	0.0544			29.8	5.0	86	1374	275	511.0	503.0	0.0073	20	40	40	0.048
CA50	3.5	0.0054			3.5		84	830	166	509.0	486.0	0.0346	40	60	0	0.058
CA51	7.2	0.0112			7.2		84	1348	270	511.0	466.0	0.0417	20	40	40	0.048
CA52	0.7	0.0012			0.7		84	351	70	500.0	483.0	0.0605	90	10	0	0.068
CA53	8.9	0.0139			8.9		84	935	187	530.0	488.0	0.0561	30	60	10	0.055
CA54	3.7	0.0058			3.7		84	616	123	503.0	466.0	0.0751	50	50	0	0.060
CA55	4.8	0.0076			4.8		84	795	159	502.0	454.0	0.0755	40	60	0	0.058
CA56	13.0	0.0203			13.0		84	1739	348	484.0	436.0	0.0345	20	30	50	0.047
CA57	1.6	0.0025			1.6		84	492	98	441.0	432.0	0.0229	60	40	0	0.062
PA1	30.2	0.0471			30.2		84	2361	472	502.0	393.0	0.0577	10	30	60	0.043
PA2	5.3	0.0083			5.3		84	750	150	504.0	450.0	0.0900	40	60	0	0.058
PA3	0.9	0.0014			0.9		84	314	63	504.0	487.0	0.0677	100	0	0	0.070
PA4	3.5	0.0054			3.5		84	738	148	493.0	452.0	0.0694	40	60	0	0.058

Prep by:
Date:

Chkd by:
Date:

WASTE MANAGEMENT OF TEXAS, INC.
SKYLINE LANDFILL
UNIT HYDROGRAPH DATA

Current Permitted Watershed Characteristics

			CN Determination					Main Reach Slope Calculation (for Espey Method)					Mannings "n" Determination			
Watershed Name	Watershed Area (ac)	Watershed Area (sq mi)	Final Cover Topslope Area (ac) CN = 85	Final Cover Sideslope Area (ac) CN = 87	Non-Final Cover Area (ac) CN = 84	Pond Area (ac) CN = 98	CN	Longest Reach (ft)	20% of Reach Length (ft)	Elevation @ 20% Reach Length from Upstream	Downstream Elevation	Slope (ft/ft)	Sheet Flow % of n = 0.070	Shallow Concentrated or Swale Flow % of n = 0.050	Channelized Flow % of n = 0.035	Composite n
PA5	38.2	0.0596			34.6	4.0	86	1974	395	504.0	442.0	0.0393	20	30	50	0.047
PA6	2.7	0.0043			2.7		84	686	137	505.0	499.0	0.0109	40	60	0	0.058
PA7	10.7	0.0167			10.7		84	1143	229	524.0	498.0	0.0284	30	50	20	0.053
PA8	18.4	0.0287			18.4		84	1894	379	496.0	477.0	0.0125	20	30	50	0.047
PA9	30.0	0.0469			30.0		84	1404	281	504.0	412.0	0.0819	20	40	40	0.048
PA10.A	13.8	0.0215			13.8		84	1177	235	501.0	433.0	0.0722	30	50	20	0.053
PA10.B	1.0	0.0016			1.0		83	246	49	476.0	452.0	0.1220	100	0	0	0.070
PA10.C	1.0	0.0016			1.0		84	331	66	486.0	459.0	0.1020	90	10	0	0.068
PA11	23.4	0.0365			20.5	3.0	86	1346	269	498.0	462.0	0.0334	20	40	40	0.048
PA12	7.1	0.0111			7.1		84	833	167	496.0	468.0	0.0420	40	60	0	0.058
PA13	11.6	0.0182			11.6		84	1180	236	498.0	475.0	0.0244	30	50	20	0.053
OS03	4.2	0.0066			4.2		84	877	175	437.0	390.0	0.0670	30	70	0	0.056
OS12	57.8	0.0904			57.8		84	1658	332	476.0	452.0	0.0181	20	40	40	0.048
OS12.A	0.2	0.0003			0.2		84	255	51	486.0	483.0	0.0147	100	0	0	0.070
OS13	16.2	0.0254			16.2		84	1194	239	489.0	443.0	0.0482	30	50	20	0.053
OS14	1.8	0.0028			1.8		84	620	124	447.0	440.0	0.0141	50	60	-10	0.062
OS15	1.4	0.0022			1.4		84	1563	313	446.0	432.0	0.0112	20	40	40	0.048
OS16	1.6	0.0025			1.6		84	645	129	435.0	426.0	0.0174	50	50	0	0.060
OS17	0.5	0.0008			0.5		84	472	94	436.0	430.0	0.0159	60	40	0	0.062
OS18	1.5	0.0023			1.5		84	510	102	429.0	424.0	0.0123	60	40	0	0.062

Prep by:
Date:

Chkd by:
Date:

WASTE MANAGEMENT OF TEXAS, INC.
SKYLINE LANDFILL
UNIT HYDROGRAPH DATA

Snyder's Hydrograph Coefficients (Espey's 10-Minute Method)

Current Permitted Conditions

Watershed Name	Longest Reach (ft)	Slope (ft/ft)	Impervious Cover %	Manning's "n"	Eff. Coeff.	Tr (min)	Tlag (min)	Area (sq mi)	qp (cfs/sq mi)	Tlag (hr)	Cp
					(A)	(B)	(C)		(D)		(E)
CA1	1756	0.0199	2.0	0.047	0.90	34.3	31.8	0.0341	823.6	0.53	0.68
CA2	624	0.0621	2.0	0.060	0.96	22.7	20.2	0.0062	1373.4	0.34	0.72
CA3	292	0.1455	2.0	0.070	1.00	16.4	13.9	0.0019	2034.3	0.23	0.74
CA4	993	0.0856	2.0	0.055	0.93	22.0	19.5	0.0194	1357.1	0.32	0.69
CA5	634	0.0572	2.0	0.060	0.96	23.2	20.7	0.0161	1287.8	0.35	0.70
CA6	351	0.0499	2.0	0.068	0.98	21.7	19.2	0.0224	1369.0	0.32	0.68
CA7	505	0.0198	2.0	0.062	0.96	28.7	26.2	0.0010	1145.4	0.44	0.78
CA8	1109	0.0180	2.0	0.053	0.93	33.3	30.8	0.0100	894.2	0.51	0.72
CA9	1182	0.0137	2.0	0.053	0.93	36.1	33.6	0.0029	859.7	0.56	0.75
CA10	217	0.1440	2.0	0.070	1.00	15.4	12.9	0.0073	2068.7	0.21	0.69
CA11	2133	0.0674	2.0	0.043	0.88	25.4	22.9	0.0227	1154.8	0.38	0.69
CA12	1296	0.1022	2.0	0.050	0.90	21.2	18.7	0.0257	1390.2	0.31	0.68
CA13	1567	0.0383	2.0	0.048	0.90	28.4	25.9	0.0270	1018.2	0.43	0.69
CA14	492	0.1575	2.0	0.064	0.96	17.0	14.5	0.0044	1893.1	0.24	0.72
CA15	830	0.1807	2.0	0.058	0.94	17.9	15.4	0.0181	1696.7	0.26	0.68
CA16	1083	0.0808	2.0	0.055	0.93	22.7	20.2	0.0289	1287.3	0.34	0.68
CA17.A	1186	0.2319	2.0	0.053	0.93	17.8	15.3	0.0250	1678.6	0.26	0.67
CA17.B	530	0.0118	2.0	0.062	0.96	33.1	30.6	0.0082	906.3	0.51	0.72
CA18	1781	0.0484	2.0	0.047	0.90	27.6	25.1	0.0240	1055.5	0.42	0.69
CA19	697	0.0377	2.0	0.058	0.94	25.4	22.9	0.0064	1213.8	0.38	0.72
CA20.A	1135	0.2203	2.0	0.053	0.93	17.9	15.4	0.0269	1668.9	0.26	0.67
CA20.B	559	0.0112	2.0	0.060	0.96	33.9	31.4	0.0066	889.8	0.52	0.73
CA21.A	1159	0.1941	2.0	0.053	0.93	18.5	16.0	0.0327	1592.6	0.27	0.67
CA21.B	532	0.0117	2.0	0.062	0.96	33.1	30.6	0.0050	922.9	0.51	0.74
CA22.A	1156	0.1903	2.0	0.053	0.93	18.6	16.1	0.0225	1609.1	0.27	0.68
CA22.B	530	0.0118	2.0	0.062	0.96	33.1	30.6	0.0042	930.8	0.51	0.74
CA23	1046	0.0729	2.0	0.055	0.93	23.1	20.6	0.0175	1288.7	0.34	0.69
CA24	300	0.0458	2.0	0.075	1.00	22.0	19.5	0.0044	1435.9	0.33	0.73
CA25.A	1537	0.1976	2.0	0.048	0.90	18.7	16.2	0.0369	1567.1	0.27	0.66
CA25.B	606	0.0103	2.0	0.060	0.96	35.3	32.8	0.0042	869.0	0.55	0.74
CA26	1310	0.0344	2.0	0.050	0.90	28.0	25.5	0.0417	1015.7	0.42	0.67
CA27	1656	0.0060	2.0	0.048	0.90	45.6	43.1	0.0115	634.0	0.72	0.71
CA28	1300	0.0375	2.0	0.050	0.90	27.3	24.8	0.0229	1067.1	0.41	0.69
CA29	602	0.0021	2.0	0.060	0.96	52.6	50.1	0.0071	555.2	0.83	0.72
CA30.A	1074	0.2386	2.0	0.055	0.93	17.3	14.8	0.0088	1807.5	0.25	0.70
CA30.B	1836	0.0075	2.0	0.047	0.90	44.2	41.7	0.0244	635.4	0.70	0.69
CA31.A	1161	0.2476	2.0	0.053	0.93	17.5	15.0	0.0164	1746.6	0.25	0.68
CA31.B	1538	0.0163	2.0	0.048	0.90	35.0	32.5	0.0163	830.0	0.54	0.70
CA32.A	1148	0.2450	2.0	0.053	0.93	17.5	15.0	0.0215	1727.8	0.25	0.67
CA32.B	1139	0.0165	2.0	0.053	0.93	34.2	31.7	0.0126	858.7	0.53	0.71
CA33.A	1094	0.2742	2.0	0.053	0.93	16.8	14.3	0.0169	1819.2	0.24	0.68
CA33.B	1930	0.0117	2.0	0.047	0.90	40.1	37.6	0.0215	710.2	0.63	0.69
CA34.A	1184	0.2428	2.0	0.053	0.93	17.6	15.1	0.0305	1686.8	0.25	0.66
CA34.B	1923	0.0046	2.0	0.047	0.90	50.7	48.2	0.0141	562.1	0.80	0.70
CA35	175	0.1357	2.0	0.060	0.94	13.4	10.9	0.0018	2530.0	0.18	0.72
CA36	616	0.0913	2.0	0.054	0.93	19.4	16.9	0.0052	1636.7	0.28	0.72
CA37	1326	0.0189	2.0	0.044	0.88	31.3	28.8	0.0283	915.0	0.48	0.69
CA40	1444	0.0139	2.0	0.048	0.90	35.9	33.4	0.0213	799.1	0.56	0.70
CA41	1268	0.2257	2.0	0.050	0.90	17.3	14.8	0.0209	1741.7	0.25	0.67
CA42	1061	0.0306	2.0	0.055	0.93	28.8	26.3	0.0069	1057.2	0.44	0.72
CA44	1109	0.0609	2.0	0.053	0.93	24.5	22.0	0.0106	1234.9	0.37	0.71
CA45	1409	0.1606	2.0	0.048	0.90	19.3	16.8	0.0273	1532.8	0.28	0.67
CA46.A	1062	0.1883	2.0	0.055	0.93	18.3	15.8	0.0259	1629.2	0.26	0.67
CA46.B	272	0.0276	2.0	0.070	1.00	24.5	22.0	0.0013	1349.8	0.37	0.77
CA47	662	0.0208	2.0	0.060	0.96	30.2	27.7	0.0041	1026.5	0.46	0.74
CA48	1566	0.0128	2.0	0.048	0.90	37.3	34.8	0.0180	771.5	0.58	0.70
CA49	1374	0.0073	2.0	0.048	0.90	41.7	39.2	0.0544	655.9	0.65	0.67

Prep by:
Date:

Chkd by:
Date:

WASTE MANAGEMENT OF TEXAS, INC.
SKYLINE LANDFILL
UNIT HYDROGRAPH DATA

Snyder's Hydrograph Coefficients (Espey's 10-Minute Method)

Current Permitted Conditions

Watershed Name	Longest Reach (ft)	Slope (ft/ft)	Impervious Cover %	Manning's "n"	Eff. Coeff.	Tr (min)	Tlag (min)	Area (sq mi)	qp (cfs/sq mi)	Tlag (hr)	Cp
					(A)	(B)	(C)		(D)		(E)
CA50	830	0.0346	2.0	0.058	0.94	27.0	24.5	0.0054	1144.8	0.41	0.73
CA51	1348	0.0417	2.0	0.048	0.90	26.8	24.3	0.0112	1120.0	0.41	0.71
CA52	351	0.0605	2.0	0.068	0.98	20.6	18.1	0.0012	1623.4	0.30	0.77
CA53	935	0.0561	2.0	0.055	0.93	24.1	21.6	0.0139	1247.0	0.36	0.70
CA54	616	0.0751	2.0	0.060	0.96	21.6	19.1	0.0058	1453.5	0.32	0.72
CA55	795	0.0755	2.0	0.058	0.94	22.0	19.5	0.0076	1405.8	0.33	0.71
CA56	1739	0.0345	2.0	0.047	0.90	29.8	27.3	0.0203	976.2	0.46	0.69
CA57	492	0.0229	2.0	0.062	0.96	27.5	25.0	0.0025	1156.2	0.42	0.75
PA1	2361	0.0577	2.0	0.043	0.88	27.0	24.5	0.0471	1049.3	0.41	0.67
PA2	750	0.0900	2.0	0.058	0.94	20.8	18.3	0.0083	1489.6	0.30	0.71
PA3	314	0.0677	2.0	0.070	1.00	20.2	17.7	0.0014	1651.0	0.29	0.76
PA4	738	0.0694	2.0	0.058	0.94	22.1	19.6	0.0054	1418.8	0.33	0.72
PA5	1974	0.0393	2.0	0.047	0.90	29.7	27.2	0.0596	938.2	0.45	0.67
PA6	686	0.0109	2.0	0.058	0.94	34.5	32.0	0.0043	889.4	0.53	0.74
PA7	1143	0.0284	2.0	0.053	0.93	29.9	27.4	0.0167	982.1	0.46	0.70
PA8	1894	0.0125	2.0	0.047	0.90	39.2	36.7	0.0287	719.1	0.61	0.69
PA9	1404	0.0819	2.0	0.048	0.90	22.9	20.4	0.0469	1254.0	0.34	0.67
PA10.A	1177	0.0722	2.0	0.053	0.93	23.8	21.3	0.0215	1238.5	0.36	0.69
PA10.B	246	0.1220	2.0	0.070	1.00	16.5	14.0	0.0016	2040.3	0.23	0.74
PA10.C	331	0.1020	2.0	0.068	0.98	17.9	15.4	0.0016	1870.8	0.26	0.75
PA11	1346	0.0334	2.0	0.048	0.90	28.3	25.8	0.0365	1007.1	0.43	0.68
PA12	833	0.0420	2.0	0.058	0.94	25.8	23.3	0.0111	1170.2	0.39	0.71
PA13	1180	0.0244	2.0	0.053	0.93	31.3	28.8	0.0182	931.8	0.48	0.70
OS03	877	0.0670	2.0	0.056	0.94	23.2	20.7	0.0066	1336.2	0.34	0.72
OS12	1658	0.0181	2.0	0.048	0.90	34.7	32.2	0.0904	782.9	0.54	0.66
OS12.A	255	0.0147	2.0	0.070	1.00	28.2	25.7	0.0003	1234.4	0.43	0.83
OS13	1194	0.0482	2.0	0.053	0.93	26.5	24.0	0.0254	1100.0	0.40	0.69
OS14	620	0.0141	2.0	0.062	0.96	32.8	30.3	0.0028	954.8	0.50	0.75
OS15	1563	0.0112	2.0	0.048	0.90	38.6	36.1	0.0022	810.9	0.60	0.76
OS16	645	0.0174	2.0	0.060	0.96	31.4	28.9	0.0025	1005.7	0.48	0.76
OS17	472	0.0159	2.0	0.062	0.96	29.9	27.4	0.0008	1107.3	0.46	0.79
OS18	510	0.0123	2.0	0.062	0.96	32.5	30.0	0.0023	973.3	0.50	0.76

(A) Conveyance efficiency from Dodson & Associates, Inc. Hands-On HEC-1, February 1999, pgs 6-19.

(B) $Tr=3.1(L^{0.23})(S^{-0.25})(I^{-0.18})(Effcoef^{1.57})$

(C) $Tlag=Tr-(5/2)$

(D) $qp=31600(A^{-0.04})(Tr^{-1.07})$

(E) $Cp=49.375(A^{-0.04})(Tr^{-1.07})(Tlag)$

Tr = surface runoff to unit hydrograph peak (min)
L = distance along main channel from study point to watershed boundary
S = main channel slope (ft/ft)
I = impervious cover within the watershed
Tlag = watershed lag time (min)
qp = Hydrograph peak discharge (cfs/sq. mi.)
Cp = Snyder's peaking coefficient

RAINFALL DATA

NOAA Atlas 14, Volume 11, Version 2
Location name: Ferris, Texas, USA*
Latitude: 32.5486°, Longitude: -96.6742°
Elevation: 490 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sandra Pavlovic, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Orlan Wilhite

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.430 (0.326-0.569)	0.500 (0.383-0.656)	0.615 (0.469-0.809)	0.710 (0.533-0.946)	0.839 (0.609-1.15)	0.936 (0.662-1.32)	1.03 (0.713-1.50)	1.14 (0.763-1.69)	1.27 (0.827-1.96)	1.38 (0.873-2.17)
10-min	0.688 (0.521-0.908)	0.800 (0.612-1.05)	0.985 (0.751-1.30)	1.14 (0.853-1.52)	1.34 (0.978-1.84)	1.50 (1.06-2.12)	1.66 (1.14-2.40)	1.82 (1.22-2.70)	2.02 (1.31-3.11)	2.18 (1.38-3.43)
15-min	0.861 (0.652-1.14)	0.998 (0.764-1.31)	1.23 (0.935-1.61)	1.41 (1.06-1.88)	1.67 (1.21-2.28)	1.86 (1.32-2.62)	2.05 (1.42-2.97)	2.25 (1.51-3.34)	2.52 (1.64-3.87)	2.73 (1.73-4.30)
30-min	1.20 (0.911-1.59)	1.39 (1.07-1.83)	1.71 (1.30-2.25)	1.96 (1.48-2.62)	2.31 (1.68-3.17)	2.57 (1.82-3.62)	2.83 (1.95-4.10)	3.11 (2.09-4.62)	3.49 (2.27-5.37)	3.79 (2.40-5.97)
60-min	1.56 (1.18-2.06)	1.82 (1.39-2.38)	2.24 (1.70-2.94)	2.58 (1.94-3.44)	3.05 (2.21-4.17)	3.40 (2.40-4.78)	3.76 (2.59-5.44)	4.14 (2.78-6.16)	4.68 (3.04-7.19)	5.10 (3.23-8.04)
2-hr	1.90 (1.46-2.48)	2.24 (1.73-2.89)	2.79 (2.14-3.62)	3.25 (2.46-4.28)	3.89 (2.85-5.27)	4.38 (3.12-6.10)	4.90 (3.40-7.01)	5.47 (3.70-8.02)	6.26 (4.09-9.50)	6.90 (4.38-10.7)
3-hr	2.10 (1.61-2.72)	2.49 (1.93-3.19)	3.12 (2.42-4.03)	3.66 (2.79-4.80)	4.43 (3.26-5.96)	5.03 (3.61-6.96)	5.67 (3.95-8.05)	6.37 (4.32-9.27)	7.35 (4.81-11.1)	8.15 (5.19-12.6)
6-hr	2.45 (1.91-3.15)	2.95 (2.30-3.71)	3.73 (2.91-4.75)	4.41 (3.40-5.71)	5.39 (4.02-7.19)	6.18 (4.47-8.46)	7.04 (4.94-9.87)	7.98 (5.44-11.5)	9.31 (6.12-13.8)	10.4 (6.64-15.8)
12-hr	2.83 (2.23-3.60)	3.44 (2.70-4.27)	4.38 (3.45-5.51)	5.20 (4.05-6.67)	6.41 (4.82-8.45)	7.40 (5.39-10.0)	8.47 (5.99-11.7)	9.67 (6.63-13.7)	11.4 (7.53-16.7)	12.8 (8.24-19.2)
24-hr	3.28 (2.60-4.12)	4.00 (3.17-4.90)	5.09 (4.06-6.34)	6.07 (4.77-7.69)	7.50 (5.68-9.76)	8.66 (6.36-11.6)	9.94 (7.07-13.6)	11.4 (7.86-15.9)	13.5 (8.96-19.5)	15.3 (9.84-22.6)
2-day	3.84 (3.09-4.78)	4.66 (3.75-5.68)	5.93 (4.79-7.32)	7.04 (5.60-8.82)	8.64 (6.59-11.1)	9.91 (7.32-13.0)	11.3 (8.10-15.3)	12.9 (8.98-17.9)	15.4 (10.2-21.9)	17.4 (11.2-25.3)
3-day	4.22 (3.42-5.22)	5.10 (4.14-6.18)	6.47 (5.26-7.93)	7.65 (6.12-9.52)	9.35 (7.17-11.9)	10.7 (7.93-14.0)	12.2 (8.74-16.3)	13.9 (9.66-19.0)	16.4 (11.0-23.2)	18.6 (12.0-26.8)
4-day	4.48 (3.64-5.51)	5.40 (4.40-6.52)	6.83 (5.58-8.34)	8.07 (6.49-10.0)	9.85 (7.58-12.5)	11.2 (8.37-14.6)	12.8 (9.21-17.0)	14.5 (10.2-19.8)	17.1 (11.5-24.1)	19.3 (12.5-27.7)
7-day	5.02 (4.12-6.12)	6.02 (4.95-7.20)	7.57 (6.24-9.16)	8.92 (7.23-10.9)	10.9 (8.43-13.6)	12.4 (9.29-15.9)	14.0 (10.2-18.5)	15.9 (11.2-21.4)	18.6 (12.5-25.8)	20.8 (13.5-29.4)
10-day	5.49 (4.53-6.65)	6.55 (5.43-7.80)	8.20 (6.81-9.87)	9.64 (7.85-11.8)	11.7 (9.12-14.6)	13.3 (10.0-17.0)	15.0 (10.9-19.6)	16.9 (11.9-22.6)	19.6 (13.2-27.0)	21.9 (14.2-30.7)
20-day	7.17 (5.98-8.58)	8.35 (7.05-9.92)	10.3 (8.65-12.3)	11.9 (9.80-14.3)	14.1 (11.1-17.4)	15.8 (12.0-19.9)	17.5 (12.8-22.6)	19.4 (13.8-25.6)	22.1 (15.0-30.0)	24.3 (15.9-33.6)
30-day	8.59 (7.22-10.2)	9.88 (8.44-11.7)	12.1 (10.2-14.3)	13.8 (11.5-16.5)	16.2 (12.8-19.7)	17.9 (13.6-22.3)	19.6 (14.5-25.1)	21.5 (15.3-28.2)	24.2 (16.5-32.6)	26.4 (17.3-36.2)
45-day	10.6 (8.96-12.5)	12.1 (10.4-14.3)	14.7 (12.5-17.3)	16.7 (13.9-19.8)	19.4 (15.4-23.5)	21.3 (16.3-26.4)	23.3 (17.2-29.5)	25.3 (18.0-32.8)	28.0 (19.1-37.3)	30.1 (19.8-40.9)
60-day	12.4 (10.5-14.6)	14.1 (12.2-16.6)	17.0 (14.6-20.0)	19.3 (16.2-22.9)	22.4 (17.9-27.0)	24.6 (18.9-30.3)	26.7 (19.8-33.7)	28.8 (20.6-37.2)	31.6 (21.6-41.8)	33.7 (22.2-45.4)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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PF graphical

CURRENT PERMITTED DRAINAGE STRUCTURE DESIGN PARAMETERS

WASTE MANAGEMENT OF TEXAS, INC.
Skyline Landfill
Pond Data for HEC-HMS
Pond 05

Reservoir

Description:	
Downstream:	R04
Method:	Outflow Structures
Storage Method:	Elevation-Storage
Elev-Stor Function:	Pond 05
Initial Condition:	Elevation
Initial Elevation:	412 ft
Main Tailwater:	Assume None
Auxiliary:	--None--
Time Step Method:	Automatic Adaption
Outlets:	0
Spillways:	1
Dam Tops:	1
Pumps:	0
Dam Break:	No
Dam Seepage:	No
Release:	No
Evaporation:	No

Outlet

Method:	
Direction:	
Number Barrels:	
Solution Method:	
Shape:	
Chart:	
Scale:	
Length:	
Rise:	
Span:	
Inlet Elevation:	
Entrance Coefficient:	
Outlet Elevation:	
Exit Coefficient:	
Mannings n:	

Spillway

Method:	Broad-Crested Spillway
Direction:	Main
Elevation:	412 ft
Length:	40 ft
Coefficient:	2.6
Gates:	0

Dam Tops

Method:	Level Overflow
Direction:	Main
Elevation:	415
Length:	800
Coefficient:	2.6

Paired Data

Elevation Storage Functions
Pond 05

Elevation (ft)	Storage (ac-ft)	Storage (cy)
400	0.000	0
402	4.000	6,453
404	13.000	20,973
406	30.000	48,400
408	56.000	90,347
410	93.000	150,040
412	101.753	164,161
414	110.505	178,282
416	121.0457	195,287

WASTE MANAGEMENT OF TEXAS, INC.
Skyline Landfill
Pond Data for HEC-HMS
Pond 06

Reservoir

Description:	
Downstream:	Pond 05
Method:	Outflow Structures
Storage Method:	Elevation-Storage
Elev-Stor Function:	Pond 06
Initial Condition:	Elevation
Initial Elevation:	424.5 ft
Main Tailwater:	Assume None
Auxiliary:	--None--
Time Step Method:	Automatic Adaption
Outlets:	1
Spillways:	1
Dam Tops:	0
Pumps:	0
Dam Break:	No
Dam Seepage:	No
Release:	No
Evaporation:	No

Outlet

Method:	Orifice Outlet
Direction:	Main
Number Barrels:	1
Center Elevation:	430 ft
Area	18 sf
Coefficient:	0.67

Spillway

Method:	Broad-Crested Spillway
Direction:	Main
Elevation:	430.7 ft
Length:	50 ft
Coefficient:	2.6
Gates:	0

Dam Tops

Method:	
Direction:	
Elevation:	
Length:	
Coefficient:	

Paired Data

Elevation Storage Functions
Pond 06

Elevation (ft)	Storage (ac-ft)	Storage (cy)
416	0.000	0
418	7.789	12,566
420	16.352	26,381
422	26.662	43,015
424	36.062	58,180
426	44.069	71,098
428	56.461	91,090
430	69.247	111,718
432	82.049	132,373

WASTE MANAGEMENT OF TEXAS, INC.
Skyline Landfill
Pond Data for HEC-HMS
Pond 08

Reservoir

Description:		
Downstream:	Pond 05	
Method:	Outflow Structures	
Storage Method:	Elevation-Storage	
Elev-Stor Function:	Pond 08	
Initial Condition:	Elevation	
Initial Elevation:	418.5	ft
Main Tailwater:	Assume None	
Auxiliary:	--None--	
Time Step Method:	Automatic Adaption	
Outlets:	1	
Spillways:	1	
Dam Tops:	0	
Pumps:	0	
Dam Break:	No	
Dam Seepage:	No	
Release:	No	
Evaporation:	No	

Outlet

Method:	Orifice Outlet	
Direction:	Main	
Number Barrels:	1	
Center Elevation:	420	ft
Area	18	sf
Coefficient:	0.67	

Spillway

Method:	Broad-Crested Spillway	
Direction:	Main	
Elevation:	422.5	ft
Length:	60	ft
Coefficient:	2.6	
Gates:	0	

Dam Tops

Method:	Level Overflow	
Direction:	Main	
Elevation:		
Length:		
Coefficient:		

Paired Data

Elevation Storage Functions
Pond 08

Elevation (ft)	Storage (ac-ft)	Storage (cy)
405	0.000	0
406	1.000	1,613
408	2.000	3,227
410	3.000	4,840
412	4.000	6,453
414	7.000	11,293
416	10.000	16,133
418	12.000	19,360
420	15.286	24,662
422	20.451	32,995
424	25.903	41,790

WASTE MANAGEMENT OF TEXAS, INC.
Skyline Landfill
Pond Data for HEC-HMS
Pond 10

Reservoir

Description:	
Downstream:	Pond 06
Method:	Outflow Structures
Storage Method:	Elevation-Storage
Elev-Stor Function:	Pond 10
Initial Condition:	Elevation
Initial Elevation:	425.5 ft
Main Tailwater:	Assume None
Auxiliary:	--None--
Time Step Method:	Automatic Adaption
Outlets:	0
Spillways:	1
Dam Tops:	1
Pumps:	0
Dam Break:	No
Dam Seepage:	No
Release:	No
Evaporation:	No

Outlet

Method:		
Direction:		
Number Barrels:		
Solution Method:		
Shape:		
Chart:		
Scale:		
Length:		ft
Diameter:		ft
Inlet Elevation:		ft
Entrance Coefficient:		
Outlet Elevation:		
Exit Coefficient:		
Mannings n:		

Spillway

Method:	Broad-Crested Spillway
Direction:	Main
Elevation:	430 ft
Length:	14 ft
Coefficient:	2.6
Gates:	0

Dam Tops

Method:	Level Overflow
Direction:	Main
Elevation:	432
Length:	200
Coefficient:	2.6

Paired Data

Elevation Storage Functions
Pond 10

Elevation (ft)	Storage (ac-ft)	Storage (cy)
415	0.000	0
416	1.061	1,712
418	3.438	5,546
420	6.171	9,955
422	9.291	14,989
424	12.829	20,697
426	16.809	27,119
428	21.990	35,478
430	27.809	44,866
432	33.934	54,748

WASTE MANAGEMENT OF TEXAS, INC.
Skyline Landfill
Pond Data for HEC-HMS
Pond 24

Reservoir

Description:	
Downstream:	R23
Method:	Outflow Structures
Storage Method:	Elevation-Storage
Elev-Stor Function:	Pond 24
Initial Condition:	Inflow = Outflow
Main Tailwater:	Assume None
Auxiliary:	--None--
Time Step Method:	Automatic Adaption
Outlets:	1
Spillways:	1
Dam Tops:	0
Pumps:	0
Dam Break:	No
Dam Seepage:	No
Release:	No
Evaporation:	No

Outlet

Method:	Culvert Outlet
Direction:	Main
Number Barrels:	2
Solution Method:	Automatic
Shape:	Circular
Chart:	1: Concrete Pipe Culvert
Scale:	1: Square edge entrance with headwall
Length:	150 ft
Diameter:	2.5 ft
Inlet Elevation:	430
Entrance Coefficient:	0.5
Outlet Elevation:	429
Exit Coefficient:	1
Mannings n:	0.013

Spillway

Method:	Broad-Crested Spillway
Direction:	Main
Elevation:	435 ft
Length:	100 ft
Coefficient:	2.6
Gates:	0

Dam Tops

Method:	
Direction:	
Elevation:	
Length:	
Coefficient:	

Paired Data

Elevation Storage Functions
Pond 24

Elevation (ft)	Storage (ac-ft)	Storage (cy)
430	0.000	0
432	2.876	4,639
434	6.057	9,771
436	9.556	15,417

WASTE MANAGEMENT OF TEXAS, INC.
Skyline Landfill
Pond Data for HEC-HMS
Pond 27

Reservoir

Description:	
Downstream:	J15
Method:	Outflow Structures
Storage Method:	Elevation-Storage
Elev-Stor Function:	Pond 27
Initial Condition:	Inflow = Outflow
Initial Elevation:	
Main Tailwater:	Assume None
Auxiliary:	--None--
Time Step Method:	Automatic Adaption
Outlets:	1
Spillways:	1
Dam Tops:	0
Pumps:	0
Dam Break:	No
Dam Seepage:	No
Release:	No
Evaporation:	No

Outlet

Method:	Culvert Outlet
Direction:	Main
Number Barrels:	1
Solution Method:	Automatic
Shape:	Circular
Chart:	1: Concrete Pipe Culvert
Scale:	1: Square edge entrance with headwall
Length:	110
Diameter:	3.5
Inlet Elevation:	415
Entrance Coefficient:	0.5
Outlet Elevation:	414
Exit Coefficient:	1
Mannings n:	0.013

Spillway

Method:	Broad-Crested Spillway
Direction:	Main
Elevation:	428 ft
Length:	100 ft
Coefficient:	2.6
Gates:	0

Dam Tops

Method:	
Direction:	
Elevation:	
Length:	
Coefficient:	

Paired Data

Elevation Storage Functions
Pond 27

Elevation (ft)	Storage (ac-ft)	Storage (cy)
415	0.000	0.00
417	2.495	4,024.90
419	5.429	8,758.30
421	8.867	14,306.20
423	12.916	20,838.30
425	17.817	28,744.00
427	23.732	38,287.60
429	30.800	49,442.60

WASTE MANAGEMENT OF TEXAS, INC.
Skyline Landfill
Pond Data for HEC-HMS
Pond 29

Reservoir

Description:	
Downstream:	J15
Method:	Outflow Structures
Storage Method:	Elevation-Storage
Elev-Stor Function:	Pond 29
Initial Condition:	Inflow = Outflow
Main Tailwater:	Assume None
Auxiliary:	--None--
Time Step Method:	Automatic Adaption
Outlets:	1
Spillways:	1
Dam Tops:	1
Pumps:	0
Dam Break:	No
Dam Seepage:	No
Release:	No
Evaporation:	No

Outlet

Method:	Culvert Outlet
Direction:	Main
Number Barrels:	1
Solution Method:	Automatic
Shape:	Circular
Chart:	1: Concrete Pipe Culvert
Scale:	1: Square edge entrance with headwall
Length:	80 ft
Diameter:	3 ft
Inlet Elevation:	415
Entrance Coefficient:	0.5
Outlet Elevation:	414
Exit Coefficient:	1
Mannings n:	0.013

Spillway

Method:	Broad-Crested Spillway
Direction:	Main
Elevation:	422.5 ft
Length:	100 ft
Coefficient:	2.6
Gates:	0

Dam Tops

Method:	Level Overflow
Direction:	Main
Elevation:	423
Length:	200
Coefficient:	2.6

Paired Data

Elevation Storage Functions
Pond 29

Elevation (ft)	Storage (ac-ft)	Storage (cy)
415	0.000	0
417	2.279	3,677
419	5.070	8,180
421	8.386	13,530
423	12.240	19,747

WASTE MANAGEMENT OF TEXAS, INC.
Skyline Landfill
Pond Data for HEC-HMS
Pond 44

Reservoir

Description:	
Downstream:	R42.2
Method:	Outflow Structures
Storage Method:	Elevation-Storage
Elev-Stor Function:	Pond 44
Initial Condition:	Inflow = Outflow
Main Tailwater:	Assume None
Auxiliary:	--None--
Time Step Method:	Automatic Adaption
Outlets:	1
Spillways:	1
Dam Tops:	1
Pumps:	0
Dam Break:	No
Dam Seepage:	No
Release:	No
Evaporation:	No

Outlet

Method:	Culvert Outlet
Direction:	Main
Number Barrels:	1
Solution Method:	Automatic
Shape:	Circular
Chart:	1: Concrete Pipe Culvert
Scale:	1: Square edge entrance with headwall
Length:	115
Diameter:	2
Inlet Elevation:	461
Entrance Coefficient:	0.5
Outlet Elevation:	460
Exit Coefficient:	1
Mannings n:	0.013

Spillway

Method:	Broad-Crested Spillway
Direction:	Main
Elevation:	473 ft
Length:	20 ft
Coefficient:	2.6
Gates:	0

Dam Tops

Method:	Level Overflow
Direction:	Main
Elevation:	474
Length:	175
Coefficient:	2.6

Paired Data

Elevation Storage Functions
Pond 44

Elevation (ft)	Storage (ac-ft)	Storage (cy)
460	0.000	0
462	0.008	13
464	1.515	2,445
466	5.408	8,725
468	10.237	16,516
470	15.889	25,635
472	22.383	36,111
474	29.724	47,954
476	38.508	62,127

WASTE MANAGEMENT OF TEXAS, INC.
Skyline Landfill
Pond Data for HEC-HMS
Pond CA-08

Reservoir

Description:	
Downstream:	R10
Method:	Outflow Structures
Storage Method:	Elevation-Storage
Elev-Stor Function:	Pond CA-08
Initial Condition:	Elevation
Initial Elevation:	460 ft
Main Tailwater:	Assume None
Auxiliary:	--None--
Time Step Method:	Automatic Adaption
Outlets:	0
Spillways:	1
Dam Tops:	1
Pumps:	0
Dam Break:	No
Dam Seepage:	No
Release:	No
Evaporation:	No

Outlet

Method:	
Direction:	
Number Barrels:	
Solution Method:	
Shape:	
Chart:	
Scale:	
Length:	ft
Diameter:	ft
Inlet Elevation:	ft
Entrance Coefficient:	
Outlet Elevation:	
Exit Coefficient:	
Mannings n:	

Spillway

Method:	Broad-Crested Spillway
Direction:	Main
Elevation:	462 ft
Length:	14 ft
Coefficient:	2.6
Gates:	0

Dam Tops

Method:	Level Overflow
Direction:	Main
Elevation:	463
Length:	60
Coefficient:	2.6

Paired Data
Elevation Storage Functions
Pond CA-08

Elevation (ft)	Storage (ac-ft)	Storage (cy)
452	0.000	0
454	2.000	3,227
456	2.500	4,033
458	5.000	8,067
460	7.500	12,100
462	14.000	22,587
464	18.500	29,847
466	24.000	38,720

WASTE MANAGEMENT OF TEXAS, INC.
Skyline Landfill
Pond Data for HEC-HMS
Pond CA-10

Reservoir

Description:	
Downstream:	R12
Method:	Outflow Structures
Storage Method:	Elevation-Storage
Elev-Stor Function:	Pond CA-10
Initial Condition:	Elevation
Initial Elevation:	477 ft
Main Tailwater:	Assume None
Auxiliary:	--None--
Time Step Method:	Automatic Adaption
Outlets:	0
Spillways:	1
Dam Tops:	0
Pumps:	0
Dam Break:	No
Dam Seepage:	No
Release:	No
Evaporation:	No

Outlet

Method:	
Direction:	
Number Barrels:	
Solution Method:	
Shape:	
Chart:	
Scale:	
Length:	ft
Diameter:	ft
Inlet Elevation:	ft
Entrance Coefficient:	
Outlet Elevation:	
Exit Coefficient:	
Mannings n:	

Spillway

Method:	Broad-Crested Spillway
Direction:	Main
Elevation:	477.5 ft
Length:	180 ft
Coefficient:	2.6
Gates:	0

Dam Tops

Method:	
Direction:	
Elevation:	
Length:	
Coefficient:	

Paired Data

Elevation Storage Functions
Pond CA-10

Elevation (ft)	Storage (ac-ft)	Storage (cy)
470	0.000	0
471	0.100	161
472	0.200	323
473	0.300	484
474	0.400	645
475	0.600	968
476	1.000	1,613
477	1.450	2,339
478	2.000	3,227
480	3.033	4,893

WASTE MANAGEMENT OF TEXAS, INC.
Skyline Landfill
Pond Data for HEC-HMS
I-07

Reservoir

Description:	
Downstream:	Pond 06
Method:	Outflow Structures
Storage Method:	Elevation-Storage
Elev-Stor Function:	I-07
Initial Condition:	Inflow = Outflow
Main Tailwater:	Assume None
Auxiliary:	R12
Time Step Method:	Automatic Adaption
Outlets:	1
Spillways:	1
Dam Tops:	0
Pumps:	0
Dam Break:	No
Dam Seepage:	No
Release:	No
Evaporation:	No

Outlet

Method:	Orifice Outlet
Direction:	Main
Number Barrels:	1
Center Elevation:	453.25
Area	7
Coefficient:	0.67

Spillway

Method:	Broad-Crested Spillway
Direction:	Auxilliary
Elevation:	453.5 ft
Length:	15 ft
Coefficient:	2.6
Gates:	

Dam Tops

Method:	
Direction:	
Elevation:	
Length:	
Coefficient:	

Paired Data

Elevation Storage Functions
I-07

Elevation (ft)	Storage (ac-ft)	(cy)
453	0.000	0
455	0.006	10.3

WASTE MANAGEMENT OF TEXAS, INC.
Skyline Landfill
Pond Data for HEC-HMS
I-09

Reservoir

Description:	
Downstream:	Pond 08
Method:	Outflow Structures
Storage Method:	Elevation-Storage
Elev-Stor Function:	I-09
Initial Condition:	Inflow = Outflow
Main Tailwater:	Assume None
Auxiliary:	CP27
Time Step Method:	Automatic Adaption
Outlets:	1
Spillways:	1
Dam Tops:	1
Pumps:	0
Dam Break:	No
Dam Seepage:	No
Release:	No
Evaporation:	No

Outlet

Method:	Orifice Outlet
Direction:	Main
Number Barrels:	1
Center Elevation:	421.5
Area	4.5
Coefficient:	0.67

Spillway

Method:	Broad-Crested Spillway
Direction:	Auxiliary
Elevation:	421.5 ft
Length:	10 ft
Coefficient:	2.6
Gates:	

Dam Tops

Method:	
Direction:	
Elevation:	
Length:	
Coefficient:	

Paired Data

Elevation Storage Functions
I-09

Elevation (ft)	Storage (ac-ft)	(cy)
421	0.000	0
423	0.009	13.9

WASTE MANAGEMENT OF TEXAS, INC.
Skyline Landfill
Pond Data for HEC-HMS
I-11

Reservoir

Description:	
Downstream:	R08
Method:	Outflow Structures
Storage Method:	Elevation-Storage
Elev-Stor Function:	I-11
Initial Condition:	Inflow = Outflow
Main Tailwater:	Assume None
Auxiliary:	--None--
Time Step Method:	Automatic Adaption
Outlets:	1
Spillways:	1
Dam Tops:	0
Pumps:	0
Dam Break:	No
Dam Seepage:	No
Release:	No
Evaporation:	No

Outlet

Method:	Culvert Outlet
Direction:	Main
Number Barrels:	1
Solution Method:	Automatic
Shape:	Circular
Chart:	1: Concrete Pipe Culvert
Scale:	1: Square edge entrance with headwall
Length:	492 ft
Diameter:	3.5 ft
Inlet Elevation:	430 ft
Entrance Coefficient:	0.5
Outlet Elevation:	426
Exit Coefficient:	1
Mannings n:	0.013

Spillway

Method:	Broad-Crested Spillway
Direction:	Main
Elevation:	435 ft
Length:	60 ft
Coefficient:	2.6
Gates:	0

Dam Tops

Method:	
Direction:	
Elevation:	
Length:	
Coefficient:	

Paired Data

Elevation Storage Functions
I-11

Elevation (ft)	Storage (ac-ft)	(cy)
428	0.000	0
430	0.003	5
432	0.147	237
434	0.694	1120
436	1.491	2406
438	2.288	3692

WASTE MANAGEMENT OF TEXAS, INC.
Skyline Landfill
Pond Data for HEC-HMS
I-12

Reservoir

Description:	
Downstream:	Pond 10
Method:	Outflow Structures
Storage Method:	Elevation-Storage
Elev-Stor Function:	I-12
Initial Condition:	Inflow = Outflow
Main Tailwater:	Assume None
Auxiliary:	--None--
Time Step Method:	Automatic Adaption
Outlets:	1
Spillways:	1
Dam Tops:	0
Pumps:	0
Dam Break:	No
Dam Seepage:	No
Release:	No
Evaporation:	No

Outlet

Method:	Orifice Outlet	
Direction:	Main	
Number Barrels:	1	
Center Elevation:	436	ft
Area	7	sf
Coefficient:	0.67	

Spillway

Method:	Broad-Crested Spillway
Direction:	Main
Elevation:	437 ft
Length:	20 ft
Coefficient:	2.6
Gates:	0

Dam Tops

Method:	
Direction:	
Elevation:	
Length:	
Coefficient:	

Paired Data

Elevation Storage Functions
I-12

Elevation (ft)	Storage (ac-ft)	(cy)
434	0.000	0
436	0.001	2
438	0.037	59

WASTE MANAGEMENT OF TEXAS, INC.
Skyline Landfill
Pond Data for HEC-HMS
I-16

Reservoir

Description:	
Downstream:	R13.3
Method:	Outflow Structures
Storage Method:	Elevation-Storage
Elev-Stor Function:	I-16
Initial Condition:	Inflow = Outflow
Main Tailwater:	Assume None
Auxiliary:	--None--
Time Step Method:	Automatic Adaption
Outlets:	1
Spillways:	1
Dam Tops:	0
Pumps:	0
Dam Break:	No
Dam Seepage:	No
Release:	No
Evaporation:	No

Outlet

Method:	Culvert Outlet
Direction:	Main
Number Barrels:	3
Solution Method:	Automatic
Shape:	Circular
Chart:	2: Corrugated Metal Pipe
Scale:	3: Pipe Projecting from Fill
Length:	268 ft
Diameter:	4 ft
Inlet Elevation:	432 ft
Entrance Coefficient:	0.8
Outlet Elevation:	430
Exit Coefficient:	1
Mannings n:	0.015

Spillway

Method:	Broad-Crested Spillway
Direction:	Main
Elevation:	458 ft
Length:	25 ft
Coefficient:	2.6
Gates:	0

Dam Tops

Method:	
Direction:	
Elevation:	
Length:	
Coefficient:	

Paired Data

Elevation Storage Functions
I-16

Elevation (ft)	Storage (ac-ft)	Storage (cy)
432	0.050	80
434	0.292	471
436	0.784	1265
438	1.584	2555
440	2.756	4447
442	4.416	7124
444	6.707	10821
446	9.761	15747
448	13.615	21965
450	18.264	29466
452	23.727	38280
454	30.138	48623
456	37.624	60700
458	45.751	73811
460	53.877	86922

WASTE MANAGEMENT OF TEXAS, INC.
Skyline Landfill
Pond Data for HEC-HMS
I-19

Reservoir

Description:	
Downstream:	J06
Method:	Outflow Structures
Storage Method:	Elevation-Storage
Elev-Stor Function:	I-19
Initial Condition:	Inflow = Outflow
Main Tailwater:	Assume None
Auxiliary:	--None--
Time Step Method:	Automatic Adaption
Outlets:	1
Spillways:	1
Dam Tops:	0
Pumps:	0
Dam Break:	No
Dam Seepage:	No
Release:	No
Evaporation:	No

Outlet

Method:	Culvert Outlet
Direction:	Main
Number Barrels:	1
Solution Method:	Automatic
Shape:	Circular
Chart:	1: Concrete Pipe Culvert
Scale:	1: Square edge entrance with headwall
Length:	260 ft
Diameter:	4 ft
Inlet Elevation:	458 ft
Entrance Coefficient:	0.5
Outlet Elevation:	455
Exit Coefficient:	1
Mannings n:	0.013

Spillway

Method:	Broad-Crested Spillway
Direction:	Main
Elevation:	476 ft
Length:	60 ft
Coefficient:	2.6
Gates:	0

Dam Tops

Method:	
Direction:	
Elevation:	
Length:	
Coefficient:	

Paired Data

Elevation Storage Functions
I-19

Elevation (ft)	Storage (ac-ft)	Storage (cy)
458	0.000	0
460	0.218	351
462	0.793	1280
464	1.775	2864
466	3.394	5475
468	5.582	9005
470	8.284	13365
472	11.517	18581
474	15.436	24903
476	19.837	32003
478	24.237	39103

WASTE MANAGEMENT OF TEXAS, INC.
Skyline Landfill
Pond Data for HEC-HMS
I-48

Reservoir

Description:	
Downstream:	CP-18
Method:	Outflow Structures
Storage Method:	Elevation-Storage
Elev-Stor Function:	I-48
Initial Condition:	Inflow = Outflow
Main Tailwater:	Assume None
Auxiliary:	--None--
Time Step Method:	Automatic Adaption
Outlets:	1
Spillways:	1
Dam Tops:	0
Pumps:	0
Dam Break:	No
Dam Seepage:	No
Release:	No
Evaporation:	No

Outlet

Method:	Culvert Outlet
Direction:	Main
Number Barrels:	1
Solution Method:	Automatic
Shape:	Circular
Chart:	1: Concrete Pipe Culvert
Scale:	3: Pipe projecting from fill
Length:	29 ft
Diameter:	4 ft
Inlet Elevation:	468 ft
Entrance Coefficient:	0.8
Outlet Elevation:	468
Exit Coefficient:	1
Mannings n:	0.013

Spillway

Method:	Broad-Crested Spillway
Direction:	Main
Elevation:	474 ft
Length:	100 ft
Coefficient:	2.6
Gates:	0

Dam Tops

Method:	
Direction:	
Elevation:	
Length:	
Coefficient:	

Paired Data

Elevation Storage Functions
I-48

Elevation (ft)	Storage (ac-ft)	(cy)
468	0.000	0
472	0.001	1
474	0.660	1,064
476	4.341	7,003

WASTE MANAGEMENT OF TEXAS, INC.
Skyline Landfill
Pond Data for HEC-HMS
I-49

Reservoir

Description:	
Downstream:	I-48
Method:	Outflow Structures
Storage Method:	Elevation-Storage
Elev-Stor Function:	I-49
Initial Condition:	Inflow = Outflow
Main Tailwater:	Assume None
Auxiliary:	--None--
Time Step Method:	Automatic Adaption
Outlets:	1
Spillways:	0
Dam Tops:	0
Pumps:	0
Dam Break:	No
Dam Seepage:	No
Release:	No
Evaporation:	No

Outlet

Method:	Culvert Outlet	
Direction:	Main	
Number Barrels:	2	
Solution Method:	Automatic	
Shape:	Circular	
Chart:	1: Concrete Pipe Culvert	
Scale:	3: Pipe projecting from fill	
Length:	280	ft
Diameter:	3	ft
Inlet Elevation:	475	ft
Entrance Coefficient:	0.8	
Outlet Elevation:	474	
Exit Coefficient:	1	
Mannings n:	0.013	

Spillway

Method:	
Direction:	
Elevation:	ft
Length:	ft
Coefficient:	
Gates:	

Dam Tops

Method:	
Direction:	
Elevation:	
Length:	
Coefficient:	

Paired Data

Elevation Storage Functions
I-49

Elevation (ft)	Storage (ac-ft)	(cy)
474	0.000	0
476	0.425	686
478	3.482	5,618
480	10.499	16,939

WASTE MANAGEMENT OF TEXAS, INC.
Skyline Landfill
Pond Data for HEC-HMS
I-OS13

Reservoir

Description:	
Downstream:	I-OS14
Method:	Outflow Structures
Storage Method:	Elevation-Storage
Elev-Stor Function:	I-OS13
Initial Condition:	Inflow = Outflow
Main Tailwater:	Assume None
Auxiliary:	R-OS15
Time Step Method:	Automatic Adaption
Outlets:	1
Spillways:	0
Dam Tops:	0
Pumps:	0
Dam Break:	No
Dam Seepage:	No
Release:	No
Evaporation:	No

Outlet

Method:	Culvert Outlet
Direction:	Main
Number Barrels:	1
Solution Method:	Automatic
Shape:	Circular
Chart:	2: Corrugated Metal Pipe
Scale:	1: Headwall
Length:	64 ft
Diameter:	3 ft
Inlet Elevation:	444 ft
Entrance Coefficient:	0.5
Outlet Elevation:	442
Exit Coefficient:	1
Mannings n:	0.015

Spillway

Method:	Broad-Crested Spillway
Direction:	Auxiliary
Elevation:	448 ft
Length:	10 ft
Coefficient:	2.6
Gates:	0

Dam Tops

Method:	
Direction:	
Elevation:	
Length:	
Coefficient:	

Paired Data

Elevation Storage Functions
I-OS13

Elevation (ft)	Storage (ac-ft)	(cy)
444	0.018	29
446	0.085	137
448	0.463	747
450	1.665	2687
452	3.353	5409

WASTE MANAGEMENT OF TEXAS, INC.
Skyline Landfill
Pond Data for HEC-HMS
I-OS14

Reservoir

Description:	
Downstream:	OH75.1
Method:	Outflow Structures
Storage Method:	Elevation-Storage
Elev-Stor Function:	I-OS14
Initial Condition:	Inflow = Outflow
Main Tailwater:	Assume None
Auxiliary:	--None--
Time Step Method:	Automatic Adaption
Outlets:	1
Spillways:	1
Dam Tops:	0
Pumps:	0
Dam Break:	No
Dam Seepage:	No
Release:	No
Evaporation:	No

Outlet

Method:	Culvert Outlet
Direction:	Main
Number Barrels:	1
Solution Method:	Automatic
Shape:	Box
Chart:	8: Flared Wingwalls
Scale:	1: Wingwalls Flared 30 to 75 degrees
Length:	34 ft
Rise:	2 ft
Span:	3 ft
Inlet Elevation:	442 ft
Entrance Coefficient:	0.5
Outlet Elevation:	442
Exit Coefficient:	1
Mannings n:	0.013

Spillway

Method:	Broad-Crested Spillway
Direction:	Main
Elevation:	443 ft
Length:	100 ft
Coefficient:	2.6
Gates:	0

Dam Tops

Method:	
Direction:	
Elevation:	
Length:	
Coefficient:	

Paired Data

Elevation Storage Functions
I-OS14

Elevation (ft)	Storage (ac-ft)	(cy)
440	0.002	3
442	0.051	82
444	0.180	290

WASTE MANAGEMENT OF TEXAS, INC.
Skyline Landfill
Pond Data for HEC-HMS
I-OS15

Reservoir

Description:	
Downstream:	I-OS16
Method:	Outflow Structures
Storage Method:	Elevation-Storage
Elev-Stor Function:	I-OS15
Initial Condition:	Inflow = Outflow
Main Tailwater:	Assume None
Auxiliary:	R-OS17
Time Step Method:	Automatic Adaption
Outlets:	1
Spillways:	0
Dam Tops:	0
Pumps:	0
Dam Break:	No
Dam Seepage:	No
Release:	No
Evaporation:	No

Outlet

Method:	Culvert Outlet
Direction:	Main
Number Barrels:	1
Solution Method:	Automatic
Shape:	Box
Chart:	10: 90 degree headwall
Scale:	1: Inlets chamfered 3/4-inch
Length:	50 ft
Rise:	2 ft
Span:	2 ft
Inlet Elevation:	432
Entrance Coefficient:	0.5
Outlet Elevation:	430
Exit Coefficient:	1
Mannings n:	0.013

Spillway

Method:	Broad-Crested Spillway
Direction:	Auxiliary
Elevation:	438 ft
Length:	10 ft
Coefficient:	2.6
Gates:	

Dam Tops

Method:	
Direction:	
Elevation:	
Length:	
Coefficient:	

Paired Data

Elevation Storage Functions
I-OS15

Elevation (ft)	Storage (ac-ft)	(cy)
432	0.001	2
434	0.025	40.9
436	0.118	190.9
438	0.339	546.9
440	0.660	1064.9

WASTE MANAGEMENT OF TEXAS, INC.
Skyline Landfill
Pond Data for HEC-HMS
I-OS16

Reservoir

Description:	
Downstream:	OH75.2
Method:	Outflow Structures
Storage Method:	Elevation-Storage
Elev-Stor Function:	I-OS16
Initial Condition:	Inflow = Outflow
Main Tailwater:	Assume None
Auxiliary:	--None--
Time Step Method:	Automatic Adaption
Outlets:	1
Spillways:	1
Dam Tops:	0
Pumps:	0
Dam Break:	No
Dam Seepage:	No
Release:	No
Evaporation:	No

Outlet

Method:	Culvert Outlet
Direction:	Main
Number Barrels:	1
Solution Method:	Automatic
Shape:	Circular
Chart:	2: Corrugated Metal Pipe
Scale:	3: Pipe projecting from fill
Length:	65 ft
Diameter:	2 ft
Inlet Elevation:	426 ft
Entrance Coefficient:	0.5
Outlet Elevation:	426
Exit Coefficient:	1
Mannings n:	0.013

Spillway

Method:	Broad-Crested Spillway
Direction:	Main
Elevation:	430 ft
Length:	100 ft
Coefficient:	2.6
Gates:	0

Dam Tops

Method:	
Direction:	
Elevation:	
Length:	
Coefficient:	

Paired Data

Elevation Storage Functions
I-OS16

Elevation (ft)	Storage (ac-ft)	(cy)
426	0.000	0
428	0.009	14.6
430	0.037	59.9
432	0.065	105.2

WASTE MANAGEMENT OF TEXAS, INC.
Skyline Landfill
Pond Data for HEC-HMS
I-OS17

Reservoir

Description:	
Downstream:	I-OS18
Method:	Outflow Structures
Storage Method:	Elevation-Storage
Elev-Stor Function:	I-OS17
Initial Condition:	Inflow = Outflow
Main Tailwater:	Assume None
Auxiliary:	--None--
Time Step Method:	Automatic Adaption
Outlets:	1
Spillways:	0
Dam Tops:	0
Pumps:	0
Dam Break:	No
Dam Seepage:	No
Release:	No
Evaporation:	No

Outlet

Method:	Culvert Outlet
Direction:	Main
Number Barrels:	1
Solution Method:	Automatic
Shape:	Box
Chart:	10: 90 degree headwall
Scale:	1: Inlets chamfered 3/4-inch
Length:	50 ft
Rise:	2 ft
Span:	2 ft
Inlet Elevation:	430
Entrance Coefficient:	0.5
Outlet Elevation:	428
Exit Coefficient:	1
Mannings n:	0.013

Spillway

Method:	
Direction:	
Elevation:	ft
Length:	ft
Coefficient:	
Gates:	

Dam Tops

Method:	
Direction:	
Elevation:	
Length:	
Coefficient:	

Paired Data

Elevation Storage Functions
I-OS17

Elevation (ft)	Storage (ac-ft)	(cy)
428	0.000	0
430	0.004	6
432	0.030	48
434	0.203	328

WASTE MANAGEMENT OF TEXAS, INC.
Skyline Landfill
Pond Data for HEC-HMS
I-OS18

Reservoir

Description:	
Downstream:	OH75.3
Method:	Outflow Structures
Storage Method:	Elevation-Storage
Elev-Stor Function:	I-OS18
Initial Condition:	Inflow = Outflow
Main Tailwater:	Assume None
Auxiliary:	--None--
Time Step Method:	Automatic Adaption
Outlets:	1
Spillways:	1
Dam Tops:	0
Pumps:	0
Dam Break:	No
Dam Seepage:	No
Release:	No
Evaporation:	No

Outlet

Method:	Culvert Outlet
Direction:	Main
Number Barrels:	1
Solution Method:	Automatic
Shape:	Circular
Chart:	2: Corrugated Metal Pipe
Scale:	3: Pipe projecting from fill
Length:	76 ft
Diameter:	2 ft
Inlet Elevation:	424 ft
Entrance Coefficient:	0.5
Outlet Elevation:	421
Exit Coefficient:	1
Mannings n:	0.013

Spillway

Method:	Broad-Crested Spillway
Direction:	Main
Elevation:	425 ft
Length:	100 ft
Coefficient:	2.6
Gates:	0

Dam Tops

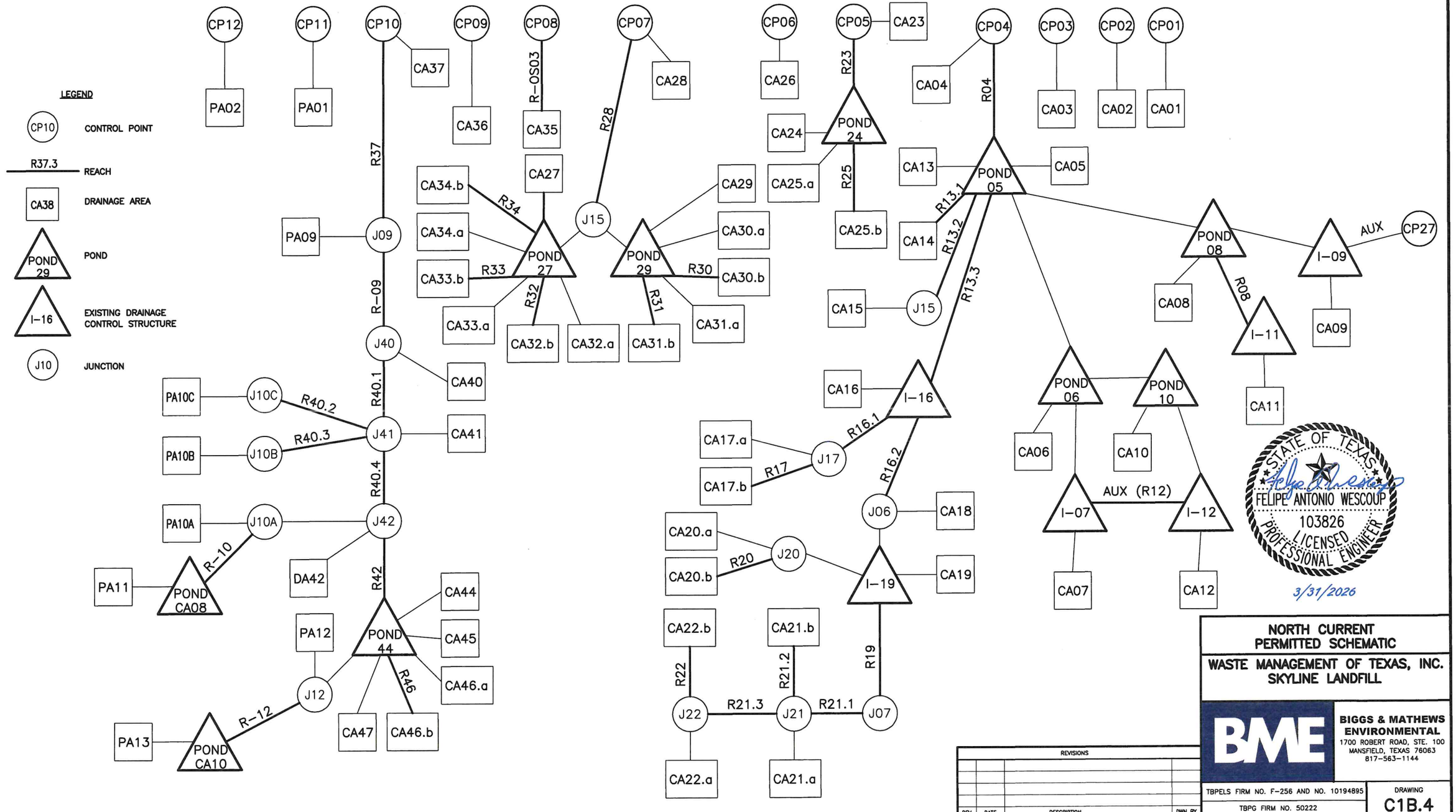
Method:	
Direction:	
Elevation:	
Length:	
Coefficient:	

Paired Data

Elevation Storage Functions
I-OS18

Elevation (ft)	Storage (ac-ft)	(cy)
424	0.004	6
426	0.127	205

CURRENT PERMITTED HYDROLOGIC ANALYSIS
25-YEAR, 24-HOUR STORM EVENT



STATE OF TEXAS
FELIPE ANTONIO WESCOUP
103826
LICENSED PROFESSIONAL ENGINEER
3/31/2026

NORTH CURRENT PERMITTED SCHEMATIC

WASTE MANAGEMENT OF TEXAS, INC.
SKYLINE LANDFILL

BIGGS & MATHEWS ENVIRONMENTAL
1700 ROBERT ROAD, STE. 100
MANSFIELD, TEXAS 76063
817-563-1144

TBPELS FIRM NO. F-256 AND NO. 10194895
TBPG FIRM NO. 50222

DRAWING C1B.4

REV	DATE	DESCRIPTION	DWN BY

REVISIONS

O:\Waste Management\Skyline\Solid Waste\P\Drawings\Part III\Att. C\C1B.4-CurDrngGraph.dwg Layout: C1B.3 User: awhite

	Project:	2025 Skyline	Simulation Run:	North CP
	Start of Run:	11Jul2025, 00:00	Basin Model:	North CP
	End of Run:	16Jul2025, 00:00	Meteorologic Model:	25-Year
	Compute Time:	13Aug2025, 11:13:33	Control Specifications	Control 1

Hydrologic Element	Drainage Area (MI^2)	Peak Discharge (CFS)	Time of Peak	Volume (ACRE-FT)
Aux (R12)	0	0	10 July 2025, 24:00	0
CA01	0.0341	61.9	11 July 2025, 12:35	10.2
CA02	0.0062	15.1	11 July 2025, 12:25	1.9
CA03	0.0019	5.8	11 July 2025, 12:15	0.6
CA04	0.0194	47.1	11 July 2025, 12:20	5.8
CA05	0.0161	40.7	11 July 2025, 12:25	5.3
CA06	0.0224	57.3	11 July 2025, 12:20	7.3
CA07	0.001	2.2	11 July 2025, 12:30	0.3
CA08	0.01	20.6	11 July 2025, 12:35	3.2
CA09	0.0029	5.5	11 July 2025, 12:35	0.9
CA10	0.0073	24.2	11 July 2025, 12:15	2.5
CA11	0.0227	50.1	11 July 2025, 12:25	6.8
CA12	0.0257	62.5	11 July 2025, 12:20	7.7
CA13	0.027	55.9	11 July 2025, 12:30	8.1
CA14	0.0044	13.6	11 July 2025, 12:15	1.4
CA15	0.0181	51	11 July 2025, 12:20	5.8
CA16	0.0289	67.6	11 July 2025, 12:25	8.7
CA17a	0.025	69.7	11 July 2025, 12:20	8
CA17b	0.0082	16.1	11 July 2025, 12:35	2.5
CA18	0.024	50.4	11 July 2025, 12:30	7.2
CA19	0.0064	14.6	11 July 2025, 12:25	1.9
CA20a	0.0269	75	11 July 2025, 12:20	8.6
CA20b	0.0066	13	11 July 2025, 12:35	2
CA21a	0.0327	89.2	11 July 2025, 12:20	10.4
CA21b	0.005	10	11 July 2025, 12:35	1.5
CA22a	0.0225	61.9	11 July 2025, 12:20	7.2
CA22b	0.0042	8.4	11 July 2025, 12:35	1.3
CA23	0.0175	41.4	11 July 2025, 12:25	5.2
CA24	0.0044	12.2	11 July 2025, 12:20	1.5
CA25a	0.0369	99.6	11 July 2025, 12:20	11.7
CA25b	0.0042	8.1	11 July 2025, 12:35	1.3
CA26	0.0417	89.9	11 July 2025, 12:30	13.3
Ca27	0.0115	18.7	11 July 2025, 12:45	3.7
CA28	0.0229	48.5	11 July 2025, 12:25	6.9
CA29	0.0071	10.5	11 July 2025, 12:50	2.2
CA30a	0.0088	25.8	11 July 2025, 12:20	2.8

CA30b	0.0244	38.5	11 July 2025, 12:45	7.5
CA31a	0.0164	47.5	11 July 2025, 12:20	5.2
CA31b	0.0163	30.3	11 July 2025, 12:35	5
CA32a	0.0215	61.6	11 July 2025, 12:20	6.8
CA32b	0.0126	24	11 July 2025, 12:35	3.9
CA33a	0.0169	50.2	11 July 2025, 12:15	5.4
CA33b	0.0215	36	11 July 2025, 12:40	6.6
CA34a	0.0305	86.5	11 July 2025, 12:20	9.7
CA34b	0.0141	20.7	11 July 2025, 12:50	4.3
CA35	0.0018	6	11 July 2025, 12:15	0.5
CA36	0.0052	13.8	11 July 2025, 12:20	1.6
CA37	0.0283	54.6	11 July 2025, 12:30	8.5
CA40	0.0213	38	11 July 2025, 12:35	6.4
CA41	0.0209	59.8	11 July 2025, 12:20	6.6
CA42	0.0069	14.5	11 July 2025, 12:30	2.1
CA44	0.0106	26.4	11 July 2025, 12:25	3.6
CA45	0.0273	72.9	11 July 2025, 12:20	8.7
CA46a	0.0259	72.3	11 July 2025, 12:20	8.2
CA46b	0.0013	3.2	11 July 2025, 12:25	0.4
CA47	0.0041	8.6	11 July 2025, 12:30	1.2
CP01	0.0341	61.9	11 July 2025, 12:35	10.2
CP02	0.0062	15.1	11 July 2025, 12:25	1.9
CP03	0.0019	5.8	11 July 2025, 12:15	0.6
CP04	0.3674	325.3	11 July 2025, 12:50	93.8
CP05	0.063	88.6	11 July 2025, 12:30	19.7
CP06	0.0417	89.9	11 July 2025, 12:30	13.3
CP07	0.2245	198.8	11 July 2025, 12:45	69.7
CP08	0.0018	5.8	11 July 2025, 12:20	0.5
CP09	0.0052	13.8	11 July 2025, 12:20	1.6
CP10	0.284	337.9	11 July 2025, 12:30	80.5
CP11	0.0471	97.4	11 July 2025, 12:25	14.1
CP12	0.0083	21.2	11 July 2025, 12:20	2.5
CP27	0	0.3	11 July 2025, 12:35	0
I-07	0.001	2.3	11 July 2025, 12:30	0.3
I-09	0.0029	5.3	11 July 2025, 12:35	0.9
I-11	0.0227	44.3	11 July 2025, 12:35	6.8
I-12	0.0257	61.8	11 July 2025, 12:25	7.7
I-16	0.1904	188.3	11 July 2025, 13:15	59.1
I-19	0.1043	159.6	11 July 2025, 12:40	32.8
JOS03	0.0084	21.5	11 July 2025, 12:20	2.5
J07	0.0644	159.1	11 July 2025, 12:25	20.4
J09	0.2557	284.3	11 July 2025, 12:30	72
J10a	0.058	49.2	11 July 2025, 12:25	11.3
J10b	0.0016	4.9	11 July 2025, 12:15	0.5

J10c	0.0016	4.6	11 July 2025, 12:20	0.5
J12	0.0293	57.5	11 July 2025, 12:30	8.5
J15	0.2016	176.3	11 July 2025, 13:10	62.9
J15.1	0.0181	51	11 July 2025, 12:20	5.8
J17	0.0332	81.9	11 July 2025, 12:20	10.5
J18	0.1283	204.2	11 July 2025, 12:35	40
J20	0.0335	84.9	11 July 2025, 12:20	10.6
J21	0.0644	162.6	11 July 2025, 12:20	20.4
J22	0.0267	68.4	11 July 2025, 12:20	8.4
J40	0.2088	184.4	11 July 2025, 12:25	58
J41	0.1875	151.3	11 July 2025, 12:25	51.6
J42	0.1634	94.5	11 July 2025, 12:25	44
OS03	0.0066	16	11 July 2025, 12:25	2
PA01	0.0471	97.4	11 July 2025, 12:25	14.1
PA02	0.0083	21.2	11 July 2025, 12:20	2.5
PA09	0.0469	108.5	11 July 2025, 12:25	14
PA10a	0.0215	49.2	11 July 2025, 12:25	6.4
PA10b	0.0016	4.9	11 July 2025, 12:15	0.5
PA10c	0.0016	4.6	11 July 2025, 12:20	0.5
PA11	0.0365	77.3	11 July 2025, 12:30	11.4
PA12	0.0111	24.6	11 July 2025, 12:25	3.3
PA13	0.0182	35.5	11 July 2025, 12:30	5.5
Pond CA08	0.0365	12.9	11 July 2025, 13:55	4.9
Pond CA10	0.0182	35.3	11 July 2025, 12:35	5.2
Pond05	0.348	306.9	11 July 2025, 12:55	88
Pond06	0.0564	0	10 July 2025, 24:00	0
Pond08	0.0356	55.8	11 July 2025, 12:50	8.4
Pond10	0.033	0	10 July 2025, 24:00	0
Pond24	0.0455	59.3	11 July 2025, 12:45	14.5
Pond27	0.1286	112.6	11 July 2025, 13:05	40.3
Pond29	0.073	63.9	11 July 2025, 13:10	22.6
Pond44	0.0985	39.6	11 July 2025, 13:35	30.6
R-OS03	0.0018	5.8	11 July 2025, 12:20	0.5
R04	0.348	306.8	11 July 2025, 12:55	88
R08	0.0227	43.7	11 July 2025, 12:35	6.8
R09	0.2088	184.3	11 July 2025, 12:30	57.9
R10	0.0365	12.9	11 July 2025, 13:55	4.9
R12	0.0182	35.1	11 July 2025, 12:35	5.2
R13.1	0.0044	13.4	11 July 2025, 12:20	1.4
R13.2	0.0181	49.6	11 July 2025, 12:25	5.7
R13.3	0.1904	188.2	11 July 2025, 13:20	59.1
R16.1	0.0332	81.1	11 July 2025, 12:20	10.5
R16.2	0.1283	203.7	11 July 2025, 12:35	40
R17	0.0082	16.1	11 July 2025, 12:35	2.5

R19	0.0644	158.3	11 July 2025, 12:25	20.4
R20	0.0066	12.9	11 July 2025, 12:35	2
R21.1	0.0644	159.1	11 July 2025, 12:25	20.4
R21.2	0.005	10	11 July 2025, 12:35	1.5
R21.3	0.0267	66.4	11 July 2025, 12:25	8.4
R22	0.0042	8.4	11 July 2025, 12:35	1.3
R23	0.0455	59.2	11 July 2025, 12:45	14.5
R25	0.0042	8	11 July 2025, 12:35	1.3
R28	0.2016	176.2	11 July 2025, 13:10	62.9
R30	0.0244	38.4	11 July 2025, 12:45	7.5
R31	0.0163	30.2	11 July 2025, 12:35	5
R32	0.0126	23.9	11 July 2025, 12:35	3.9
R33	0.0215	35.9	11 July 2025, 12:40	6.6
R34	0.0141	20.6	11 July 2025, 12:50	4.3
R37	0.2557	283.3	11 July 2025, 12:30	72
R40.1	0.1875	151.1	11 July 2025, 12:25	51.6
R40.2	0.0016	4.5	11 July 2025, 12:20	0.5
R40.3	0.0016	4.7	11 July 2025, 12:20	0.5
R40.4	0.1634	94.2	11 July 2025, 12:30	44
R42	0.0985	39.6	11 July 2025, 13:40	30.6
R46	0.0013	3.2	11 July 2025, 12:25	0.4

Project: 2025 Skyline Simulation Run: North CP

Reservoir: Pond05

Start of Run:	11Jul2025, 00:00	Basin Model:	North CP
End of Run:	16Jul2025, 00:00	Meteorologic Model:	25-Years
Compute Time:	13Aug2025, 11:13:33	Control Specifications:	Control 01

Volume Units: ACRE-FT

Computed Results

Peak Inflow:	343.3 (CFS)	Date/Time of Peak Inflow:	11Jul2025, 12:30
Peak Discharge:	306.9 (CFS)	Date/Time of Peak Discharge:	11Jul2025, 12:55
Inflow Volume:	88.0 (ACRE-FT)	Peak Storage:	110.8 (ACRE-FT)
Discharge Volume:	88.0 (ACRE-FT)	Peak Elevation:	414.1 (FT)

Project: 2025 Skyline Simulation Run: North CP

Reservoir: Pond06

Start of Run:	11Jul2025, 00:00	Basin Model:	North CP
End of Run:	16Jul2025, 00:00	Meteorologic Model:	25-Years
Compute Time:	13Aug2025, 11:13:33	Control Specifications:	Control 01

Volume Units: ACRE-FT

Computed Results

Peak Inflow:	59.1 (CFS)	Date/Time of Peak Inflow:	11Jul2025, 12:20
Peak Discharge:	0.0 (CFS)	Date/Time of Peak Discharge:	11Jul2025, 00:00
Inflow Volume:	7.6 (ACRE-FT)	Peak Storage:	45.6 (ACRE-FT)
Discharge Volume:	0.0 (ACRE-FT)	Peak Elevation:	426.3 (FT)

Project: 2025 Skyline Simulation Run: North CP

Reservoir: Pond08

Start of Run:	11Jul2025, 00:00	Basin Model:	North CP
End of Run:	16Jul2025, 00:00	Meteorologic Model:	25-Years
Compute Time:	13Aug2025, 11:13:33	Control Specifications:	Control 01

Volume Units: ACRE-FT

Computed Results

Peak Inflow:	69.6 (CFS)	Date/Time of Peak Inflow:	11Jul2025, 12:35
Peak Discharge:	55.8 (CFS)	Date/Time of Peak Discharge:	11Jul2025, 12:50
Inflow Volume:	10.9 (ACRE-FT)	Peak Storage:	16.1 (ACRE-FT)
Discharge Volume:	8.4 (ACRE-FT)	Peak Elevation:	420.3 (FT)

Project: 2025 Skyline Simulation Run: North CP

Reservoir: Pond10

Start of Run:	11Jul2025, 00:00	Basin Model:	North CP
End of Run:	16Jul2025, 00:00	Meteorologic Model:	25-Years
Compute Time:	13Aug2025, 11:13:33	Control Specifications:	Control 01

Volume Units: ACRE-FT

Computed Results

Peak Inflow:	80.9 (CFS)	Date/Time of Peak Inflow:	11Jul2025, 12:20
Peak Discharge:	0.0 (CFS)	Date/Time of Peak Discharge:	11Jul2025, 00:00
Inflow Volume:	10.2 (ACRE-FT)	Peak Storage:	26.0 (ACRE-FT)
Discharge Volume:	0.0 (ACRE-FT)	Peak Elevation:	429.4 (FT)

Project: 2025 Skyline Simulation Run: North CP

Reservoir: Pond24

Start of Run:	11Jul2025, 00:00	Basin Model:	North CP
End of Run:	16Jul2025, 00:00	Meteorologic Model:	25-Years
Compute Time:	13Aug2025, 11:13:33	Control Specifications:	Control 01

Volume Units: ACRE-FT

Computed Results

Peak Inflow:	117.6 (CFS)	Date/Time of Peak Inflow:	11Jul2025, 12:20
Peak Discharge:	59.3 (CFS)	Date/Time of Peak Discharge:	11Jul2025, 12:45
Inflow Volume:	14.5 (ACRE-FT)	Peak Storage:	4.8 (ACRE-FT)
Discharge Volume:	14.5 (ACRE-FT)	Peak Elevation:	433.2 (FT)

Project: 2025 Skyline Simulation Run: North CP

Reservoir: Pond27

Start of Run:	11Jul2025, 00:00	Basin Model:	North CP
End of Run:	16Jul2025, 00:00	Meteorologic Model:	25-Years
Compute Time:	13Aug2025, 11:13:33	Control Specifications:	Control 01

Volume Units: ACRE-FT

Computed Results

Peak Inflow:	263.0 (CFS)	Date/Time of Peak Inflow:	11Jul2025, 12:20
Peak Discharge:	112.6 (CFS)	Date/Time of Peak Discharge:	11Jul2025, 13:05
Inflow Volume:	40.3 (ACRE-FT)	Peak Storage:	12.5 (ACRE-FT)
Discharge Volume:	40.3 (ACRE-FT)	Peak Elevation:	422.8 (FT)

Project: 2025 Skyline Simulation Run: North CP

Reservoir: Pond29

Start of Run:	11Jul2025, 00:00	Basin Model:	North CP
End of Run:	16Jul2025, 00:00	Meteorologic Model:	25-Years
Compute Time:	13Aug2025, 11:13:33	Control Specifications:	Control 01

Volume Units: ACRE-FT

Computed Results

Peak Inflow:	125.7 (CFS)	Date/Time of Peak Inflow:	11Jul2025, 12:20
Peak Discharge:	63.9 (CFS)	Date/Time of Peak Discharge:	11Jul2025, 13:10
Inflow Volume:	22.7 (ACRE-FT)	Peak Storage:	7.1 (ACRE-FT)
Discharge Volume:	22.6 (ACRE-FT)	Peak Elevation:	420.2 (FT)

Project: 2025 Skyline Simulation Run: North CP

Reservoir: Pond44

Start of Run:	11Jul2025, 00:00	Basin Model:	North CP
End of Run:	16Jul2025, 00:00	Meteorologic Model:	25-Years
Compute Time:	13Aug2025, 11:13:33	Control Specifications:	Control 01

Volume Units: ACRE-FT

Computed Results

Peak Inflow:	228.4 (CFS)	Date/Time of Peak Inflow:	11Jul2025, 12:20
Peak Discharge:	39.6 (CFS)	Date/Time of Peak Discharge:	11Jul2025, 13:35
Inflow Volume:	30.6 (ACRE-FT)	Peak Storage:	13.7 (ACRE-FT)
Discharge Volume:	30.6 (ACRE-FT)	Peak Elevation:	469.2 (FT)

Project: 2025 Skyline Simulation Run: North CP

Reservoir: Pond CA08

Start of Run:	11Jul2025, 00:00	Basin Model:	North CP
End of Run:	16Jul2025, 00:00	Meteorologic Model:	25-Years
Compute Time:	13Aug2025, 11:13:33	Control Specifications:	Control 01

Volume Units: ACRE-FT

Computed Results

Peak Inflow:	77.3 (CFS)	Date/Time of Peak Inflow:	11Jul2025, 12:30
Peak Discharge:	12.9 (CFS)	Date/Time of Peak Discharge:	11Jul2025, 13:55
Inflow Volume:	11.4 (ACRE-FT)	Peak Storage:	15.1 (ACRE-FT)
Discharge Volume:	4.9 (ACRE-FT)	Peak Elevation:	462.5 (FT)

Project: 2025 Skyline Simulation Run: North CP

Reservoir: Pond CA10

Start of Run:	11Jul2025, 00:00	Basin Model:	North CP
End of Run:	16Jul2025, 00:00	Meteorologic Model:	25-Years
Compute Time:	13Aug2025, 11:13:33	Control Specifications:	Control 01

Volume Units: ACRE-FT

Computed Results

Peak Inflow:	35.5 (CFS)	Date/Time of Peak Inflow:	11Jul2025, 12:30
Peak Discharge:	35.3 (CFS)	Date/Time of Peak Discharge:	11Jul2025, 12:35
Inflow Volume:	5.5 (ACRE-FT)	Peak Storage:	1.8 (ACRE-FT)
Discharge Volume:	5.2 (ACRE-FT)	Peak Elevation:	477.7 (FT)

Project: 2025 Skyline Simulation Run: North CP

Reservoir: I-07

Start of Run:	11Jul2025, 00:00	Basin Model:	North CP
End of Run:	16Jul2025, 00:00	Meteorologic Model:	25-Years
Compute Time:	13Aug2025, 11:13:33	Control Specifications:	Control 01

Volume Units: ACRE-FT

Computed Results

Peak Inflow:	2.2 (CFS)	Date/Time of Peak Inflow:	11Jul2025, 12:30
Peak Discharge:	2.3 (CFS)	Date/Time of Peak Discharge:	11Jul2025, 12:30
Inflow Volume:	0.3 (ACRE-FT)	Peak Storage:	0.0 (ACRE-FT)
Discharge Volume:	0.3 (ACRE-FT)	Peak Elevation:	453.3 (FT)

Project: 2025 Skyline Simulation Run: North CP

Reservoir: I-09

Start of Run:	11Jul2025, 00:00	Basin Model:	North CP
End of Run:	16Jul2025, 00:00	Meteorologic Model:	25-Years
Compute Time:	13Aug2025, 11:13:33	Control Specifications:	Control 01

Volume Units: ACRE-FT

Computed Results

Peak Inflow:	5.5 (CFS)	Date/Time of Peak Inflow:	11Jul2025, 12:35
Peak Discharge:	5.3 (CFS)	Date/Time of Peak Discharge:	11Jul2025, 12:35
Inflow Volume:	0.9 (ACRE-FT)	Peak Storage:	0.0 (ACRE-FT)
Discharge Volume:	0.9 (ACRE-FT)	Peak Elevation:	421.5 (FT)

Project: 2025 Skyline Simulation Run: North CP

Reservoir: I-11

Start of Run:	11Jul2025, 00:00	Basin Model:	North CP
End of Run:	16Jul2025, 00:00	Meteorologic Model:	25-Years
Compute Time:	13Aug2025, 11:13:33	Control Specifications:	Control 01

Volume Units: ACRE-FT

Computed Results

Peak Inflow:	50.1 (CFS)	Date/Time of Peak Inflow:	11Jul2025, 12:25
Peak Discharge:	44.3 (CFS)	Date/Time of Peak Discharge:	11Jul2025, 12:35
Inflow Volume:	6.8 (ACRE-FT)	Peak Storage:	0.5 (ACRE-FT)
Discharge Volume:	6.8 (ACRE-FT)	Peak Elevation:	433.4 (FT)

Project: 2025 Skyline Simulation Run: North CP

Reservoir: I-12

Start of Run:	11Jul2025, 00:00	Basin Model:	North CP
End of Run:	16Jul2025, 00:00	Meteorologic Model:	25-Years
Compute Time:	13Aug2025, 11:13:33	Control Specifications:	Control 01

Volume Units: ACRE-FT

Computed Results

Peak Inflow:	62.5 (CFS)	Date/Time of Peak Inflow:	11Jul2025, 12:20
Peak Discharge:	61.8 (CFS)	Date/Time of Peak Discharge:	11Jul2025, 12:25
Inflow Volume:	7.7 (ACRE-FT)	Peak Storage:	0.0 (ACRE-FT)
Discharge Volume:	7.7 (ACRE-FT)	Peak Elevation:	437.5 (FT)

Project: 2025 Skyline Simulation Run: North CP

Reservoir: I-16

Start of Run:	11Jul2025, 00:00	Basin Model:	North CP
End of Run:	16Jul2025, 00:00	Meteorologic Model:	25-Years
Compute Time:	13Aug2025, 11:13:33	Control Specifications:	Control 01

Volume Units: ACRE-FT

Computed Results

Peak Inflow:	331.4 (CFS)	Date/Time of Peak Inflow:	11Jul2025, 12:25
Peak Discharge:	188.3 (CFS)	Date/Time of Peak Discharge:	11Jul2025, 13:15
Inflow Volume:	59.1 (ACRE-FT)	Peak Storage:	10.8 (ACRE-FT)
Discharge Volume:	59.1 (ACRE-FT)	Peak Elevation:	446.6 (FT)

Project: 2025 Skyline Simulation Run: North CP

Reservoir: I-19

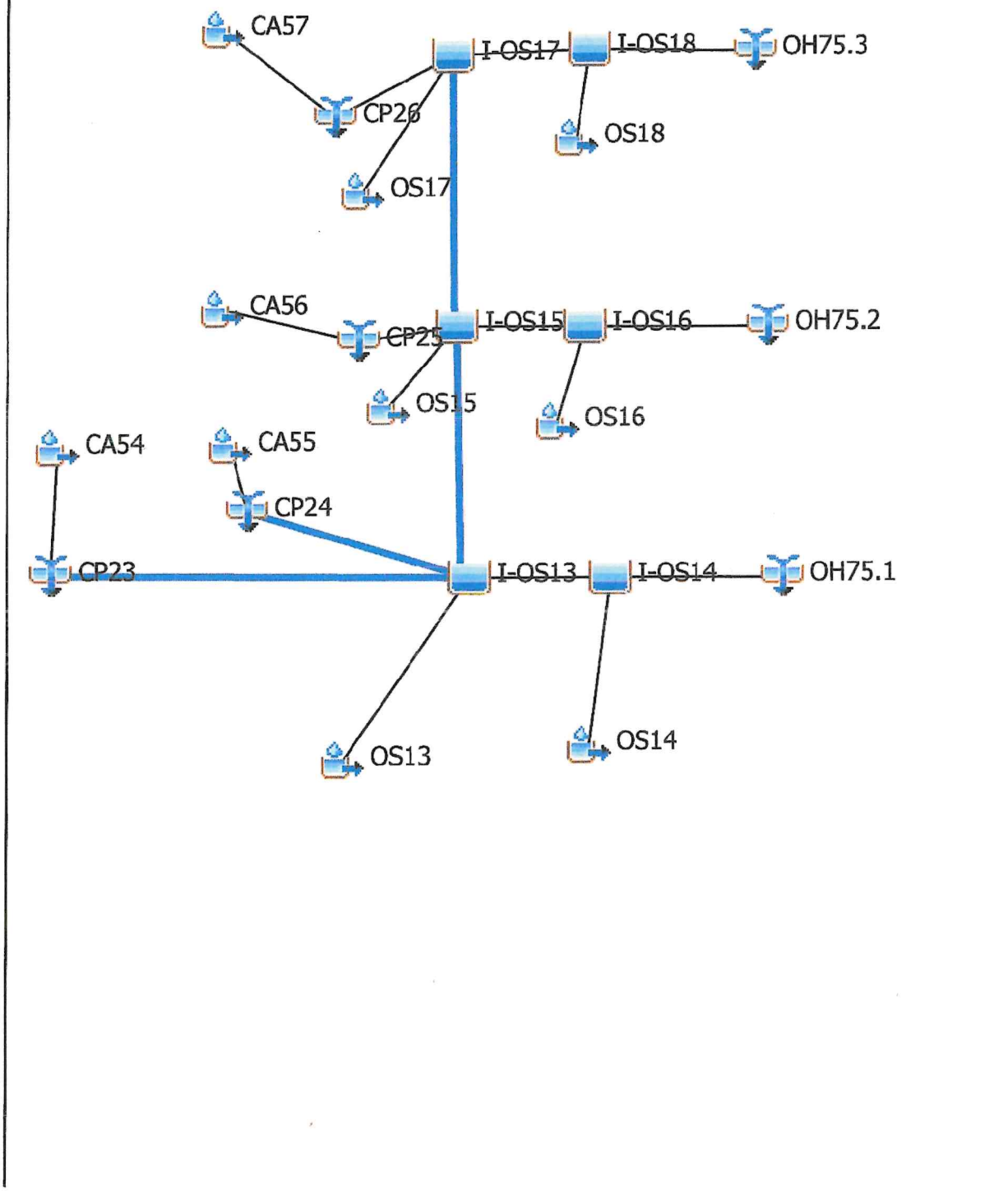
Start of Run:	11Jul2025, 00:00	Basin Model:	North CP
End of Run:	16Jul2025, 00:00	Meteorologic Model:	25-Years
Compute Time:	13Aug2025, 11:13:33	Control Specifications:	Control 01

Volume Units: ACRE-FT

Computed Results

Peak Inflow:	251.4 (CFS)	Date/Time of Peak Inflow:	11Jul2025, 12:25
Peak Discharge:	159.6 (CFS)	Date/Time of Peak Discharge:	11Jul2025, 12:40
Inflow Volume:	32.9 (ACRE-FT)	Peak Storage:	4.6 (ACRE-FT)
Discharge Volume:	32.8 (ACRE-FT)	Peak Elevation:	467.1 (FT)

EAST CURRENT PERMITTED SCHEMATIC



Project:	2025 Skyline	Simulation Run:	East CP
Start of Run:	11Jul2025, 00:00	Basin Model:	East CP
End of Run:	16Jul2025, 00:00	Meteorologic Model:	25-Year
Compute Time:	13Aug2025, 11:13:33	Control Specifications	Control 1

Hydrologic Element	Drainage Area (MI^2)	Peak Discharge (CFS)	Time of Peak	Volume (ACRE-FT)
CA54	0.0058	14.5	11 July 2025, 12:20	1.7
CA55	0.0076	18.6	11 July 2025, 12:20	2.3
CA56	0.0203	40.3	11 July 2025, 12:30	6.1
CA57	0.0025	5.4	11 July 2025, 12:30	0.7
CP23	0.0058	14.5	11 July 2025, 12:20	1.7
CP24	0.0076	18.6	11 July 2025, 12:20	2.3
CP25	0.0203	40.3	11 July 2025, 12:30	6.1
CP26	0.0025	5.4	11 July 2025, 12:30	0.7
I-OS13	0.0387	59.6	11 July 2025, 12:35	11.1
I-OS14	0.0415	65.5	11 July 2025, 12:35	11.9
I-OS15	0.0225	45	11 July 2025, 12:45	7.2
I-OS16	0.025	50	11 July 2025, 12:45	7.9
I-OS17	0.0033	7.1	11 July 2025, 12:30	1
I-OS18	0.0056	11.7	11 July 2025, 12:35	1.7
OH75.1	0.0415	65.5	11 July 2025, 12:35	11.9
OH75.2	0.025	50	11 July 2025, 12:45	7.9
OH75.3	0.0056	11.7	11 July 2025, 12:35	1.7
OS13	0.0253	54.2	11 July 2025, 12:25	7.6
OS14	0.0028	5.6	11 July 2025, 12:30	0.8
OS15	0.0022	4	11 July 2025, 12:40	0.7
OS16	0.0025	5.2	11 July 2025, 12:30	0.7
OS17	0.0008	1.8	11 July 2025, 12:30	0.2
OS18	0.0023	4.7	11 July 2025, 12:30	0.7
R-OS13.1	0.0058	14.3	11 July 2025, 12:25	1.7
R-OS13.2	0.0076	18.6	11 July 2025, 12:25	2.3
R-OS15	0	15	11 July 2025, 12:40	0.5
R-OS17	0	4.3	11 July 2025, 12:50	0

Project: 2025 Skyline Simulation Run: Esat CP

Reservoir: I-OS13

Start of Run:	11Jul2025, 00:00	Basin Model:	East CP
End of Run:	16Jul2025, 00:00	Meteorologic Model:	25-Years
Compute Time:	13Aug2025, 11:12:38	Control Specifications:	Control 01

Volume Units: ACRE-FT

Computed Results

Peak Inflow:	87.1 (CFS)	Date/Time of Peak Inflow:	11Jul2025, 12:25
Peak Discharge:	59.6 (CFS)	Date/Time of Peak Discharge:	11Jul2025, 12:35
Inflow Volume:	11.6 (ACRE-FT)	Peak Storage:	0.9 (ACRE-FT)
Discharge Volume:	11.1 (ACRE-FT)	Peak Elevation:	448.7 (FT)

Project: 2025 Skyline Simulation Run: Esat CP

Reservoir: I-OS14

Start of Run:	11Jul2025, 00:00	Basin Model:	East CP
End of Run:	16Jul2025, 00:00	Meteorologic Model:	25-Years
Compute Time:	13Aug2025, 11:12:38	Control Specifications:	Control 01

Volume Units: ACRE-FT

Computed Results

Peak Inflow:	65.2 (CFS)	Date/Time of Peak Inflow:	11Jul2025, 12:35
Peak Discharge:	65.5 (CFS)	Date/Time of Peak Discharge:	11Jul2025, 12:35
Inflow Volume:	11.9 (ACRE-FT)	Peak Storage:	0.1 (ACRE-FT)
Discharge Volume:	11.9 (ACRE-FT)	Peak Elevation:	443.4 (FT)

Project: 2025 Skyline Simulation Run: Esat CP

Reservoir: I-OS15

Start of Run:	11Jul2025, 00:00	Basin Model:	East CP
End of Run:	16Jul2025, 00:00	Meteorologic Model:	25-Years
Compute Time:	13Aug2025, 11:12:38	Control Specifications:	Control 01

Volume Units: ACRE-FT

Computed Results

Peak Inflow:	54.8 (CFS)	Date/Time of Peak Inflow:	11Jul2025, 12:40
Peak Discharge:	45.0 (CFS)	Date/Time of Peak Discharge:	11Jul2025, 12:45
Inflow Volume:	7.3 (ACRE-FT)	Peak Storage:	0.4 (ACRE-FT)
Discharge Volume:	7.2 (ACRE-FT)	Peak Elevation:	438.3 (FT)

Project: 2025 Skyline Simulation Run: Esat CP

Reservoir: I-OS16

Start of Run:	11Jul2025, 00:00	Basin Model:	East CP
End of Run:	16Jul2025, 00:00	Meteorologic Model:	25-Years
Compute Time:	13Aug2025, 11:12:38	Control Specifications:	Control 01

Volume Units: ACRE-FT

Computed Results

Peak Inflow:	49.1 (CFS)	Date/Time of Peak Inflow:	11Jul2025, 12:45
Peak Discharge:	50.0 (CFS)	Date/Time of Peak Discharge:	11Jul2025, 12:45
Inflow Volume:	7.9 (ACRE-FT)	Peak Storage:	0.0 (ACRE-FT)
Discharge Volume:	7.9 (ACRE-FT)	Peak Elevation:	430.2 (FT)

Project: 2025 Skyline Simulation Run: Esat CP

Reservoir: I-OS17

Start of Run:	11Jul2025, 00:00	Basin Model:	East CP
End of Run:	16Jul2025, 00:00	Meteorologic Model:	25-Years
Compute Time:	13Aug2025, 11:12:38	Control Specifications:	Control 01

Volume Units: ACRE-FT

Computed Results

Peak Inflow:	8.4 (CFS)	Date/Time of Peak Inflow:	11Jul2025, 12:50
Peak Discharge:	7.1 (CFS)	Date/Time of Peak Discharge:	11Jul2025, 12:30
Inflow Volume:	1.0 (ACRE-FT)	Peak Storage:	0.0 (ACRE-FT)
Discharge Volume:	1.0 (ACRE-FT)	Peak Elevation:	431.3 (FT)

Project: 2025 Skyline Simulation Run: Esat CP

Reservoir: I-OS18

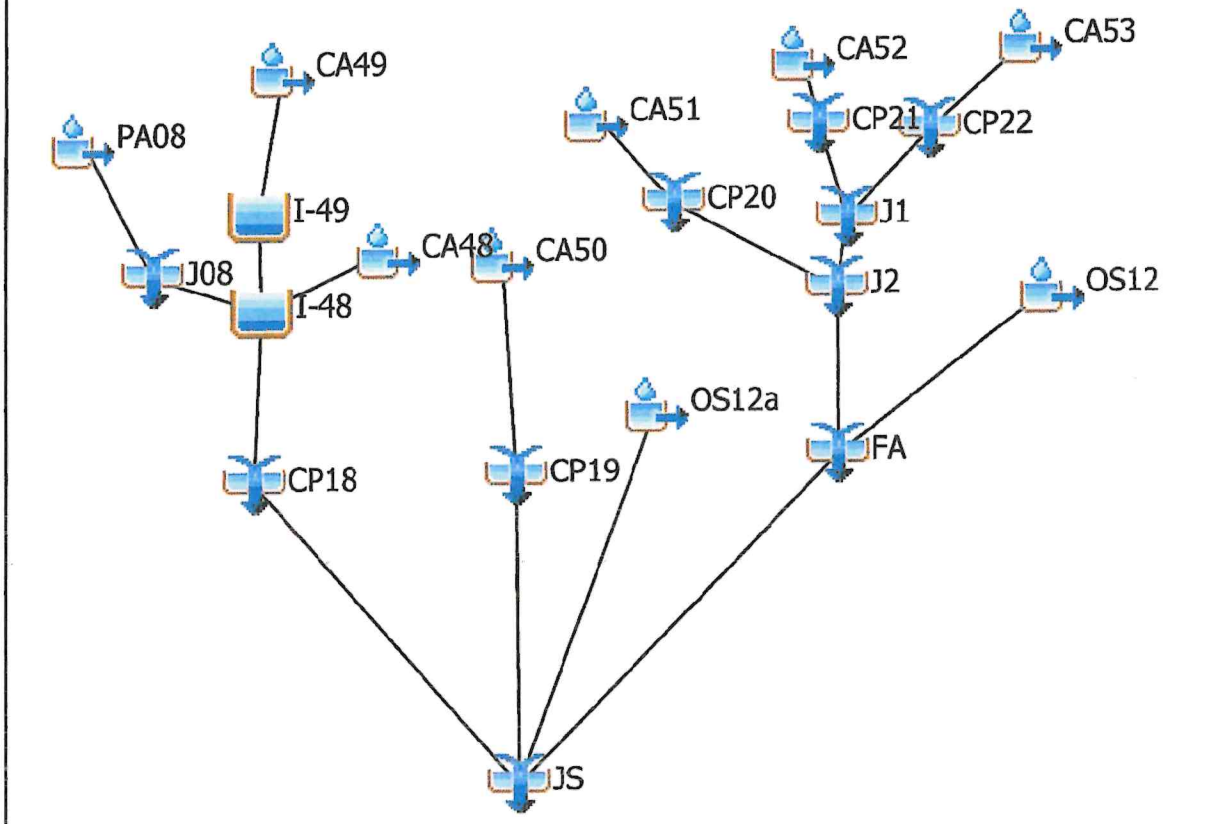
Start of Run:	11Jul2025, 00:00	Basin Model:	East CP
End of Run:	16Jul2025, 00:00	Meteorologic Model:	25-Years
Compute Time:	13Aug2025, 11:12:38	Control Specifications:	Control 01

Volume Units: ACRE-FT

Computed Results

Peak Inflow:	11.8 (CFS)	Date/Time of Peak Inflow:	11Jul2025, 12:30
Peak Discharge:	11.7 (CFS)	Date/Time of Peak Discharge:	11Jul2025, 12:35
Inflow Volume:	1.7 (ACRE-FT)	Peak Storage:	0.1 (ACRE-FT)
Discharge Volume:	1.7 (ACRE-FT)	Peak Elevation:	425.1 (FT)

SOUTH CURRENT PERMITTED SCHEMATIC



Project:	2025 Skyline	Simulation Run:	South CP
Start of Run:	11Jul2025, 00:00	Basin Model:	South CP
End of Run:	16Jul2025, 00:00	Meteorologic Model:	25-Year
Compute Time:	08 Dec2025, 10:22:47	Control Specifications	Control 1

Hydrologic Element	Drainage Area (MI^2)	Peak Discharge (CFS)	Time of Peak	Volume (ACRE-FT)
CA48	0.018	30.3	11 July 2025, 12:40	5.4
CA49	0.0544	88.8	11 July 2025, 12:40	17
CA50	0.0054	12.4	11 July 2025, 12:25	1.6
CA51	0.0112	24.2	11 July 2025, 12:25	3.4
CA52	0.0012	3.3	11 July 2025, 12:20	0.4
CA53	0.0139	32.1	11 July 2025, 12:25	4.2
CP18	0.1011	120.5	11 July 2025, 13:00	31
CP19	0.0054	12.4	11 July 2025, 12:25	1.6
CP20	0.0112	24.2	11 July 2025, 12:25	3.4
CP21	0.0012	3.3	11 July 2025, 12:20	0.4
CP22	0.0139	32.1	11 July 2025, 12:25	4.2
FA	0.1167	209.5	11 July 2025, 12:30	35
I-48	0.1011	120.5	11 July 2025, 13:00	31
I-49	0.0544	60.8	11 July 2025, 13:10	17
JS	0.2235	312.8	11 July 2025, 12:35	67.6
J08	0.0287	48.3	11 July 2025, 12:40	8.6
J1	0.0151	35.1	11 July 2025, 12:25	4.5
J2	0.0263	59.3	11 July 2025, 12:25	7.9
OS12	0.0904	157.9	11 July 2025, 12:35	27.1
OS12a	0.0003	0.7	11 July 2025, 12:30	0.1
PA08	0.0287	48.3	11 July 2025, 12:40	8.6

Project: 2025 Skyline Simulation Run: South CP

Reservoir: I-48

Start of Run:	11Jul2025, 00:00	Basin Model:	South CP
End of Run:	16Jul2025, 00:00	Meteorologic Model:	25-Years
Compute Time:	08Dec2025, 10:22:47	Control Specifications:	Control 01

Volume Units: ACRE-FT

Computed Results

Peak Inflow:	126.6 (CFS)	Date/Time of Peak Inflow:	11Jul2025, 12:50
Peak Discharge:	120.5 (CFS)	Date/Time of Peak Discharge:	11Jul2025, 13:00
Inflow Volume:	31.0 (ACRE-FT)	Peak Storage:	0.8 (ACRE-FT)
Discharge Volume:	31.0 (ACRE-FT)	Peak Elevation:	474.1 (FT)

Project: 2025 Skyline Simulation Run: South CP

Reservoir: I-49

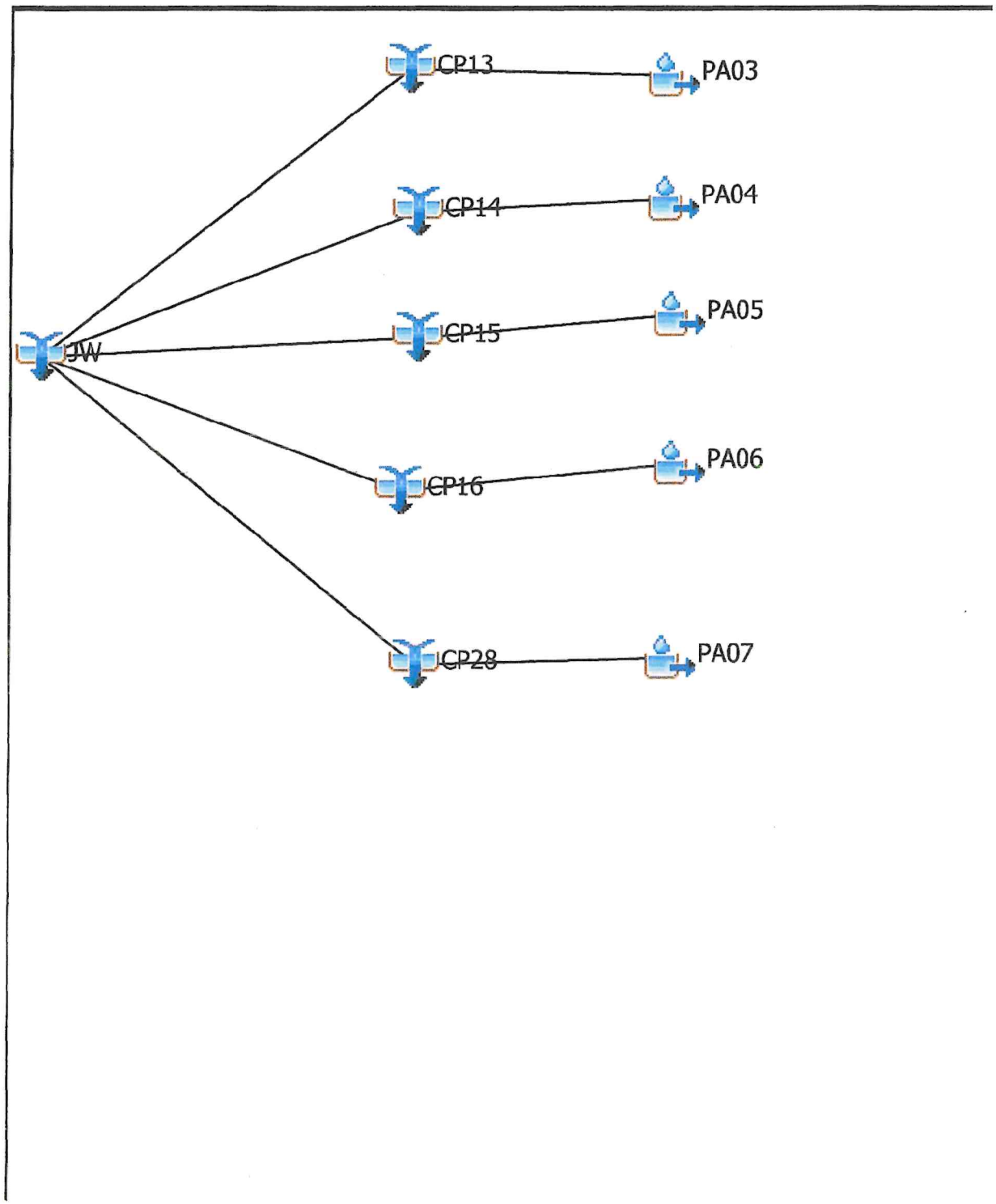
Start of Run:	11Jul2025, 00:00	Basin Model:	South CP
End of Run:	16Jul2025, 00:00	Meteorologic Model:	25-Years
Compute Time:	08Dec2025, 10:22:47	Control Specifications:	Control 01

Volume Units: ACRE-FT

Computed Results

Peak Inflow:	88.8 (CFS)	Date/Time of Peak Inflow:	11Jul2025, 12:40
Peak Discharge:	60.8 (CFS)	Date/Time of Peak Discharge:	11Jul2025, 13:10
Inflow Volume:	17.0 (ACRE-FT)	Peak Storage:	3.6 (ACRE-FT)
Discharge Volume:	17.0 (ACRE-FT)	Peak Elevation:	478.0 (FT)

WEST CURRENT PERMITTED SCHEMATIC



Project:	2025 Skyline	Simulation Run:	West CP
Start of Run:	11Jul2025, 00:00	Basin Model:	West CP
End of Run:	16Jul2025, 00:00	Meteorologic Model:	25-Year
Compute Time:	08 Dec2025, 10:23:19	Control Specifications	Control 1

Hydrologic Element	Drainage Area (MI^2)	Peak Discharge (CFS)	Time of Peak	Volume (ACRE-FT)
CP13	0.0014	3.8	11 July 2025, 12:20	0.4
CP14	0.0054	13.4	11 July 2025, 12:20	1.6
CP15	0.0596	121.3	11 July 2025, 12:30	18.6
CP16	0.0043	8.3	11 July 2025, 12:35	1.3
CP28	0.0167	33.5	11 July 2025, 12:30	5
JW	0.0874	177.7	11 July 2025, 12:30	26.9
PA03	0.0014	3.8	11 July 2025, 12:20	0.4
PA04	0.0054	13.4	11 July 2025, 12:20	1.6
PA05	0.0596	121.3	11 July 2025, 12:30	18.6
PA06	0.0043	8.3	11 July 2025, 12:35	1.3
PA07	0.0167	33.5	11 July 2025, 12:30	5

CURRENT PERMITTED VELOCITY SUMMARY

WASTE MANAGEMENT OF TEXAS, INC.
SKYLINE LANDFILL
Current Permitted 25-Year Velocity Calculations at Permit Boundary Comparison Points

Required: Determine the 25-year flow depths and velocities at the permit boundary.

Method: Calculate the flow depths and velocities using Manning's Equation.

Solution:

		Velocity Calculations						
Comparison Point	Q (cfs)	Width[1] (ft)	Bottom Slope[2] (%)	Side Slopes[3] (h:v)	Manning's n	Depth (ft)	Velocity (fps)	Shear Stress (psf)
CP01	61.9	500	10.0	0.0	0.030	**0.05**	**2.26**	**0.34**
CP02	15.1	120	14.0	0.0	0.030	**0.05**	**2.52**	**0.44**
CP03	5.8	200	12.0	0.0	0.030	**0.02**	**1.34**	**0.16**
CP04	325.3	6	9.0	2.0	0.030	**1.90**	**17.53**	**10.64**
CP05	88.6	370	5.0	0.0	0.030	**0.10**	**2.39**	**0.31**
CP06	89.9	365	2.0	0.0	0.030	**0.13**	**1.84**	**0.17**
CP07	198.8	4	3.0	2.0	0.030	**2.24**	**10.50**	**4.19**
CP08	5.8	200	20.0	0.0	0.030	**0.02**	**1.56**	**0.23**
CP09	13.8	15	6.0	0.0	0.030	**0.22**	**4.28**	**0.81**
CP10	337.9	200	11.0	0.0	0.030	**0.26**	**6.61**	**1.76**
CP11	97.4	750	2.0	0.0	0.030	**0.09**	**1.42**	**0.11**
CP12	21.2	250	2.0	0.0	0.030	**0.07**	**1.20**	**0.09**
CP13	3.8	200	6	0	0.030	**0.02**	**0.92**	**0.08**
CP14	13.4	100	7.0	0.0	0.030	**0.06**	**2.09**	**0.28**
CP15	121.3	120	5.0	0.0	0.030	**0.24**	**4.24**	**0.74**
CP16	8.3	500	1.0	0.0	0.030	**0.03**	**0.51**	**0.02**
CP17	51.5	10	4.0	0.0	0.030	**0.71**	**7.23**	**1.78**
CP18	120.5	30	2.0	10.0	0.030	**0.68**	**4.83**	**0.85**
CP19	12.4	15	3.0	5.0	0.030	**0.24**	**3.17**	**0.45**
CP20	24.2	125	2.6	0.0	0.030	**0.11**	**1.80**	**0.17**
CP21	3.3	50	5.0	0.0	0.030	**0.05**	**1.43**	**0.14**
CP22	32.1	600	3.0	0.0	0.030	**0.05**	**1.13**	**0.09**
CP23	14.5	10	10.0	6.0	0.030	**0.23**	**5.47**	**1.45**
CP24	18.6	10	12.0	10.0	0.030	**0.25**	**6.00**	**1.86**
CP25	40.3	10	8.0	2.0	0.030	**0.47**	**7.89**	**2.33**
CP26	5.4	20	5.0	0.0	0.030	**0.11**	**2.50**	**0.34**
CP27	0.3	25	1.0	0.0	0.030	**0.03**	**0.44**	**0.02**
CP28	33.5	500	1.0	0.0	0.030	**0.08**	**0.89**	**0.05**

Notes:

1. Comparison points where surface water runoff enters or exits the permit boundary in established natural or constructed channels; width refers to the bottom width of the channel.
   Comparison points where surface water runoff enters or exits the permit boundary as sheet flow or not well established channels; width refers to the sheet flow width.
2. For channels, bottom slope is the slope of the channel bottom where surface water enters or exits the permit boundary.
   For sheet flow, bottom slope is the slope of the ground where surface water enters or exits the permit boundary.
3. For channels, side slope is the average side slope of the channel where surface water enters or exits the permit boundary.
   For sheet flow, there are no side slopes and are represented by "0" in this table.

CURRENT PERMITTED FLOW AND BOUNDARY ANALYSIS SUMMARY

WASTE MANAGEMENT OF TEXAS, INC.
SKYLINE LANDFILL

Current Permitted Flow Summary

Watershed Name	Drainage Area (Ac)	Drainage Area (mi^2)	25-Year Peak Flow (cfs)	25-Year Volume (Ac-ft)
CA1	21.8	0.0341	61.9	10.20
CA2	4.0	0.0062	15.1	1.90
CA3	1.2	0.0019	5.8	0.60
CA4	12.4	0.0194	47.1	5.80
CA5	10.3	0.0161	40.7	5.30
CA6	14.3	0.0224	57.3	7.30
CA7	0.7	0.0010	2.2	0.30
CA8	6.4	0.0100	20.6	3.20
CA9	1.9	0.0029	5.5	0.90
CA10	4.7	0.0073	24.2	2.50
CA11	14.5	0.0227	50.1	6.80
CA12	16.4	0.0257	62.5	7.70
CA13	17.3	0.0270	55.9	8.10
CA14	2.8	0.0044	13.6	1.40
CA15	11.6	0.0181	51.0	5.80
CA16	18.5	0.0289	67.6	8.70
CA17.A	16.0	0.0250	69.7	8.00
CA17.B	5.3	0.0082	16.1	2.50
CA18	15.4	0.0240	50.4	7.20
CA19	4.1	0.0064	14.6	1.90
CA20.A	17.2	0.0269	75.0	8.60
CA20.B	4.2	0.0066	13.0	2.00
CA21.A	21.0	0.0327	89.2	10.40
CA21.B	3.2	0.0050	10.0	1.50
CA22.A	14.4	0.0225	61.9	7.20
CA22.B	2.7	0.0042	8.4	1.30
CA23	11.2	0.0175	41.4	5.20
CA24	2.8	0.0044	12.2	1.50
CA25.A	23.6	0.0369	99.6	11.70
CA25.B	2.7	0.0042	8.1	1.30
CA26	26.7	0.0417	89.9	13.30
CA27	7.4	0.0115	18.7	3.70
CA28	14.7	0.0229	48.5	6.90
CA29	4.5	0.0071	10.5	2.20
CA30.A	5.6	0.0088	25.8	2.80
CA30.B	15.6	0.0244	38.5	7.50
CA31.A	10.5	0.0164	47.5	5.20
CA31.B	10.4	0.0163	30.3	5.00
CA32.A	13.7	0.0215	61.6	6.80
CA32.B	8.1	0.0126	24.0	3.90
CA33.A	10.8	0.0169	50.2	5.40

WASTE MANAGEMENT OF TEXAS, INC.
SKYLINE LANDFILL

Current Permitted Flow Summary

Watershed Name	Drainage Area (Ac)	Drainage Area (mi^2)	25-Year Peak Flow (cfs)	25-Year Volume (Ac-ft)
CA33.B	13.8	0.0215	36.0	6.60
CA34.A	19.5	0.0305	86.5	9.70
CA34.B	9.0	0.0141	20.7	4.30
CA35	1.1	0.0018	6.0	0.50
CA36	3.3	0.0052	13.8	1.60
CA37	18.1	0.0283	54.6	8.50
CA40	13.6	0.0213	38.0	6.40
CA41	13.4	0.0209	59.8	6.60
CA42	4.4	0.0069	14.5	2.10
CA44	6.8	0.0106	26.4	3.60
CA45	17.5	0.0273	72.9	8.70
CA46.A	16.6	0.0259	72.3	8.20
CA46.B	0.8	0.0013	3.2	0.40
CA47	2.6	0.0041	8.6	1.20
CA48	11.5	0.0180	30.3	5.40
CA49	34.8	0.0544	88.8	17.00
CA50	3.5	0.0054	12.4	1.60
CA51	7.2	0.0112	24.2	3.40
CA52	0.7	0.0012	3.3	0.40
CA53	8.9	0.0139	32.1	4.20
CA54	3.7	0.0058	14.5	1.70
CA55	4.8	0.0076	18.6	2.30
CA56	13.0	0.0203	40.3	6.10
CA57	1.6	0.0025	5.4	0.70
PA1	30.2	0.0471	97.4	14.10
PA2	5.3	0.0083	21.2	2.50
PA3	0.9	0.0014	3.8	0.40
PA4	3.5	0.0054	13.4	1.60
PA5	38.2	0.0596	121.3	18.60
PA6	2.7	0.0043	8.3	1.30
PA7	10.7	0.0167	33.5	5.00
PA8	18.4	0.0287	48.3	8.60
PA9	30.0	0.0469	108.5	14.00
PA10.A	13.8	0.0215	49.2	6.40
PA10.B	1.0	0.0016	4.9	0.50
PA10.C	1.0	0.0016	4.6	0.50
PA11	23.4	0.0365	77.3	11.40
PA12	7.1	0.0111	24.6	3.30
PA13	11.6	0.0182	35.5	5.50
OS03	4.2	0.0066	16.0	2.00
OS12	57.8	0.0904	157.9	27.10
OS12.A	0.2	0.0003	0.7	0.10
OS13	16.2	0.0254	54.2	7.60
OS14	1.8	0.0028	5.6	0.80
OS15	1.4	0.0022	4.0	0.70
OS16	1.6	0.0025	5.2	0.70
OS17	0.5	0.0008	1.8	0.20
OS18	1.5	0.0023	4.7	0.70

Current Permitted Boundary Analysis Summary

Comparison Point	Total Contributing Drainage Area (mi^2)	25-Year Flow Rate (cfs)	25-Year Volume (ac-ft)	25-Year Velocity (fps)
CP1	0.0341	61.9	10.2	2.26
CP2	0.0062	15.1	1.9	2.52
CP3	0.0019	5.8	0.6	1.34
CP4	0.3674	325.3	93.8	17.53
CP5	0.0630	88.6	19.7	2.39
CP6	0.0417	89.9	13.3	1.84
CP7	0.2245	198.8	69.7	10.50
CP8	0.0018	5.8	0.5	1.56
CP9	0.0052	13.8	1.6	4.28
CP10	0.2840	337.9	80.5	6.61
CP11	0.0471	97.4	14.1	1.42
CP12	0.0083	21.2	2.5	1.20
CP13	0.0014	3.8	0.4	0.92
CP14	0.0054	13.4	1.6	2.09
CP15	0.0596	121.3	18.6	4.24
CP16	0.0043	8.3	1.3	0.51
CP18	0.1011	120.5	31.0	4.83
CP19	0.0054	12.4	1.6	3.17
CP20	0.0112	24.2	3.4	1.80
CP21	0.0012	3.3	0.4	1.43
CP22	0.0139	32.1	4.2	1.13
CP23	0.0058	14.5	1.7	5.47
CP24	0.0076	18.6	2.3	6.00
CP25	0.0203	40.3	6.1	7.89
CP26	0.0025	5.4	0.7	2.50
CP27	0.0000	0.3	0.0	0.44
CP28	0.0167	33.5	5.0	0.89

ATTACHMENT C1
APPENDIX C1C

POSTDEVELOPMENT HYDROLOGIC CALCULATIONS

CONTENTS

Postdevelopment Narrative C1C.1

Postdevelopment Drainage Area Drawing C1C.4

Postdeveloped Watershed Characteristics C1C.7

Postdevelopment Drainage Structure Design Parameters C1C.14

Postdeveloped Hydrologic Analysis
25-Year, 24-Hour Storm Event C1C.39

Postdeveloped Velocity Summary C1C.74

Postdeveloped Flow and Boundary Analysis Summary C1C.76

POSTDEVELOPMENT NARRATIVE

30 TAC §330.305(a)

The post development hydrologic analysis represents the hydrologic calculations as defined by the landfill completion plan for the Skyline Landfill MSW Permit No. 42E in accordance with §330.305.

POSTDEVELOPMENT DRAINAGE AREA DRAWINGS

The Postdevelopment Drainage Area Summary (Drawing C1C.1) delineates the drainage areas that contribute stormwater runon or runoff to the proposed permit boundary. Drainage areas within the permit boundary are designated by the prefix "DA".

POSTDEVELOPMENT WATERSHED CHARACTERISTICS

Watershed characteristics have been developed for the postdevelopment hydrologic evaluation. The watershed characteristics address drainage area runoff characteristics, unit hydrograph data, reach characteristics, existing culverts, and the proposed final condition drainage system including the detention ponds. This information is included on pages C1C.7 and C1C.8.

The first table, titled Postdeveloped Watershed Characteristics, pages C1C.8 to C1C.11, provides the summary of drainage areas, soil types, Curve Numbers (CN) values, initial loss, reach slope calculations, and determination of Manning's n value. The Soil Conservation Service (SCS) CN were derived from watershed characteristic tables from the SCS Technical Report 55 (TR-55), which included evaluation of anticipated postdevelopment soil and surface cover/condition characteristics. The second table, titled Unit Hydrograph Data - Snyder's Hydrograph Coefficients, page C1C.12 and 13, provides the determination of the Snyder's Unit Hydrograph parameters. The runoff characteristics for the off-site drainage areas did not change from the current permitted condition.

POSTDEVELOPMENT DRAINAGE STRUCTURE DESIGN PARAMETERS

Pages C1C.14 through C1C.39 include drainage structure data for the proposed ponds and culverts for the surface impoundments incorporated into the hydrologic model. The postdevelopment hydrologic model is defined by the landfill completion plan for the Skyline Landfill MSW Permit No. 42E

HYDROLOGIC ANALYSIS

For the hydrologic evaluation, HEC-HMS was used for the precipitation runoff simulation for the postdevelopment condition. The following describes the various modeling components. The HEC-HMS hydrologic analysis results begin on page C1C.40.

Watershed Subareas and Schematization

The drainage areas that contribute flow to the Skyline Landfill MSW 42E permit boundary were delineated into subareas to derive peak flows to determine current permitted runon and runoff flows. Hydrographs are developed for each subarea and appropriately combined and routed through the swales and perimeter channels. The subareas are shown on Drawing C1C.1. For the HEC-HMS schematic of the postdevelopment condition, refer to Drawing C1C.3 and page C1C.40.

Time Step

The time step, or the program computation interval, is the duration of the unit hydrograph. The time step is selected as 5 minutes, which results in 289 hydrograph ordinates in 24 hours.

Hypothetical Precipitation

A return period of 25 years and a duration of 24 hours was used for the design storm. The rainfall data used is shown in the rainfall data table on page C1B.16. The precipitation is assumed to be evenly distributed over the entire landfill for each time interval.

Precipitation Losses

Precipitation losses (the precipitation that does not contribute to the runoff) are calculated using the Soil Conservation Service (SCS) Curve Number (CN) method. CN is a function of soil cover, land use, and antecedent moisture conditions. The CN values used for each drainage area are shown in the Postdeveloped Watershed Characteristic table on pages C1C.8 to C1C.11.

Synthetic Unit Hydrographs and Flow Routing

The rainfall/runoff transformation was performed with the Unit Hydrograph Method. The synthetic unit hydrographs for each watershed were derived by the Snyder Method and Espey's "10-Minute Method" for estimating Snyder Parameters for the landfill permit boundary. The parameters and input values for this model are included in the Unit Hydrograph Data table on pages C1C.8 to C1C.11.

The Kinematic Wave Method was used for routing of the flood wave through the drainage channels. This method is capable of accounting for hydrograph attenuation based on physical channel properties such as length, bottom slope, channel shape, bottom width, and channel roughness.

Post Developed Velocity Summary

Surface water velocities were determined for each discharge point where the surface water enters or exits the permit boundary. The 25-year, 24-hour peak flow rate was analyzed to determine the velocity at the permit boundary. Manning's Equation was used to evaluate the velocities at the discharge points. Refer to Drawing C1C.1 for location of discharge

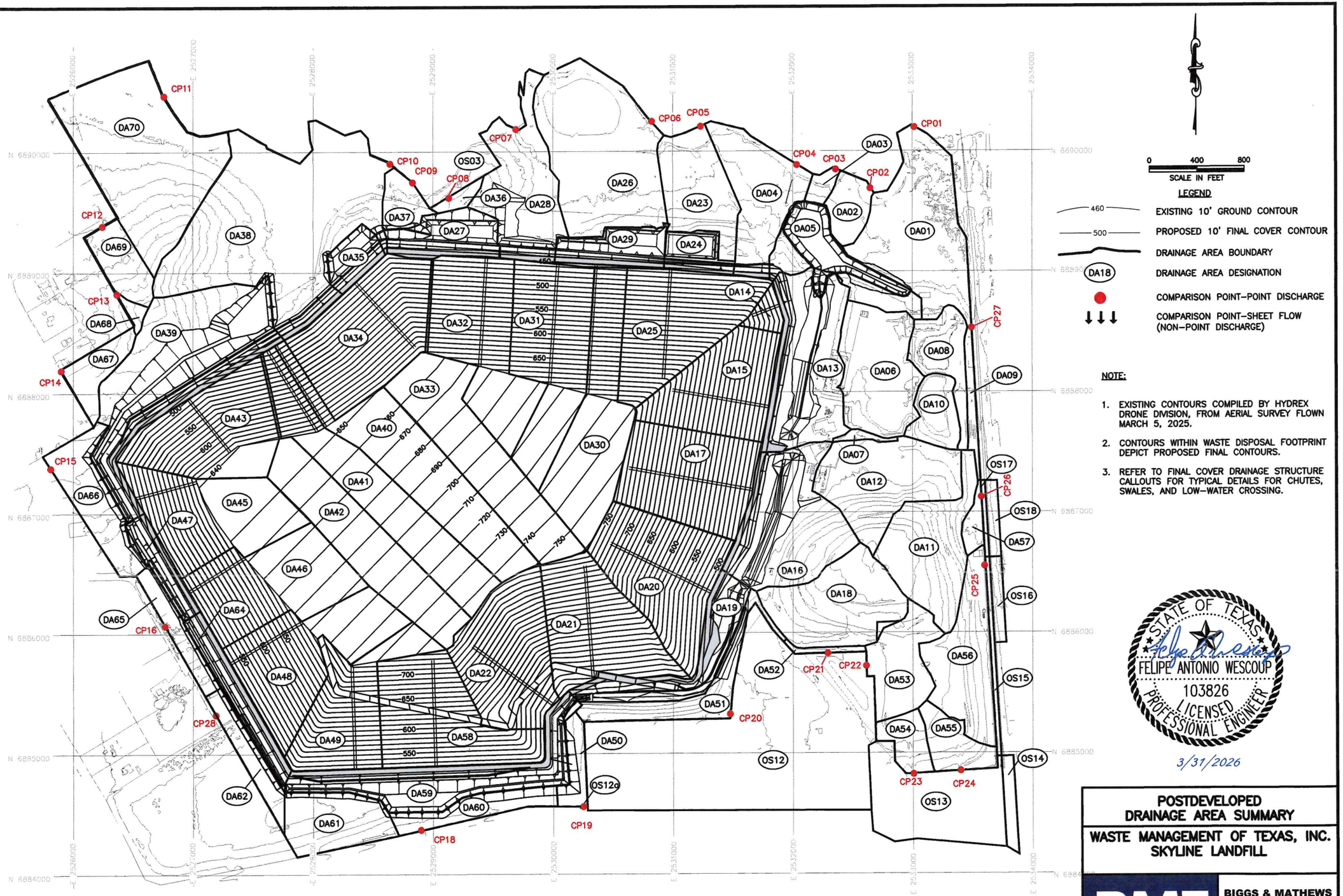
points and peak flow rates. Refer to the postdevelopment velocity summary on pages C1C.75 for postdeveloped velocity calculations.

POSTDEVELOPMENT FLOW AND BOUNDARY ANALYSIS SUMMARY

The postdevelopment flow summary table on page C1C.77 lists the postdevelopment runoff for each drainage area for the 25-year rainfall event. This table summarizes the results of the postdevelopment hydrologic evaluation. The boundary analysis summary for the postdevelopment condition is provided on page C1C.79. The table provides for each comparison point (CP01 through CP28) the peak flow rate, velocity, and volume resulting from the HEC-HMS evaluation for the 25-year, 24 hour rainfall.

POSTDEVELOPMENT DRAINAGE AREA DRAWING

POSTDEVELOPED DRAINAGE AREAS			
WATERSHED NAME	AREA (ac)	25-YEAR FLOW RATE (cfs)	25-YEAR VOLUME (ac-ft)
DA01	21.8	61.90	10.20
DA02	4.0	15.10	1.90
DA03	1.2	5.80	0.60
DA04	12.9	49.10	6.10
DA05	10.5	42.50	5.40
DA06	14.3	57.30	7.30
DA07	0.7	2.20	0.30
DA08	6.4	20.60	3.20
DA09	1.9	5.50	0.90
DA10	4.7	24.20	2.50
DA11	14.5	50.10	6.80
DA12	16.4	61.20	7.70
DA13	19.1	61.50	9.10
DA14	1.8	9.20	0.90
DA15	16.1	72.10	8.00
DA16	19.5	67.80	9.30
DA17	19.3	87.80	9.60
DA18	15.4	50.40	7.20
DA19	10.0	30.00	4.80
DA20	20.7	93.90	10.30
DA21	18.8	81.70	9.30
DA22	19.1	81.30	9.50
DA23	11.1	41.10	5.20
DA24	3.7	17.30	2.00
DA25	20.1	89.30	10.00
DA26	26.7	82.20	12.50
DA27	7.0	32.20	4.00
DA28	15.4	53.80	7.20
DA29	6.1	26.00	3.20
DA30	20.1	78.00	9.80
DA31	21.0	84.90	10.30
DA32	20.5	82.90	10.00
DA33	20.9	74.80	10.00
DA34	22.0	85.90	10.50
DA35	3.7	19.30	2.00
DA36	1.1	5.60	0.50
DA37	3.3	13.10	1.50
DA38	43.9	138.20	20.60
DA39	28.3	93.90	13.80
DA40	21.5	77.10	10.30
DA41	20.2	73.60	9.60
DA42	19.4	69.60	9.30
DA43	18.8	78.50	9.40
DA45	18.8	73.00	9.20
DA46	19.3	74.80	9.40
DA47	3.9	13.40	2.00
DA48	20.0	77.50	9.70
DA49	15.7	64.90	7.80
DA50	3.0	10.40	1.40
DA51	7.5	25.30	3.50
DA52	0.7	3.10	0.40
DA53	8.9	37.60	4.20
DA54	3.7	14.50	1.70
DA55	4.8	18.40	2.20
DA56	13.0	40.30	6.10
DA57	1.6	5.60	0.70
DA58	19.8	86.50	9.90
DA59	16.1	50.10	8.10
DA60	5.3	16.90	2.50
DA61	9.0	29.60	4.20
DA62	4.5	14.50	2.10
DA64	5.7	16.10	3.10
DA65	4.0	12.30	1.90
DA66	9.2	33.00	4.30
DA67	4.4	16.80	2.00
DA68	0.8	3.60	0.40
DA69	5.3	21.20	2.50
DA70	30.1	97.20	14.10
OS03	4.2	16.00	2.0
OS12	57.8	157.90	27.1
OS12.A	0.2	0.7	0.1
OS13	16.2	59.60	11.10
OS14	1.8	65.50	11.90
OS15	1.4	45.00	7.20
OS16	1.6	49.90	7.90
OS17	0.5	7.30	1.00
OS18	1.5	11.90	1.70



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SCALE IN FEET

LEGEND

- 460 — EXISTING 10' GROUND CONTOUR
- 500 — PROPOSED 10' FINAL COVER CONTOUR
- DRAINAGE AREA BOUNDARY
- DA18 — DRAINAGE AREA DESIGNATION
- COMPARISON POINT-POINT DISCHARGE
- COMPARISON POINT-SHEET FLOW (NON-POINT DISCHARGE)

NOTE:

1. EXISTING CONTOURS COMPILED BY HYDREX DRONE DIVISION, FROM AERIAL SURVEY FLOWN MARCH 5, 2025.
2. CONTOURS WITHIN WASTE DISPOSAL FOOTPRINT DEPICT PROPOSED FINAL CONTOURS.
3. REFER TO FINAL COVER DRAINAGE STRUCTURE CALLOUTS FOR TYPICAL DETAILS FOR CHUTES, SWALES, AND LOW-WATER CROSSING.

STATE OF TEXAS
FELIPE ANTONIO WESCOUP
103826
LICENSED
PROFESSIONAL ENGINEER

3/31/2026

POSTDEVELOPED DRAINAGE AREA SUMMARY

WASTE MANAGEMENT OF TEXAS, INC. SKYLINE LANDFILL

REVISIONS			
REV	DATE	DESCRIPTION	DWN BY

BIGGS & MATHEWS ENVIRONMENTAL
1700 ROBERT ROAD, STE. 100
MANSFIELD, TEXAS 76063
817-563-1144

TBPELS FIRM NO. F-256 AND NO. 10194895
TBPG FIRM NO. 50222

DRAWING C1C.1

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NOTE:

1. EXISTING CONTOURS COMPILED BY HYDREX DRONE DIVISION, FROM AERIAL SURVEY FLOWN MARCH 5, 2025.
2. CONTOURS WITHIN WASTE DISPOSAL FOOTPRINT DEPICT PROPOSED FINAL CONTOURS.
3. REFER TO FINAL COVER DRAINAGE STRUCTURE CALLOUTS FOR TYPICAL DETAILS FOR CHUTES, SWALES, AND LOW–WATER CROSSING.

POSTDEVELOPED BOUNDARY ANALYSIS SUMMARY

BOUNDARY COMPARISON POINT	TOTAL CONTRIBUTING DRAINAGE AREA	25–YEAR FLOWRATE (cfs)	25–YEAR VOLUME (ac–ft)	25–YEAR VELOCITY (fps)
CP1	0.0341	61.9	10.2	2.3
CP2	0.0062	15.1	1.9	2.5
CP3	0.0019	5.8	0.6	1.3
CP4	0.3782	316.2	94.3	8.0
CP5	0.0547	85.0	17.2	2.3
CP6	0.0417	82.2	12.5	1.8
CP7	0.2136	191.0	66.8	6.6
CP8	0.0018	5.6	0.5	1.5
CP9	0.0051	13.1	1.5	4.2
CP10	0.2671	320.5	82.0	6.5
CP11	0.0471	97.4	14.1	1.4
CP12	0.0083	21.2	2.5	1.2
CP13	0.0013	3.6	0.4	0.9
CP14	0.0068	16.8	2.0	2.3
CP15	0.0855	130.6	20.3	4.4
CP16	0.0063	12.3	1.9	0.6
CP18	0.1029	110.6	32.2	4.7
CP19	0.0047	10.4	1.4	3.0
CP20	0.0117	25.3	3.5	1.8
CP21	0.0012	3.1	0.4	1.4
CP22	0.0139	37.6	4.2	1.2
CP23	0.0058	14.5	1.7	5.5
CP24	0.0075	18.4	2.2	6.0
CP25	0.0203	40.3	6.1	7.9
CP26	0.0025	5.6	0.7	2.5
CP27	0.0000	0.3	0.0	0.4
CP28	0.0070	26.7	8.3	0.8

STATE OF TEXAS
FELIPE ANTONIO WESCOUP
103826
LICENSED
PROFESSIONAL ENGINEER
3/31/2026

REVISIONS			
REV	DATE	DESCRIPTION	DWN BY

POSTDEVELOPED BOUNDARY ANALYSIS SUMMARY

WASTE MANAGEMENT OF TEXAS, INC.
SKYLINE LANDFILL

BIGGS & MATHEWS ENVIRONMENTAL
1700 ROBERT ROAD, STE. 100
MANSFIELD, TEXAS 76063
817–563–1144

TBPELS FIRM NO. F–256 AND NO. 10194895
TBPG FIRM NO. 50222

DRAWING C1C.2

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POSTDEVELOPED WATERSHED CHARACTERISTICS

WASTE MANAGEMENT OF TEXAS, INC.
SKYLINE LANDFILL
UNIT HYDROGRAPH DATA
Postdeveloped Watershed Characteristics

			CN Determination						Main Reach Slope Calculation (for Espey Method)					Mannings "n" Determination			
Watershed Name	Watershed Area (ac)	Watershed Area (sq mi)	Non-Final Cover Area (ac) CN = 84	Final Cover Topslope Area (ac) CN = 85	Final Cover Sideslope Area (ac) CN = 87	Channel Area (ac) CN=87	Pond Area (ac) CN = 98	CN	Longest Reach (ft)	20% of Reach Length (ft)	Elevation @ 20% Reach Length from Upstream	Downstream Elevation	Slope (ft/ft)	Sheet Flow % of n = 0.070	Shallow Concentrated or Swale Flow	Channelized Flow % of n = 0.035	Composite n
DA01	21.8	0.0341	21.8	0.0	0.0	0.0	0.0	84	1756	351	407.0	379.0	0.0199	15	35	50	0.046
DA02	4.0	0.0062	4.0	0.0	0.0	0.0	0.0	84	624	125	411.0	380.0	0.0621	50	50	0	0.060
DA03	1.2	0.0019	1.2	0.0	0.0	0.0	0.0	84	292	58	416.0	382.0	0.1455	100	0	0	0.070
DA04	12.9	0.0202	12.9	0.0	0.0	0.0	0.0	84	993	199	450.0	382.0	0.0856	30	60	10	0.055
DA05	10.5	0.0164	6.9	0.0	0.0	0.0	3.6	89	634	127	441.0	412.0	0.0572	45	55	0	0.059
DA06	14.3	0.0224	9.6	0.0	0.0	0.0	4.7	88	351	70	439.0	425.0	0.0499	85	15	0	0.067
DA07	0.7	0.0010	0.7	0.0	0.0	0.0	0.0	84	505	101	462.0	454.0	0.0198	60	40	0	0.062
DA08	6.4	0.0100	4.6	0.0	0.0	0.0	1.8	88	1109	222	436.0	420.0	0.0180	25	55	20	0.052
DA09	1.9	0.0029	1.9	0.0	0.0	0.0	0.0	84	1182	236	435.0	422.0	0.0137	25	50	25	0.051
DA10	4.7	0.0073	2.3	0.0	0.0	0.0	2.4	91	217	43	451.0	426.0	0.1440	100	0	0	0.070
DA11	14.5	0.0227	14.5	0.0	0.0	0.0	0.0	84	2133	427	544.0	429.0	0.0674	15	30	55	0.045
DA12	16.4	0.0257	16.4	0.0	0.0	0.0	0.0	84	1296	259	542.0	436.0	0.1022	25	45	30	0.051
DA13	19.1	0.0299	13.0	0.0	0.0	6.1	0.0	85	1598	320	461.0	413.0	0.0375	20	40	40	0.048
DA14	1.8	0.0028	0.0	0.0	1.8	0.0	0.0	87	416	83	555.0	470.0	0.2554	70	30	0	0.064
DA15	16.1	0.0252	0.0	0.0	16.1	0.0	0.0	87	1308	262	740.0	470.0	0.2580	25	45	30	0.051
DA16	19.5	0.0305	14.3	0.0	0.0	5.2	0.0	85	1639	328	540.0	457.0	0.0633	20	35	45	0.047
DA17	19.3	0.0302	0.0	0.0	19.3	0.0	0.0	87	1380	276	755.0	474.0	0.2545	20	45	35	0.049
DA18	15.4	0.0240	15.4	0.0	0.0	0.0	0.0	84	1781	356	544.0	475.0	0.0484	15	35	50	0.046
DA19	10.0	0.0156	5.8	0.0	0.0	4.2	0.0	85	2061	412	504.0	466.0	0.0230	15	30	55	0.045
DA20	20.7	0.0323	0.0	0.0	20.7	0.0	0.0	87	1343	269	755.0	490.0	0.2466	20	45	35	0.049
DA21	18.8	0.0293	0.0	0.0	18.8	0.0	0.0	87	1428	286	753.0	525.0	0.1996	20	40	40	0.048
DA22	19.1	0.0298	0.0	0.0	19.1	0.0	0.0	87	1755	351	748.0	449.0	0.2130	15	35	50	0.046
DA23	11.1	0.0174	11.1	0.0	0.0	0.0	0.0	84	1046	209	444.0	383.0	0.0729	30	55	15	0.054
DA24	3.7	0.0058	1.8	0.0	0.0	0.0	1.9	91	360	72	457.0	430.0	0.0938	85	15	0	0.067

WASTE MANAGEMENT OF TEXAS, INC.
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			CN Determination						Main Reach Slope Calculation (for Espey Method)					Mannings "n" Determination			
Watershed Name	Watershed Area (ac)	Watershed Area (sq mi)	Non-Final Cover Area (ac) CN = 84	Final Cover Topslope Area (ac) CN = 85	Final Cover Sideslope Area (ac) CN = 87	Channel Area (ac) CN=87	Pond Area (ac) CN = 98	CN	Longest Reach (ft)	20% of Reach Length (ft)	Elevation @ 20% Reach Length from Upstream	Downstream Elevation	Slope (ft/ft)	Sheet Flow % of n = 0.070	Shallow Concentrated or Swale Flow	Channelized Flow % of n = 0.035	Composite n
DA25	20.1	0.0315	0.0	0.0	20.1	0.0	0.0	87	1448	290	730.0	452.0	0.2400	20	40	40	0.048
DA26	26.7	0.0417	26.7	0.0	0.0	0.0	0.0	84	1310	262	420.0	384.0	0.0344	25	45	30	0.051
DA27	7.0	0.0109	1.5	0.0	0.0	0.0	5.5	95	518	104	451.0	415.0	0.0869	60	40	0	0.062
DA28	15.4	0.0240	15.4	0.0	0.0	0.0	0.0	84	1224	245	456.0	390.0	0.0674	25	50	25	0.051
DA29	6.1	0.0096	3.9	0.0	0.0	0.0	2.3	89	575	115	457.0	423.0	0.0739	50	50	0	0.060
DA30	20.1	0.0314	0.0	13.4	6.7	0.0	0.0	86	2449	490	755.0	455.0	0.1531	10	25	65	0.042
DA31	21.0	0.0329	0.0	5.9	15.1	0.0	0.0	86	2005	401	728.0	457.0	0.1690	15	30	55	0.045
DA32	20.5	0.0321	0.0	6.7	13.8	0.0	0.0	86	1820	364	708.0	455.0	0.1738	15	35	50	0.046
DA33	20.9	0.0326	0.0	20.6	0.2	0.0	0.0	85	3063	613	752.0	457.0	0.1204	10	20	70	0.042
DA34	22.0	0.0344	0.0	22.0	0.0	0.0	0.0	85	1641	328	648.0	451.0	0.1501	20	35	45	0.047
DA35	3.7	0.0057	1.6	0.0	0.0	0.0	2.1	92	228	46	451.0	420.0	0.1700	100	0	0	0.070
DA36	1.1	0.0018	1.1	0.0	0.0	0.0	0.0	84	175	35	462.0	443.0	0.1357	100	0	0	0.070
DA37	3.3	0.0051	3.3	0.0	0.0	0.0	0.0	84	616	123	436.0	391.0	0.0913	50	50	0	0.060
DA38	43.9	0.0687	43.9	0.0	0.0	0.0	0.0	84	2234	447	500.0	420.0	0.0448	15	25	60	0.044
DA39	28.3	0.0442	17.6	0.0	0.0	8.8	1.9	86	2254	451	509.0	420.0	0.0494	15	25	60	0.044
DA40	21.5	0.0336	0.0	19.6	1.9	0.0	0.0	85	3235	647	750.0	448.0	0.1167	10	20	70	0.042
DA41	20.2	0.0315	0.0	16.0	4.2	0.0	0.0	85	2932	586	748.0	448.0	0.1279	10	20	70	0.042
DA42	19.4	0.0303	0.0	19.0	0.4	0.0	0.0	85	3192	638	745.0	447.0	0.1167	10	20	70	0.042
DA43	18.8	0.0294	0.0	0.0	18.8	0.0	0.0	87	1150	230	650.0	498.0	0.1652	25	50	25	0.051
DA45	18.8	0.0294	0.0	8.6	10.2	0.0	0.0	86	1881	376	666.0	501.0	0.1096	15	30	55	0.045
DA46	19.3	0.0301	0.0	10.1	9.2	0.0	0.0	86	1855	371	717.0	522.0	0.1314	15	30	55	0.045
DA47	3.9	0.0061	1.9	0.0	0.0	0.8	1.2	89	1027	205	521.0	501.0	0.0243	30	60	10	0.055
DA48	20.0	0.0312	0.0	6.8	13.1	0.0	0.0	86	1949	390	728.0	521.0	0.1328	15	30	55	0.045
DA49	15.7	0.0245	0.0	2.6	13.0	0.0	0.0	87	1622	324	745.0	521.0	0.1726	20	35	45	0.047
DA50	3.0	0.0047	3.0	0.0	0.0	0.0	0.0	84	830	166	509.0	486.0	0.0346	35	65	0	0.057

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Watershed Name	Watershed Area (ac)	Watershed Area (sq mi)	Non-Final Cover Area (ac) CN = 84	Final Cover Topslope Area (ac) CN = 85	Final Cover Sideslope Area (ac) CN = 87	Channel Area (ac) CN=87	Pond Area (ac) CN = 98	CN	Longest Reach (ft)	20% of Reach Length (ft)	Elevation @ 20% Reach Length from Upstream	Downstream Elevation	Slope (ft/ft)	Sheet Flow % of n = 0.070	Shallow Concentrated or Swale Flow	Channelized Flow % of n = 0.035	Composite n
DA51	7.5	0.0117	7.5	0.0	0.0	0.0	0.0	84	1348	270	511.0	466.0	0.0417	20	45	35	0.049
DA52	0.7	0.0012	0.7	0.0	0.0	0.0	0.0	84	350	70	500.0	483.0	0.0607	85	15	0	0.067
DA53	8.9	0.0139	8.9	0.0	0.0	0.0	0.0	84	935	187	530.0	488.0	0.0561	30	65	5	0.055
DA54	3.7	0.0058	3.7	0.0	0.0	0.0	0.0	84	616	123	503.0	466.0	0.0751	50	50	0	0.060
DA55	4.8	0.0075	4.8	0.0	0.0	0.0	0.0	84	795	159	502.0	454.0	0.0755	40	50	10	0.057
DA56	13.0	0.0203	13.0	0.0	0.0	0.0	0.0	84	1739	348	484.0	436.0	0.0345	15	35	50	0.046
DA57	1.6	0.0025	1.6	0.0	0.0	0.0	0.0	84	492	98	441.0	432.0	0.0229	60	40	0	0.062
DA58	19.8	0.0310	0.0	0.0	19.8	0.0	0.0	87	1187	237	735.0	521.0	0.2254	25	50	25	0.051
DA59	16.1	0.0251	8.5	0.0	0.0	3.4	4.2	88	1723	345	510.0	480.0	0.0218	15	35	50	0.046
DA60	5.3	0.0083	5.3	0.0	0.0	0.0	0.0	84	1209	242	503.0	474.0	0.0300	25	50	25	0.051
DA61	9.0	0.0140	9.0	0.0	0.0	0.0	0.0	84	1290	258	520.0	477.0	0.0417	25	45	30	0.051
DA62	4.5	0.0070	4.5	0.0	0.0	0.0	0.0	84	1080	216	520.0	498.0	0.0255	30	40	30	0.052
DA64	5.7	0.0090	0.0	0.0	0.0	1.0	4.5	91	1623	325	510.0	501.0	0.0069	20	25	55	0.046
DA65	4.0	0.0063	4.0	0.0	0.0	0.0	0.0	84	628	126	506.0	499.0	0.0139	50	50	0	0.060
DA66	9.2	0.0143	9.2	0.0	0.0	0.0	0.0	84	1103	221	500.0	442.0	0.0657	25	55	20	0.052
DA67	4.4	0.0068	4.4	0.0	0.0	0.0	0.0	84	738	148	493.0	452.0	0.0694	40	60	0	0.058
DA68	0.8	0.0013	0.8	0.0	0.0	0.0	0.0	84	314	63	504.0	487.0	0.0677	95	5	0	0.069
DA69	5.3	0.0083	5.3	0.0	0.0	0.0	0.0	84	750	150	504.0	450.0	0.0900	40	60	0	0.058
DA70	30.1	0.0471	30.1	0.0	0.0	0.0	0.0	84	2361	472	502.0	393.0	0.0577	15	25	60	0.044
OS03	4.2	0.0066	4.2	0.0	0.0	0.0	0.0	84	877	175	437.0	390.0	0.0670	35	65	0	0.057
OS12	57.8	0.0904	57.8	0.0	0.0	0.0	0.0	84	1658	332	476.0	452.0	0.0181	20	35	45	0.047
OS12.A	0.2	0.0003	0.2	0.0	0.0	0.0	0.0	84	255	51	486.0	483.0	0.0147	100	0	0	0.070
OS13	16.2	0.0254	16.2	0.0	0.0	0.0	0.0	84	1194	239	489.0	443.0	0.0482	25	50	25	0.051
OS14	1.8	0.0028	1.8	0.0	0.0	0.0	0.0	84	620	124	447.0	440.0	0.0141	50	50	0	0.060

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Watershed Name	Watershed Area (ac)	Watershed Area (sq mi)	Non-Final Cover Area (ac) CN = 84	Final Cover Topslope Area (ac) CN = 85	Final Cover Sideslope Area (ac) CN = 87	Channel Area (ac) CN=87	Pond Area (ac) CN = 98	CN	Longest Reach (ft)	20% of Reach Length (ft)	Elevation @ 20% Reach Length from Upstream	Downstream Elevation	Slope (ft/ft)	Sheet Flow % of n = 0.070	Shallow Concentrated or Swale Flow	Channelized Flow % of n = 0.035	Composite n
OS15	1.4	0.0022	1.4	0.0	0.0	0.0	0.0	84	1563	313	446.0	432.0	0.0112	20	40	40	0.048
OS16	1.6	0.0025	1.6	0.0	0.0	0.0	0.0	84	645	129	435.0	426.0	0.0174	45	55	0	0.059
OS17	0.5	0.0008	0.5	0.0	0.0	0.0	0.0	84	472	94	436.0	430.0	0.0159	65	35	0	0.063
OS18	1.5	0.0023	1.5	0.0	0.0	0.0	0.0	84	510	102	429.0	424.0	0.0123	60	40	0	0.062

WASTE MANAGEMENT OF TEXAS, INC.
SKYLINE LANDFILL
UNIT HYDROGRAPH DATA

Snyder's Hydrograph Coefficients (Espey's 10-Minute Method)

Postdeveloped Conditions

Watershed Name	Longest Reach (ft)	Slope (ft/ft)	Impervious Cover %	Manning's "n"	Eff. Coeff.	Tr (min)	Tlag (min)	Area (sq mi)	qp (cfs/sq mi)	Tlag (hr)	Cp
					(A)	(B)	(C)		(D)		(E)
DA01	1756	0.0199	2.0	0.046	0.90	34.3	31.8	0.0341	823.6	0.53	0.68
DA02	624	0.0621	2.0	0.060	0.96	22.7	20.2	0.0062	1373.4	0.34	0.72
DA03	292	0.1455	2.0	0.070	1.00	16.4	13.9	0.0019	2034.3	0.23	0.74
DA04	993	0.0856	2.0	0.055	0.93	22.0	19.5	0.0202	1354.9	0.32	0.69
DA05	634	0.0572	2.0	0.059	0.94	22.4	19.9	0.0164	1338.0	0.33	0.69
DA06	351	0.0499	2.0	0.067	0.98	21.7	19.2	0.0224	1369.0	0.32	0.68
DA07	505	0.0198	2.0	0.062	0.96	28.7	26.2	0.0010	1145.4	0.44	0.78
DA08	1109	0.0180	2.0	0.052	0.93	33.3	30.8	0.0100	894.2	0.51	0.72
DA09	1182	0.0137	2.0	0.051	0.93	36.1	33.6	0.0029	859.7	0.56	0.75
DA10	217	0.1440	2.0	0.070	1.00	15.4	12.9	0.0073	2068.7	0.21	0.69
DA11	2133	0.0674	2.0	0.045	0.88	25.4	22.9	0.0227	1154.8	0.38	0.69
DA12	1296	0.1022	2.0	0.051	0.93	22.3	19.8	0.0257	1317.9	0.33	0.68
DA13	1598	0.0375	2.0	0.048	0.90	28.6	26.1	0.0299	1003.8	0.44	0.68
DA14	416	0.2554	2.0	0.064	0.96	14.5	12.0	0.0028	2287.7	0.20	0.71
DA15	1308	0.2580	2.0	0.051	0.93	17.8	15.3	0.0252	1685.7	0.25	0.67
DA16	1639	0.0633	2.0	0.047	0.90	25.3	22.8	0.0305	1146.3	0.38	0.68
DA17	1380	0.2545	2.0	0.049	0.90	17.2	14.7	0.0302	1735.9	0.24	0.66
DA18	1781	0.0484	2.0	0.046	0.90	27.6	25.1	0.0240	1055.5	0.42	0.69
DA19	2061	0.0230	2.0	0.045	0.88	32.9	30.4	0.0156	887.2	0.51	0.70
DA20	1343	0.2466	2.0	0.049	0.90	17.2	14.7	0.0323	1728.1	0.24	0.66
DA21	1428	0.1996	2.0	0.048	0.90	18.4	15.9	0.0293	1614.8	0.26	0.67
DA22	1755	0.2130	2.0	0.046	0.90	19.0	16.5	0.0298	1560.8	0.27	0.67
DA23	1046	0.0729	2.0	0.054	0.93	23.1	20.6	0.0174	1289.0	0.34	0.69
DA24	360	0.0938	2.0	0.067	0.98	18.6	16.1	0.0058	1700.3	0.27	0.71
DA25	1448	0.2400	2.0	0.048	0.90	17.6	15.1	0.0315	1685.9	0.25	0.66
DA26	1310	0.0344	2.0	0.051	0.93	29.4	26.9	0.0417	962.9	0.45	0.67
DA27	518	0.0869	2.0	0.062	0.96	20.0	17.5	0.0109	1537.4	0.29	0.70
DA28	1224	0.0674	2.0	0.051	0.93	24.5	22.0	0.0240	1198.8	0.37	0.69
DA29	575	0.0739	2.0	0.060	0.96	21.3	18.8	0.0096	1442.5	0.31	0.71
DA30	2449	0.1531	2.0	0.042	0.88	21.3	18.8	0.0314	1372.2	0.31	0.67
DA31	2005	0.1690	2.0	0.045	0.88	19.9	17.4	0.0329	1477.2	0.29	0.67
DA32	1820	0.1738	2.0	0.046	0.90	20.1	17.6	0.0321	1460.6	0.29	0.67
DA33	3063	0.1204	2.0	0.042	0.88	23.9	21.4	0.0326	1215.9	0.36	0.68
DA34	1641	0.1501	2.0	0.047	0.90	20.4	17.9	0.0344	1436.7	0.30	0.67
DA35	228	0.1700	2.0	0.070	1.00	14.9	12.4	0.0057	2157.5	0.21	0.70
DA36	175	0.1357	2.0	0.070	1.00	14.8	12.3	0.0018	2272.6	0.21	0.73
DA37	616	0.0913	2.0	0.060	0.96	20.5	18.0	0.0051	1538.7	0.30	0.72
DA38	2234	0.0448	2.0	0.044	0.88	28.4	25.9	0.0687	979.0	0.43	0.66
DA39	2254	0.0494	2.0	0.044	0.88	27.8	25.3	0.0442	1020.6	0.42	0.67
DA40	3235	0.1167	2.0	0.042	0.88	24.4	21.9	0.0336	1188.2	0.36	0.68
DA41	2932	0.1279	2.0	0.042	0.88	23.3	20.8	0.0315	1250.9	0.35	0.68
DA42	3192	0.1167	2.0	0.042	0.88	24.3	21.8	0.0303	1197.3	0.36	0.68
DA43	1150	0.1652	2.0	0.051	0.93	19.3	16.8	0.0294	1534.8	0.28	0.67
DA45	1881	0.1096	2.0	0.045	0.88	21.8	19.3	0.0294	1342.7	0.32	0.68
DA46	1855	0.1314	2.0	0.045	0.88	20.8	18.3	0.0301	1412.8	0.31	0.67

WASTE MANAGEMENT OF TEXAS, INC.
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Snyder's Hydrograph Coefficients (Espey's 10-Minute Method)

Postdeveloped Conditions

Watershed Name	Longest Reach (ft)	Slope (ft/ft)	Impervious Cover %	Manning's "n"	Eff. Coeff.	Tr (min)	Tlag (min)	Area (sq mi)	qp (cfs/sq mi)	Tlag (hr)	Cp
					(A)	(B)	(C)		(D)		(E)
DA47	1027	0.0243	2.0	0.055	0.93	30.3	27.8	0.0061	1007.2	0.46	0.73
DA48	1949	0.1328	2.0	0.045	0.88	21.0	18.5	0.0312	1397.6	0.31	0.67
DA49	1622	0.1726	2.0	0.047	0.90	19.6	17.1	0.0245	1516.2	0.29	0.68
DA50	830	0.0346	2.0	0.057	0.94	27.0	24.5	0.0047	1151.4	0.41	0.73
DA51	1348	0.0417	2.0	0.049	0.90	26.8	24.3	0.0117	1117.8	0.41	0.71
DA52	350	0.0607	2.0	0.067	0.98	20.6	18.1	0.0012	1625.7	0.30	0.77
DA53	935	0.0561	2.0	0.055	0.94	24.6	22.1	0.0139	1218.2	0.37	0.70
DA54	616	0.0751	2.0	0.060	0.96	21.6	19.1	0.0058	1453.4	0.32	0.72
DA55	795	0.0755	2.0	0.057	0.94	22.0	19.5	0.0075	1406.3	0.33	0.71
DA56	1739	0.0345	2.0	0.046	0.90	29.8	27.3	0.0203	976.2	0.46	0.69
DA57	492	0.0229	2.0	0.062	0.96	27.5	25.0	0.0025	1155.7	0.42	0.75
DA58	1187	0.2254	2.0	0.051	0.93	18.0	15.5	0.0310	1651.4	0.26	0.67
DA59	1723	0.0218	2.0	0.046	0.90	33.4	30.9	0.0251	857.7	0.51	0.69
DA60	1209	0.0300	2.0	0.051	0.93	29.9	27.4	0.0083	1010.4	0.46	0.72
DA61	1290	0.0417	2.0	0.051	0.93	27.9	25.4	0.0140	1063.3	0.42	0.70
DA62	1080	0.0255	2.0	0.052	0.93	30.3	27.8	0.0070	1001.0	0.46	0.73
DA64	1623	0.0069	2.0	0.046	0.90	43.9	41.4	0.0090	667.8	0.69	0.72
DA65	628	0.0139	2.0	0.060	0.96	33.0	30.5	0.0063	918.6	0.51	0.73
DA66	1103	0.0657	2.0	0.052	0.93	24.0	21.5	0.0143	1247.2	0.36	0.70
DA67	738	0.0694	2.0	0.058	0.94	22.1	19.6	0.0068	1406.0	0.33	0.72
DA68	314	0.0677	2.0	0.069	0.98	19.6	17.1	0.0013	1710.7	0.28	0.76
DA69	750	0.0900	2.0	0.058	0.94	20.8	18.3	0.0083	1489.5	0.30	0.71
DA70	2361	0.0577	2.0	0.044	0.88	27.0	24.5	0.0471	1049.4	0.41	0.67
OS03	877	0.0670	2.0	0.057	0.94	23.2	20.7	0.0066	1336.2	0.34	0.72
OS12	1658	0.0181	2.0	0.047	0.90	34.7	32.2	0.0904	782.9	0.54	0.66
OS12.A	255	0.0147	2.0	0.070	1.00	28.2	25.7	0.0003	1234.4	0.43	0.83
OS13	1194	0.0482	2.0	0.051	0.93	26.5	24.0	0.0254	1100.0	0.40	0.69
OS14	620	0.0141	2.0	0.060	0.96	32.8	30.3	0.0028	954.8	0.50	0.75
OS15	1563	0.0112	2.0	0.048	0.90	38.6	36.1	0.0022	810.9	0.60	0.76
OS16	645	0.0174	2.0	0.059	0.94	30.3	27.8	0.0025	1045.6	0.46	0.76
OS17	472	0.0159	2.0	0.063	0.96	29.9	27.4	0.0008	1107.3	0.46	0.79
OS18	510	0.0123	2.0	0.062	0.96	32.5	30.0	0.0023	973.3	0.50	0.76

(A) Conveyance efficiency from Dodson & Associates, Inc. Hands-On HEC-1, February 1999, pgs 6-19.

(B) $Tr=3.1(L^{0.23})(S^{-0.25})(I^{-0.18})(Effcoef^{-1.57})$

(C) $Tlag=Tr-(5/2)$

(D) $qp=31600(A^{-0.04})(Tr^{-1.07})$

(E) $Cp=49.375(A^{-0.04})(Tr^{-1.07})(Tlag)$

Tr = Surface runoff to unit hydrograph peak (min)
L = Distance along main channel from study point to watershed boundary
S = Main channel slope (ft/ft)
I = Impervious cover within the watershed
Tlag = Watershed lag time (min)
qp = Hydrograph peak discharge (cfs/sq. mi.)
Cp = Snyder's peaking coefficient

POSTDEVELOPMENT DRAINAGE STRUCTURE DESIGN PARAMETERS

WASTE MANAGEMENT OF TEXAS, INC.
Skyline Landfill
Pond Data for HEC-HMS
Pond 05
North Postdeveloped Permited Schematic - Page 40

Reservoir

Description:	
Downstream:	R04
Method:	Outflow Structures
Storage Method:	Elevation-Storage
Elev-Stor Function:	Pond 05
Initial Condition:	Elevation
Initial Elevation:	410 ft
Main Tailwater:	Assume None
Auxiliary:	--None--
Time Step Method:	Automatic Adaption
Outlets:	1
Spillways:	1
Dam Tops:	1
Pumps:	0
Dam Break:	No
Dam Seepage:	No
Release:	No
Evaporation:	No

Outlet

Method:	Culvert Outlet
Direction:	Main
Number Barrels:	1
Solution Method:	Automatic
Shape:	Box
Chart:	8: Flared Wingwalls
Scale:	1: Wingwalls flared 30 to 75 degrees
Length:	100 ft
Rise:	3 ft
Span:	10 ft
Inlet Elevation:	412
Entrance Coefficient:	0.5
Outlet Elevation:	411
Exit Coefficient:	1
Mannings n:	0.013

Spillway

Method:	Broad-Crested Spillway
Direction:	Main
Elevation:	418 ft
Length:	40 ft
Coefficient:	2.6
Gates:	0

Dam Tops

Method:	Level Overflow
Direction:	Main
Elevation:	419
Length:	800
Coefficient:	2.6

Paired Data

Elevation Storage Functions
Pond 05

Elevation (ft)	Storage (ac-ft)	Storage (cy)
410	7.906	12,755
412	16.766	27,049
414	26.462	42,692
416	37.005	59,702
418	48.557	78,339
420	60.951	98,334
422	74.272	119,826

WASTE MANAGEMENT OF TEXAS, INC.
Skyline Landfill
Pond Data for HEC-HMS
Pond 08
North Postdeveloped Permited Schematic - Page 40

Reservoir

Description:	
Downstream:	Pond 05
Method:	Outflow Structures
Storage Method:	Elevation-Storage
Elev-Stor Function:	Pond 08
Initial Condition:	Elevation
Initial Elevation:	418.5 ft
Main Tailwater:	Assume None
Auxiliary:	--None--
Time Step Method:	Automatic Adaption
Outlets:	1
Spillways:	1
Dam Tops:	0
Pumps:	0
Dam Break:	No
Dam Seepage:	No
Release:	No
Evaporation:	No

Outlet

Method:	Orifice Outlet
Direction:	Main
Number Barrels:	1
Center Elevation:	420 ft
Area	18 sf
Coefficient:	0.67

Spillway

Method:	Broad-Crested Spillway
Direction:	Main
Elevation:	422.5 ft
Length:	60 ft
Coefficient:	2.6
Gates:	0

Dam Tops

Method:	Level Overflow
Direction:	Main
Elevation:	
Length:	
Coefficient:	

Paired Data

Elevation Storage Functions
Pond 08

Elevation (ft)	Storage (ac-ft)	Storage (cy)
405	0.000	0
406	1.000	1,613
408	2.000	3,227
410	3.000	4,840
412	4.000	6,453
414	7.000	11,293
416	10.000	16,133
418	12.000	19,360
420	15.286	24,662
422	20.451	32,995
424	25.903	41,790

WASTE MANAGEMENT OF TEXAS, INC.
Skyline Landfill
Pond Data for HEC-HMS
Pond 10
North Postdeveloped Permited Schematic - Page 40

Reservoir

Description:	
Downstream:	Pond 06
Method:	Outflow Structures
Storage Method:	Elevation-Storage
Elev-Stor Function:	Pond 10
Initial Condition:	Elevation
Initial Elevation:	425.5 ft
Main Tailwater:	Assume None
Auxiliary:	--None--
Time Step Method:	Automatic Adaption
Outlets:	0
Spillways:	1
Dam Tops:	1
Pumps:	0
Dam Break:	No
Dam Seepage:	No
Release:	No
Evaporation:	No

Outlet

Method:		
Direction:		
Number Barrels:		
Solution Method:		
Shape:		
Chart:		
Scale:		
Length:		ft
Diameter:		ft
Inlet Elevation:		ft
Entrance Coefficient:		
Outlet Elevation:		
Exit Coefficient:		
Mannings n:		

Spillway

Method:	Broad-Crested Spillway
Direction:	Main
Elevation:	430 ft
Length:	14 ft
Coefficient:	2.6
Gates:	0

Dam Tops

Method:	Level Overflow
Direction:	Main
Elevation:	432
Length:	200
Coefficient:	2.6

Paired Data

Elevation Storage Functions
Pond 10

Elevation (ft)	Storage (ac-ft)	Storage (cy)
415	0.000	0
416	1.061	1,712
418	3.438	5,546
420	6.171	9,955
422	9.291	14,989
424	12.829	20,697
426	16.809	27,119
428	21.990	35,478
430	27.809	44,866
432	33.934	54,748

WASTE MANAGEMENT OF TEXAS, INC.
Skyline Landfill
Pond Data for HEC-HMS
Pond 24
North Postdeveloped Permited Schematic - Page 40

Reservoir

Description:	
Downstream:	R23
Method:	Outflow Structures
Storage Method:	Elevation-Storage
Elev-Stor Function:	Pond 24
Initial Condition:	Inflow = Outflow
Main Tailwater:	Assume None
Auxiliary:	--None--
Time Step Method:	Automatic Adaption
Outlets:	1
Spillways:	1
Dam Tops:	0
Pumps:	0
Dam Break:	No
Dam Seepage:	No
Release:	No
Evaporation:	No

Outlet

Method:	Culvert Outlet
Direction:	Main
Number Barrels:	2
Solution Method:	Automatic
Shape:	Circular
Chart:	1: Concrete Pipe Culvert
Scale:	1: Square edge entrance with headwall
Length:	150 ft
Diameter:	2.5 ft
Inlet Elevation:	430
Entrance Coefficient:	0.5
Outlet Elevation:	429
Exit Coefficient:	1
Mannings n:	0.013

Spillway

Method:	Broad-Crested Spillway
Direction:	Main
Elevation:	435 ft
Length:	100 ft
Coefficient:	2.6
Gates:	0

Dam Tops

Method:	
Direction:	
Elevation:	
Length:	
Coefficient:	

Paired Data

Elevation Storage Functions
Pond 24

Elevation (ft)	Storage (ac-ft)	Storage (cy)
430	0.000	0
432	2.876	4,640
434	6.057	9,773
436	9.559	15,422
437.11	11.407	18,403

WASTE MANAGEMENT OF TEXAS, INC.
Skyline Landfill
Pond Data for HEC-HMS
Pond 27
North Postdeveloped Permited Schematic - Page 40

Reservoir

Description:	
Downstream:	J29
Method:	Outflow Structures
Storage Method:	Elevation-Storage
Elev-Stor Function:	Pond 27
Initial Condition:	Inflow = Outflow
Initial Elevation:	
Main Tailwater:	Assume None
Auxiliary:	--None--
Time Step Method:	Automatic Adaption
Outlets:	1
Spillways:	1
Dam Tops:	0
Pumps:	0
Dam Break:	No
Dam Seepage:	No
Release:	No
Evaporation:	No

Outlet

Method:	Culvert Outlet
Direction:	Main
Number Barrels:	1
Solution Method:	Automatic
Shape:	Circular
Chart:	1: Concrete Pipe Culvert
Scale:	1: Square edge entrance with headwall
Length:	110
Diameter:	3.5
Inlet Elevation:	415
Entrance Coefficient:	0.5
Outlet Elevation:	414
Exit Coefficient:	1
Mannings n:	0.013

Spillway

Method:	Broad-Crested Spillway
Direction:	Main
Elevation:	426 ft
Length:	100 ft
Coefficient:	2.6
Gates:	0

Dam Tops

Method:	
Direction:	Main
Elevation:	427
Length:	580
Coefficient:	2.6

Paired Data

Elevation Storage Functions
Pond 27

Elevation (ft)	Storage (ac-ft)	Storage (cy)
415	0.000	0.00
416	0.052	84.00
418	0.483	778.90
420	1.380	2,226.30
422	2.781	4,487.00
424	4.691	7,568.70
426	7.099	11,452.80
428	30.800	16,162.50

WASTE MANAGEMENT OF TEXAS, INC.
Skyline Landfill
Pond Data for HEC-HMS
Pond 29
North Postdeveloped Permited Schematic - Page 40

Reservoir

Description:	
Downstream:	J29
Method:	Outflow Structures
Storage Method:	Elevation-Storage
Elev-Stor Function:	Pond 29
Initial Condition:	Inflow = Outflow
Main Tailwater:	Assume None
Auxiliary:	--None--
Time Step Method:	Automatic Adaption
Outlets:	1
Spillways:	1
Dam Tops:	1
Pumps:	0
Dam Break:	No
Dam Seepage:	No
Release:	No
Evaporation:	No

Outlet

Method:	Culvert Outlet
Direction:	Main
Number Barrels:	1
Solution Method:	Automatic
Shape:	Circular
Chart:	1: Concrete Pipe Culvert
Scale:	1: Square edge entrance with headwall
Length:	80 ft
Diameter:	2 ft
Inlet Elevation:	412
Entrance Coefficient:	0.5
Outlet Elevation:	411
Exit Coefficient:	1
Mannings n:	0.013

Spillway

Method:	Broad-Crested Spillway
Direction:	Main
Elevation:	419.5 ft
Length:	100 ft
Coefficient:	2.6
Gates:	0

Dam Tops

Method:	Level Overflow
Direction:	Main
Elevation:	420
Length:	400
Coefficient:	2.6

Paired Data

Elevation Storage Functions
Pond 29

Elevation (ft)	Storage (ac-ft)	(cy)
412	0.000	0
414	2.299	3,709
416	5.140	8,293
418	8.580	13,842
420	12.704	20,496
422	17.816	28,744

WASTE MANAGEMENT OF TEXAS, INC.
Skyline Landfill
Pond Data for HEC-HMS
Pond 35 Post
North Postdeveloped Permited Schematic - Page 40

Reservoir

Description:	
Downstream:	Pond 27
Method:	Outflow Structures
Storage Method:	Elevation-Storage
Elev-Stor Function:	Pond 35 Post
Initial Condition:	Inflow = Outflow
Main Tailwater:	Assume None
Auxiliary:	--None--
Time Step Method:	Automatic Adaption
Outlets:	1
Spillways:	1
Dam Tops:	1
Pumps:	0
Dam Break:	No
Dam Seepage:	No
Release:	No
Evaporation:	No

Outlet

Method:	Culvert Outlet
Direction:	Main
Number Barrels:	1
Solution Method:	Automatic
Shape:	Circular
Chart:	1: Concrete Pipe Culvert
Scale:	1: Square edge entrance with headwall
Length:	150
Diameter:	1.5
Inlet Elevation:	420
Entrance Coefficient:	0.5
Outlet Elevation:	419
Exit Coefficient:	1
Mannings n:	0.013

Spillway

Method:	Broad-Crested Spillway
Direction:	Main
Elevation:	431 ft
Length:	100 ft
Coefficient:	2.6
Gates:	0

Dam Tops

Method:	Level Overflow
Direction:	Main
Elevation:	431.94
Length:	400
Coefficient:	2.6

Paired Data

Elevation Storage Functions
Pond 35 Post

Elevation (ft)	Storage (ac-ft)	Storage (cy)
420	0.000	0
422	1.871	3,018
424	4.153	6,701
426	6.920	11,164
428	10.211	16,474
430	14.068	22,697
432	16.598	26,779

WASTE MANAGEMENT OF TEXAS, INC.
Skyline Landfill
Pond Data for HEC-HMS
Pond 39
North Postdeveloped Permited Schematic - Page 40

Reservoir

Description:	
Downstream:	CP10
Method:	Outflow Structures
Storage Method:	Elevation-Storage
Elev-Stor Function:	Pond 39
Initial Condition:	Inflow = Outflow
Main Tailwater:	Assume None
Auxiliary:	--None--
Time Step Method:	Automatic Adaption
Outlets:	1
Spillways:	1
Dam Tops:	1
Pumps:	0
Dam Break:	No
Dam Seepage:	No
Release:	No
Evaporation:	No

Outlet

Method:	Culvert Outlet
Direction:	Main
Number Barrels:	3
Solution Method:	Automatic
Shape:	Circular
Chart:	1: Concrete Pipe Culvert
Scale:	1: Square edge entrance with headwall
Length:	280
Diameter:	3
Inlet Elevation:	420
Entrance Coefficient:	0.5
Outlet Elevation:	419
Exit Coefficient:	1
Mannings n:	0.013

Spillway

Method:	Broad-Crested Spillway
Direction:	Main
Elevation:	427 ft
Length:	40 ft
Coefficient:	2.6
Gates:	0

Dam Tops

Method:	Level Overflow
Direction:	Main
Elevation:	428
Length:	300
Coefficient:	2.6

Paired Data

Elevation Storage Functions
Pond 39

Elevation (ft)	Storage (ac-ft)	Storage (cy)
420	0.024	38
422	4.248	6,853
424	9.201	14,844
426	14.945	24,111
428	21.536	34,744
430	25.390	40,963

WASTE MANAGEMENT OF TEXAS, INC.
Skyline Landfill
Pond Data for HEC-HMS
POND 47
West Postdeveloped Permited Schematic - Page 58

Reservoir

Description:	
Downstream:	CP15
Method:	Outflow Structures
Storage Method:	Elevation-Storage
Elev-Stor Function:	POND 47
Initial Condition:	Inflow = Outflow
Main Tailwater:	Assume None
Auxiliary:	None
Time Step Method:	Automatic Adaption
Outlets:	1
Spillways:	0
Dam Tops:	0
Pumps:	0
Dam Break:	No
Dam Seepage:	No
Release:	No
Evaporation:	No

Spillway

Method:	Broad-Crested Spillway
Direction:	Main
Elevation:	496 ft
Length:	50 ft
Coefficient:	2.6
Gates:	0

Dam Tops

Method:	
Direction:	
Elevation:	
Length:	
Coefficient:	

Outlet

Method:	Culvert Outlet	
Direction:	Main	
Number Barrels:	1	
Solution Method:	Automatic	
Shape:	Circular	
Chart:	1: Concrete Pipe Culvert	
Scale:	1:Square edge entrance with headwall	
Length:	58	ft
Diameter:	4	ft
Inlet Elevation:	491	ft
Entrance Coefficient:	0.5	
Outlet Elevation:	490	
Exit Coefficient:	1	
Mannings n:	0.013	

Paired Data

Elevation Storage Functions
POND 47

Elevation (ft)	Storage (ac-ft)	(cy)
491	0.000	0
492	0.014	22
494	0.142	230
496	0.447	721
498	0.679	1,096

WASTE MANAGEMENT OF TEXAS, INC.
Skyline Landfill
Pond Data for HEC-HMS
Pond 59
South Postdeveloped Permited Schematic - Page 71

Reservoir

Description:	
Downstream:	CP18
Method:	Outflow Structures
Storage Method:	Elevation-Storage
Elev-Stor Function:	Pond 59
Initial Condition:	Inflow = Outflow
Main Tailwater:	Assume None
Auxiliary:	--None--
Time Step Method:	Automatic Adaption
Outlets:	1
Spillways:	1
Dam Tops:	1
Pumps:	0
Dam Break:	No
Dam Seepage:	No
Release:	No
Evaporation:	No

Outlet

Method:	Culvert Outlet
Direction:	Main
Number Barrels:	1
Solution Method:	Automatic
Shape:	Circular
Chart:	1: Concrete Pipe Culvert
Scale:	1: Square edge entrance with headwall
Length:	100
Diameter:	4
Inlet Elevation:	480
Entrance Coefficient:	0.5
Outlet Elevation:	479
Exit Coefficient:	1
Mannings n:	0.013

Spillway

Method:	Broad-Crested Spillway
Direction:	Main
Elevation:	489 ft
Length:	70 ft
Coefficient:	2.6
Gates:	0

Dam Tops

Method:	Level Overflow
Direction:	Main
Elevation:	490
Length:	450
Coefficient:	2.6

Paired Data

Elevation Storage Functions
Pond 59

Elevation (ft)	Storage (ac-ft)	Storage (cy)
480	0.049	79
482	3.361	5,422
484	7.696	12,416
486	13.421	21,652
488	20.894	33,708
490	30.198	48,720
492	35.561	57,372

WASTE MANAGEMENT OF TEXAS, INC.
Skyline Landfill
Pond Data for HEC-HMS
I-07
North Postdeveloped Permited Schematic - Page 40

Reservoir

Description:	
Downstream:	Pond 06
Method:	Outflow Structures
Storage Method:	Elevation-Storage
Elev-Stor Function:	I-07
Initial Condition:	Inflow = Outflow
Main Tailwater:	Assume None
Auxiliary:	R12
Time Step Method:	Automatic Adaption
Outlets:	1
Spillways:	1
Dam Tops:	0
Pumps:	0
Dam Break:	No
Dam Seepage:	No
Release:	No
Evaporation:	No

Outlet

Method:	Orifice Outlet
Direction:	Main
Number Barrels:	1
Center Elevation:	453.25
Area	7
Coefficient:	0.67

Spillway

Method:	Broad-Crested Spillway
Direction:	Auxilliary
Elevation:	453.5 ft
Length:	15 ft
Coefficient:	2.6
Gates:	

Dam Tops

Method:	
Direction:	
Elevation:	
Length:	
Coefficient:	

Paired Data

Elevation Storage Functions
I-07

Elevation (ft)	Storage (ac-ft)	(cy)
453	0.000	0
455	0.006	10.3

WASTE MANAGEMENT OF TEXAS, INC.
Skyline Landfill
Pond Data for HEC-HMS
I-09
North Postdeveloped Permited Schematic - Page 40

Reservoir

Description:	
Downstream:	Pond 08
Method:	Outflow Structures
Storage Method:	Elevation-Storage
Elev-Stor Function:	I-09
Initial Condition:	Inflow = Outflow
Main Tailwater:	Assume None
Auxiliary:	CP27
Time Step Method:	Automatic Adaption
Outlets:	1
Spillways:	1
Dam Tops:	1
Pumps:	0
Dam Break:	No
Dam Seepage:	No
Release:	No
Evaporation:	No

Outlet

Method:	Orifice Outlet
Direction:	Main
Number Barrels:	1
Center Elevation:	421.5
Area	4.5
Coefficient:	0.67

Spillway

Method:	Broad-Crested Spillway
Direction:	Auxiliary
Elevation:	421.5 ft
Length:	10 ft
Coefficient:	2.6
Gates:	

Dam Tops

Method:	
Direction:	
Elevation:	
Length:	
Coefficient:	

Paired Data

Elevation Storage Functions
I-09

Elevation (ft)	Storage (ac-ft)	(cy)
421	0.000	0
423	0.009	13.9

WASTE MANAGEMENT OF TEXAS, INC.
Skyline Landfill
Pond Data for HEC-HMS
I-11
North Postdeveloped Permited Schematic - Page 40

Reservoir

Description:	
Downstream:	R08
Method:	Outflow Structures
Storage Method:	Elevation-Storage
Elev-Stor Function:	I-11
Initial Condition:	Inflow = Outflow
Main Tailwater:	Assume None
Auxiliary:	--None--
Time Step Method:	Automatic Adaption
Outlets:	1
Spillways:	1
Dam Tops:	0
Pumps:	0
Dam Break:	No
Dam Seepage:	No
Release:	No
Evaporation:	No

Outlet

Method:	Culvert Outlet
Direction:	Main
Number Barrels:	1
Solution Method:	Automatic
Shape:	Circular
Chart:	1: Concrete Pipe Culvert
Scale:	1: Square edge entrance with headwall
Length:	492 ft
Diameter:	3.5 ft
Inlet Elevation:	430 ft
Entrance Coefficient:	0.5
Outlet Elevation:	426
Exit Coefficient:	1
Mannings n:	0.013

Spillway

Method:	Broad-Crested Spillway
Direction:	Main
Elevation:	435 ft
Length:	60 ft
Coefficient:	2.6
Gates:	0

Dam Tops

Method:	
Direction:	
Elevation:	
Length:	
Coefficient:	

Paired Data

Elevation Storage Functions
I-11

Elevation (ft)	Storage (ac-ft)	(cy)
428	0.000	0
430	0.003	5
432	0.147	237
434	0.694	1120
436	1.491	2406
438	2.288	3692

WASTE MANAGEMENT OF TEXAS, INC.
Skyline Landfill
Pond Data for HEC-HMS
I-12
North Postdeveloped Permited Schematic - Page 40

Reservoir

Description:	
Downstream:	Pond 10
Method:	Outflow Structures
Storage Method:	Elevation-Storage
Elev-Stor Function:	I-12
Initial Condition:	Inflow = Outflow
Main Tailwater:	Assume None
Auxiliary:	--None--
Time Step Method:	Automatic Adaption
Outlets:	1
Spillways:	1
Dam Tops:	0
Pumps:	0
Dam Break:	No
Dam Seepage:	No
Release:	No
Evaporation:	No

Outlet

Method:	Orifice Outlet
Direction:	Main
Number Barrels:	1
Center Elevation:	436 ft
Area	7 sf
Coefficient:	0.67

Spillway

Method:	Broad-Crested Spillway
Direction:	Main
Elevation:	437 ft
Length:	20 ft
Coefficient:	2.6
Gates:	0

Dam Tops

Method:	
Direction:	
Elevation:	
Length:	
Coefficient:	

Paired Data

Elevation Storage Functions
I-12

Elevation (ft)	Storage (ac-ft)	(cy)
434	0.000	0
436	0.001	2
438	0.037	59

WASTE MANAGEMENT OF TEXAS, INC.
Skyline Landfill
Pond Data for HEC-HMS
I-16
North Postdeveloped Permited Schematic - Page 40

Reservoir

Description:	
Downstream:	R16
Method:	Outflow Structures
Storage Method:	Elevation-Storage
Elev-Stor Function:	I-16
Initial Condition:	Inflow = Outflow
Main Tailwater:	Assume None
Auxiliary:	--None--
Time Step Method:	Automatic Adaption
Outlets:	1
Spillways:	1
Dam Tops:	0
Pumps:	0
Dam Break:	No
Dam Seepage:	No
Release:	No
Evaporation:	No

Outlet

Method:	Culvert Outlet
Direction:	Main
Number Barrels:	3
Solution Method:	Automatic
Shape:	Circular
Chart:	2: Corrugated Metal Pipe
Scale:	3: Pipe Projecting from Fill
Length:	310 ft
Diameter:	3.5 ft
Inlet Elevation:	446.19 ft
Entrance Coefficient:	0.8
Outlet Elevation:	443.77
Exit Coefficient:	1
Mannings n:	0.015

Spillway

Method:	Broad-Crested Spillway
Direction:	Main
Elevation:	456 ft
Length:	110 ft
Coefficient:	2.6
Gates:	0

Dam Tops

Method:	
Direction:	
Elevation:	
Length:	
Coefficient:	

Paired Data

Elevation Storage Functions
I-16

Elevation (ft)	Storage (ac-ft)	Storage (cy)
446.19	0.000	0
448	0.067	108.8
450	0.313	505.1
452	0.839	1354.1
454	1.764	2846.3
456	3.182	5133.9
458	4.744	7653.8

WASTE MANAGEMENT OF TEXAS, INC.
Skyline Landfill
Pond Data for HEC-HMS
I-19
North Postdeveloped Permited Schematic - Page 40

Reservoir

Description:	
Downstream:	R19
Method:	Outflow Structures
Storage Method:	Elevation-Storage
Elev-Stor Function:	I-19
Initial Condition:	Inflow = Outflow
Main Tailwater:	Assume None
Auxiliary:	--None--
Time Step Method:	Automatic Adaption
Outlets:	1
Spillways:	1
Dam Tops:	0
Pumps:	0
Dam Break:	No
Dam Seepage:	No
Release:	No
Evaporation:	No

Outlet

Method:	Culvert Outlet
Direction:	Main
Number Barrels:	2
Solution Method:	Automatic
Shape:	Circular
Chart:	1: Concrete Pipe Culvert
Scale:	1: Square edge entrance with headwall
Length:	82 ft
Diameter:	4 ft
Inlet Elevation:	466.83 ft
Entrance Coefficient:	0.5
Outlet Elevation:	466.33
Exit Coefficient:	1
Mannings n:	0.013

Spillway

Method:	Broad-Crested Spillway
Direction:	Main
Elevation:	473.5 ft
Length:	82 ft
Coefficient:	2.6
Gates:	0

Dam Tops

Method:	
Direction:	
Elevation:	
Length:	
Coefficient:	

Paired Data

Elevation Storage Functions
I-19

Elevation (ft)	Storage (ac-ft)	Storage (cy)
466.83	0.000	0
468	0.025	40.3
470	0.177	285
472	0.566	913.1
474	1.454	2346.3
476	3.118	5031.1

WASTE MANAGEMENT OF TEXAS, INC.
Skyline Landfill
Pond Data for HEC-HMS
I-64
West Postdeveloped Permited Schematic - Page 58

Reservoir

Description:	
Downstream:	I-47
Method:	Outflow Structures
Storage Method:	Elevation-Storage
Elev-Stor Function:	I-64
Initial Condition:	Inflow = Outflow
Main Tailwater:	Assume None
Auxiliary:	CP28
Time Step Method:	Automatic Adaption
Outlets:	2
Spillways:	0
Dam Tops:	0
Pumps:	0
Dam Break:	No
Dam Seepage:	No
Release:	No
Evaporation:	No

Paired Data
Elevation Storage Functions
I-64

Elevation (ft)	Storage (ac-ft)	(cy)
501	0.000	0
502	0.543	877
504	2.606	4,204
506	5.901	9,521
507	8.211	13,247

Outlet

Method:	Culvert Outlet	
Direction:	Main	
Number Barrels:	1	
Solution Method:	Automatic	
Shape:	Circular	
Chart:	1: Concrete Pipe Culvert	
Scale:	1:Square edge entrance with headwall	
Length:	50	ft
Diameter:	1	ft
Inlet Elevation:	501	ft
Entrance Coefficient:	0.5	
Outlet Elevation:	500	
Exit Coefficient:	1	
Mannings n:	0.013	

Outlet

Method:	Culvert Outlet	
Direction:	Auxliary	
Number Barrels:	1	
Solution Method:	Automatic	
Shape:	Circular	
Chart:	1: Concrete Pipe Culvert	
Scale:	1:Square edge entrance with headwall	
Length:	50	ft
Diameter:	1.5	ft
Inlet Elevation:	502	ft
Entrance Coefficient:	0.5	
Outlet Elevation:	501	
Exit Coefficient:	1	
Mannings n:	0.013	

WASTE MANAGEMENT OF TEXAS, INC.
Skyline Landfill
Pond Data for HEC-HMS
I-OS13
East Postdeveloped Permited Schematic - Page 63

Reservoir

Description:	
Downstream:	I-OS14
Method:	Outflow Structures
Storage Method:	Elevation-Storage
Elev-Stor Function:	I-OS13
Initial Condition:	Inflow = Outflow
Main Tailwater:	Assume None
Auxiliary:	R-OS15
Time Step Method:	Automatic Adaption
Outlets:	1
Spillways:	0
Dam Tops:	0
Pumps:	0
Dam Break:	No
Dam Seepage:	No
Release:	No
Evaporation:	No

Outlet

Method:	Culvert Outlet
Direction:	Main
Number Barrels:	1
Solution Method:	Automatic
Shape:	Circular
Chart:	2: Corrugated Metal Pipe
Scale:	1: Headwall
Length:	64 ft
Diameter:	3 ft
Inlet Elevation:	444 ft
Entrance Coefficient:	0.5
Outlet Elevation:	442
Exit Coefficient:	1
Mannings n:	0.015

Spillway

Method:	Broad-Crested Spillway
Direction:	Auxiliary
Elevation:	448 ft
Length:	10 ft
Coefficient:	2.6
Gates:	0

Dam Tops

Method:	
Direction:	
Elevation:	
Length:	
Coefficient:	

Paired Data

Elevation Storage Functions
I-OS13

Elevation (ft)	Storage (ac-ft)	(cy)
444	0.018	29
446	0.085	137
448	0.463	747
450	1.665	2687
452	3.353	5409

WASTE MANAGEMENT OF TEXAS, INC.
Skyline Landfill
Pond Data for HEC-HMS
I-OS14
East Postdeveloped Permited Schematic - Page 63

Reservoir

Description:	
Downstream:	OH75.1
Method:	Outflow Structures
Storage Method:	Elevation-Storage
Elev-Stor Function:	I-OS14
Initial Condition:	Inflow = Outflow
Main Tailwater:	Assume None
Auxiliary:	--None--
Time Step Method:	Automatic Adaption
Outlets:	1
Spillways:	1
Dam Tops:	0
Pumps:	0
Dam Break:	No
Dam Seepage:	No
Release:	No
Evaporation:	No

Outlet

Method:	Culvert Outlet
Direction:	Main
Number Barrels:	1
Solution Method:	Automatic
Shape:	Box
Chart:	8: Flared Wingwalls
Scale:	1: Wingwalls Flared 30 to 75 degrees
Length:	34 ft
Rise:	2 ft
Span:	3 ft
Inlet Elevation:	442 ft
Entrance Coefficient:	0.5
Outlet Elevation:	442
Exit Coefficient:	1
Mannings n:	0.013

Spillway

Method:	Broad-Crested Spillway
Direction:	Main
Elevation:	443 ft
Length:	100 ft
Coefficient:	2.6
Gates:	0

Dam Tops

Method:	
Direction:	
Elevation:	
Length:	
Coefficient:	

Paired Data

Elevation Storage Functions
I-OS14

Elevation (ft)	Storage (ac-ft)	(cy)
440	0.002	3
442	0.051	82
444	0.180	290

WASTE MANAGEMENT OF TEXAS, INC.
Skyline Landfill
Pond Data for HEC-HMS
I-OS15
East Postdeveloped Permited Schematic - Page 63

Reservoir

Description:	
Downstream:	I-OS16
Method:	Outflow Structures
Storage Method:	Elevation-Storage
Elev-Stor Function:	I-OS15
Initial Condition:	Inflow = Outflow
Main Tailwater:	Assume None
Auxiliary:	R-OS17
Time Step Method:	Automatic Adaption
Outlets:	1
Spillways:	0
Dam Tops:	0
Pumps:	0
Dam Break:	No
Dam Seepage:	No
Release:	No
Evaporation:	No

Outlet

Method:	Culvert Outlet
Direction:	Main
Number Barrels:	1
Solution Method:	Automatic
Shape:	Box
Chart:	10: 90 degree headwall
Scale:	1: Inlets chamfered 3/4-inch
Length:	50 ft
Rise:	2 ft
Span:	2 ft
Inlet Elevation:	432
Entrance Coefficient:	0.5
Outlet Elevation:	430
Exit Coefficient:	1
Mannings n:	0.013

Spillway

Method:	Broad-Crested Spillway
Direction:	Auxiliary
Elevation:	438 ft
Length:	10 ft
Coefficient:	2.6
Gates:	

Dam Tops

Method:	
Direction:	
Elevation:	
Length:	
Coefficient:	

Paired Data

Elevation Storage Functions
I-OS15

Elevation (ft)	Storage (ac-ft)	(cy)
432	0.001	2
434	0.025	40.9
436	0.118	190.9
438	0.339	546.9
440	0.660	1064.9

WASTE MANAGEMENT OF TEXAS, INC.
Skyline Landfill
Pond Data for HEC-HMS
I-OS16
East Postdeveloped Permited Schematic - Page 63

Reservoir

Description:	
Downstream:	OH75.2
Method:	Outflow Structures
Storage Method:	Elevation-Storage
Elev-Stor Function:	I-OS16
Initial Condition:	Inflow = Outflow
Main Tailwater:	Assume None
Auxiliary:	--None--
Time Step Method:	Automatic Adaption
Outlets:	1
Spillways:	1
Dam Tops:	0
Pumps:	0
Dam Break:	No
Dam Seepage:	No
Release:	No
Evaporation:	No

Outlet

Method:	Culvert Outlet
Direction:	Main
Number Barrels:	1
Solution Method:	Automatic
Shape:	Circular
Chart:	2: Corrugated Metal Pipe
Scale:	3: Pipe projecting from fill
Length:	65 ft
Diameter:	2 ft
Inlet Elevation:	426 ft
Entrance Coefficient:	0.5
Outlet Elevation:	426
Exit Coefficient:	1
Mannings n:	0.013

Spillway

Method:	Broad-Crested Spillway
Direction:	Main
Elevation:	430 ft
Length:	100 ft
Coefficient:	2.6
Gates:	0

Dam Tops

Method:	
Direction:	
Elevation:	
Length:	
Coefficient:	

Paired Data

Elevation Storage Functions
I-OS16

Elevation (ft)	Storage (ac-ft)	(cy)
426	0.000	0
428	0.009	14.6
430	0.037	59.9
432	0.065	105.2

WASTE MANAGEMENT OF TEXAS, INC.
Skyline Landfill
Pond Data for HEC-HMS
I-OS17
East Postdeveloped Permited Schematic - Page 63

Reservoir

Description:	
Downstream:	I-OS18
Method:	Outflow Structures
Storage Method:	Elevation-Storage
Elev-Stor Function:	I-OS17
Initial Condition:	Inflow = Outflow
Main Tailwater:	Assume None
Auxiliary:	--None--
Time Step Method:	Automatic Adaption
Outlets:	1
Spillways:	0
Dam Tops:	0
Pumps:	0
Dam Break:	No
Dam Seepage:	No
Release:	No
Evaporation:	No

Outlet

Method:	Culvert Outlet
Direction:	Main
Number Barrels:	1
Solution Method:	Automatic
Shape:	Box
Chart:	10: 90 degree headwall
Scale:	1: Inlets chamfered 3/4-inch
Length:	50 ft
Rise:	2 ft
Span:	2 ft
Inlet Elevation:	430
Entrance Coefficient:	0.5
Outlet Elevation:	428
Exit Coefficient:	1
Mannings n:	0.013

Spillway

Method:	
Direction:	
Elevation:	ft
Length:	ft
Coefficient:	
Gates:	

Dam Tops

Method:	
Direction:	
Elevation:	
Length:	
Coefficient:	

Paired Data

Elevation Storage Functions
I-OS17

Elevation (ft)	Storage (ac-ft)	(cy)
428	0.000	0
430	0.004	6
432	0.030	48
434	0.203	328

WASTE MANAGEMENT OF TEXAS, INC.
Skyline Landfill
Pond Data for HEC-HMS
I-OS18
East Postdeveloped Permited Schematic - Page 63

Reservoir

Description:	
Downstream:	OH75.3
Method:	Outflow Structures
Storage Method:	Elevation-Storage
Elev-Stor Function:	I-OS18
Initial Condition:	Inflow = Outflow
Main Tailwater:	Assume None
Auxiliary:	--None--
Time Step Method:	Automatic Adaption
Outlets:	1
Spillways:	1
Dam Tops:	0
Pumps:	0
Dam Break:	No
Dam Seepage:	No
Release:	No
Evaporation:	No

Outlet

Method:	Culvert Outlet
Direction:	Main
Number Barrels:	1
Solution Method:	Automatic
Shape:	Circular
Chart:	2: Corrugated Metal Pipe
Scale:	3: Pipe projecting from fill
Length:	76 ft
Diameter:	2 ft
Inlet Elevation:	424 ft
Entrance Coefficient:	0.5
Outlet Elevation:	421
Exit Coefficient:	1
Mannings n:	0.013

Spillway

Method:	Broad-Crested Spillway
Direction:	Main
Elevation:	425 ft
Length:	100 ft
Coefficient:	2.6
Gates:	0

Dam Tops

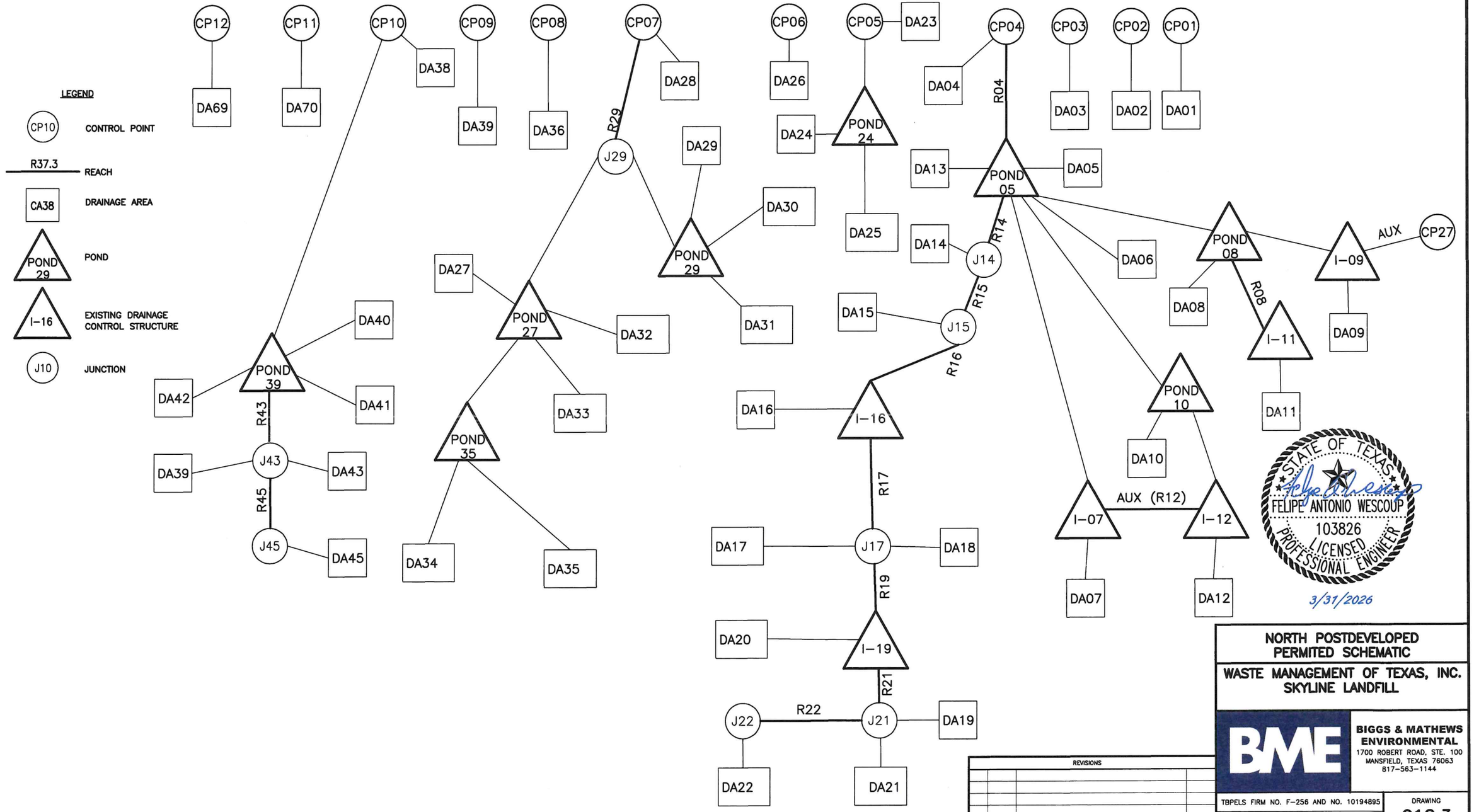
Method:	
Direction:	
Elevation:	
Length:	
Coefficient:	

Paired Data

Elevation Storage Functions
I-OS18

Elevation (ft)	Storage (ac-ft)	(cy)
424	0.004	6
426	0.127	205

POSTDEVELOPED HYDROLOGIC ANALYSIS
25-YEAR, 24-HOUR STORM EVENT



STATE OF TEXAS
FELIPE ANTONIO WESCOUP
103826
LICENSED
PROFESSIONAL ENGINEER
3/31/2026

NORTH POSTDEVELOPED PERMITED SCHEMATIC

WASTE MANAGEMENT OF TEXAS, INC. SKYLINE LANDFILL

REVISIONS			
REV	DATE	DESCRIPTION	DWN BY

BIGGS & MATHEWS ENVIRONMENTAL
1700 ROBERT ROAD, STE. 100
MANSFIELD, TEXAS 76063
817-563-1144
TBPELS FIRM NO. F-256 AND NO. 10194895
TBPG FIRM NO. 50222

DRAWING C1C.3

O:\Waste Management\Skyline\Solid Waste\P\Drawings\Part III\Att. C\C1C.3-DespDrngGraph.dwg Layout: C1B.3 User: awhite

Project:	2025 Skyline	Simulation Run:	North Post Two
Start of Run:	11Jul2025, 00:00	Basin Model:	North Post -Two
End of Run:	16Jul2025, 00:00	Meteorologic Model:	25-Year
Compute Time:	01OCt2025, 09:45:42	Control Specifications	Control 1

Hydrologic Element	Drainage Area (MI^2)	Peak Discharge (CFS)	Time of Peak	Volume (ACRE-FT)
CP01	0.0341	61.9	11 July 2025, 12:35	10.2
CP02	0.0062	15.1	11 July 2025, 12:25	1.9
CP03	0.0019	5.8	11 July 2025, 12:15	0.6
CP04	0.3782	314.7	11 July 2025, 13:05	96.4
CP05	0.0547	85	11 July 2025, 12:30	17.2
CP06	0.0417	82.2	11 July 2025, 12:30	12.5
CP07	0.2136	191	11 July 2025, 12:35	66.8
CP08	0.0018	5.6	11 July 2025, 12:15	0.5
CP09	0.0051	13.1	11 July 2025, 12:20	1.5
CP10	0.2671	320.5	11 July 2025, 12:35	82
CP11	0.0471	97.4	11 July 2025, 12:25	14.1
CP12	0.0083	21.2	11 July 2025, 12:20	2.5
CP27	0	0.3	11 July 2025, 12:35	0
DA01	0.0341	61.9	11 July 2025, 12:35	10.2
DA02	0.0062	15.1	11 July 2025, 12:25	1.9
DA03	0.0019	5.8	11 July 2025, 12:15	0.6
DA04	0.0202	49.1	11 July 2025, 12:20	6.1
DA05	0.0164	42.5	11 July 2025, 12:20	5.4
DA06	0.0224	57.3	11 July 2025, 12:20	7.3
DA07	0.001	2.2	11 July 2025, 12:30	0.3
DA08	0.01	20.6	11 July 2025, 12:35	3.2
DA09	0.0029	5.5	11 July 2025, 12:35	0.9
DA10	0.0073	24.2	11 July 2025, 12:15	2.5
DA11	0.0227	50.1	11 July 2025, 12:25	6.8
DA12	0.0257	61.2	11 July 2025, 12:25	7.7
DA13	0.0299	61.5	11 July 2025, 12:30	9.1
DA14	0.0028	9.2	11 July 2025, 12:15	0.9
DA15	0.0252	72.1	11 July 2025, 12:20	8
DA16	0.0305	67.8	11 July 2025, 12:25	9.3
DA17	0.0302	87.8	11 July 2025, 12:15	9.6
DA18	0.024	50.4	11 July 2025, 12:30	7.2
DA19	0.0156	30	11 July 2025, 12:35	4.8
DA20	0.0323	93.9	11 July 2025, 12:15	10.3
DA21	0.0293	81.7	11 July 2025, 12:20	9.3
DA22	0.0298	81.3	11 July 2025, 12:20	9.5
DA23	0.0174	41.1	11 July 2025, 12:25	5.2

DA24	0.0058	17.3	11 July 2025, 12:20	2
DA25	0.0315	89.3	11 July 2025, 12:20	10
DA26	0.0417	82.2	11 July 2025, 12:30	12.5
DA27	0.0109	32.2	11 July 2025, 12:20	4
DA28	0.024	53.8	11 July 2025, 12:25	7.2
DA29	0.0096	26	11 July 2025, 12:20	3.2
DA30	0.0314	78	11 July 2025, 12:20	9.8
DA31	0.0329	84.9	11 July 2025, 12:20	10.3
DA32	0.0321	82.9	11 July 2025, 12:20	10
DA33	0.0326	74.8	11 July 2025, 12:25	10
DA34	0.0344	85.9	11 July 2025, 12:20	10.5
DA35	0.0057	19.3	11 July 2025, 12:15	2
DA36	0.0018	5.6	11 July 2025, 12:15	0.5
DA37	0.0051	13.1	11 July 2025, 12:20	1.5
DA38	0.0687	138.2	11 July 2025, 12:30	20.6
DA39	0.0442	93.9	11 July 2025, 12:30	13.8
DA40	0.0336	77.1	11 July 2025, 12:25	10.3
DA41	0.0315	73.6	11 July 2025, 12:25	9.6
DA42	0.0303	69.6	11 July 2025, 12:25	9.3
DA43	0.0294	78.5	11 July 2025, 12:20	9.4
DA45	0.0294	73	11 July 2025, 12:20	9.2
DA69	0.0083	21.2	11 July 2025, 12:20	2.5
DA70	0.0471	97.4	11 July 2025, 12:25	14.1
I-07	0.001	2.3	11 July 2025, 12:30	0.3
I-09	0.0029	5.3	11 July 2025, 12:35	0.9
I-11	0.0227	44.3	11 July 2025, 12:35	6.8
I-12	0.0257	61	11 July 2025, 12:25	7.7
I-16	0.1917	378.4	11 July 2025, 12:35	59.7
I-19	0.107	243.3	11 July 2025, 12:30	33.8
J03	0.0084	20.7	11 July 2025, 12:20	2.5
J14	0.2197	422.5	11 July 2025, 12:30	68.7
J15	0.2169	419.6	11 July 2025, 12:30	67.8
J17	0.1612	359.6	11 July 2025, 12:25	50.6
J21	0.0747	186.3	11 July 2025, 12:20	23.6
J22	0.0298	81.3	11 July 2025, 12:20	9.5
J29	0.1896	152.2	11 July 2025, 12:45	59.6
J43	0.103	238.1	11 July 2025, 12:25	32.3
J45	0.0294	73	11 July 2025, 12:20	9.2
OS03	0.0066	16	11 July 2025, 12:25	2
POND05	0.358	301.2	11 July 2025, 13:05	90.3
POND08	0.0356	55.8	11 July 2025, 12:50	8.4
POND10	0.033	0	10 July 2025, 24:00	0
POND24	0.0373	50.2	11 July 2025, 12:40	12
POND27	0.1157	116	11 July 2025, 12:40	36.4

POND29	0.0739	38	11 July 2025, 13:20	23.2
POND35	0.0401	6.6	11 July 2025, 15:10	12.5
POND39	0.1984	204.6	11 July 2025, 12:55	61.4
R04	0.358	301.2	11 July 2025, 13:10	90.3
R08	0.0227	43.7	11 July 2025, 12:35	6.8
R12 AUX	0	0	10 July 2025, 24:00	0
R14	0.2197	422.2	11 July 2025, 12:30	68.7
R15	0.2169	418.4	11 July 2025, 12:35	67.8
R16	0.1917	377.7	11 July 2025, 12:35	59.8
R17	0.1612	358.9	11 July 2025, 12:25	50.6
R19	0.107	242.6	11 July 2025, 12:30	33.8
R21	0.0747	183.1	11 July 2025, 12:25	23.5
R22	0.0298	80.5	11 July 2025, 12:20	9.5
R29	0.1896	152.1	11 July 2025, 12:50	59.6
R43	0.103	236.4	11 July 2025, 12:25	32.3

Project: 2025 Skyline Simulation Run: North Post Two

Reservoir: POND05

Start of Run:	11Jul2025, 00:00	Basin Model:	North Post Two
End of Run:	16Jul2025, 00:00	Meteorologic Model:	25-Years
Compute Time:	01Oct2025, 09:45:42	Control Specifications:	Control 01

Volume Units: ACRE-FT

Computed Results

Peak Inflow:	613.0 (CFS)	Date/Time of Peak Inflow:	11Jul2025, 12:30
Peak Discharge:	301.2 (CFS)	Date/Time of Peak Discharge:	11Jul2025, 13:05
Inflow Volume:	99.2 (ACRE-FT)	Peak Storage:	48.8 (ACRE-FT)
Discharge Volume:	90.3 (ACRE-FT)	Peak Elevation:	418.0 (FT)

Project: 2025 Skyline Simulation Run: North Post Two

Reservoir: POND08

Start of Run:	11Jul2025, 00:00	Basin Model:	North Post Two
End of Run:	16Jul2025, 00:00	Meteorologic Model:	25-Years
Compute Time:	01Oct2025, 09:45:42	Control Specifications:	Control 01

Volume Units: ACRE-FT

Computed Results

Peak Inflow:	69.6 (CFS)	Date/Time of Peak Inflow:	11Jul2025, 12:35
Peak Discharge:	55.8 (CFS)	Date/Time of Peak Discharge:	11Jul2025, 12:50
Inflow Volume:	10.9 (ACRE-FT)	Peak Storage:	16.1 (ACRE-FT)
Discharge Volume:	8.4 (ACRE-FT)	Peak Elevation:	420.3 (FT)

Project: 2025 Skyline Simulation Run: North Post Two

Reservoir: POND10

Start of Run:	11Jul2025, 00:00	Basin Model:	North Post Two
End of Run:	16Jul2025, 00:00	Meteorologic Model:	25-Years
Compute Time:	01Oct2025, 09:45:42	Control Specifications:	Control 01

Volume Units: ACRE-FT

Computed Results

Peak Inflow:	78.7 (CFS)	Date/Time of Peak Inflow:	11Jul2025, 12:20
Peak Discharge:	0.0 (CFS)	Date/Time of Peak Discharge:	11Jul2025, 00:00
Inflow Volume:	10.2 (ACRE-FT)	Peak Storage:	26.0 (ACRE-FT)
Discharge Volume:	0.0 (ACRE-FT)	Peak Elevation:	429.4 (FT)

Project: 2025 Skyline Simulation Run: North Post Two

Reservoir: POND24

Start of Run:	11Jul2025, 00:00	Basin Model:	North Post Two
End of Run:	16Jul2025, 00:00	Meteorologic Model:	25-Years
Compute Time:	01Oct2025, 09:45:42	Control Specifications:	Control 01

Volume Units: ACRE-FT

Computed Results

Peak Inflow:	106.6 (CFS)	Date/Time of Peak Inflow:	11Jul2025, 12:20
Peak Discharge:	50.2 (CFS)	Date/Time of Peak Discharge:	11Jul2025, 12:40
Inflow Volume:	12.0 (ACRE-FT)	Peak Storage:	4.2 (ACRE-FT)
Discharge Volume:	12.0 (ACRE-FT)	Peak Elevation:	432.9 (FT)

Project: 2025 Skyline Simulation Run: North Post Two

Reservoir: POND27

Start of Run:	11Jul2025, 00:00	Basin Model:	North Post Two
End of Run:	16Jul2025, 00:00	Meteorologic Model:	25-Years
Compute Time:	01Oct2025, 09:45:42	Control Specifications:	Control 01

Volume Units: ACRE-FT

Computed Results

Peak Inflow:	191.4 (CFS)	Date/Time of Peak Inflow:	11Jul2025, 12:20
Peak Discharge:	116.0 (CFS)	Date/Time of Peak Discharge:	11Jul2025, 12:40
Inflow Volume:	36.5 (ACRE-FT)	Peak Storage:	3.8 (ACRE-FT)
Discharge Volume:	36.4 (ACRE-FT)	Peak Elevation:	423.1 (FT)

Project: 2025 Skyline Simulation Run: North Post Two

Reservoir: POND29

Start of Run:	11Jul2025, 00:00	Basin Model:	North Post Two
End of Run:	16Jul2025, 00:00	Meteorologic Model:	25-Years
Compute Time:	01Oct2025, 09:45:42	Control Specifications:	Control 01

Volume Units: ACRE-FT

Computed Results

Peak Inflow:	188.9 (CFS)	Date/Time of Peak Inflow:	11Jul2025, 12:20
Peak Discharge:	38.0 (CFS)	Date/Time of Peak Discharge:	11Jul2025, 13:20
Inflow Volume:	23.2 (ACRE-FT)	Peak Storage:	10.9 (ACRE-FT)
Discharge Volume:	23.2 (ACRE-FT)	Peak Elevation:	419.1 (FT)

Project: 2025 Skyline Simulation Run: North Post Two

Reservoir: POND35

Start of Run:	11Jul2025, 00:00	Basin Model:	North Post Two
End of Run:	16Jul2025, 00:00	Meteorologic Model:	25-Years
Compute Time:	01Oct2025, 09:45:42	Control Specifications:	Control 01

Volume Units: ACRE-FT

Computed Results

Peak Inflow:	103.0 (CFS)	Date/Time of Peak Inflow:	11Jul2025, 12:20
Peak Discharge:	6.6 (CFS)	Date/Time of Peak Discharge:	11Jul2025, 15:10
Inflow Volume:	12.5 (ACRE-FT)	Peak Storage:	8.1 (ACRE-FT)
Discharge Volume:	12.5 (ACRE-FT)	Peak Elevation:	426.7 (FT)

Project: 2025 Skyline Simulation Run: North Post Two

Reservoir: POND39

Start of Run:	11Jul2025, 00:00	Basin Model:	North Post Two
End of Run:	16Jul2025, 00:00	Meteorologic Model:	25-Years
Compute Time:	01Oct2025, 09:45:42	Control Specifications:	Control 01

Volume Units: ACRE-FT

Computed Results

Peak Inflow:	456.8 (CFS)	Date/Time of Peak Inflow:	11Jul2025, 12:25
Peak Discharge:	204.6 (CFS)	Date/Time of Peak Discharge:	11Jul2025, 12:55
Inflow Volume:	61.5 (ACRE-FT)	Peak Storage:	18.0 (ACRE-FT)
Discharge Volume:	61.4 (ACRE-FT)	Peak Elevation:	426.9 (FT)

Project: 2025 Skyline Simulation Run: North Post Two

Reservoir: I-07

Start of Run:	11Jul2025, 00:00	Basin Model:	North Post Two
End of Run:	16Jul2025, 00:00	Meteorologic Model:	25-Years
Compute Time:	01Oct2025, 09:45:42	Control Specifications:	Control 01

Volume Units: ACRE-FT

Computed Results

Peak Inflow:	2.2 (CFS)	Date/Time of Peak Inflow:	11Jul2025, 12:30
Peak Discharge:	2.3 (CFS)	Date/Time of Peak Discharge:	11Jul2025, 12:30
Inflow Volume:	0.3 (ACRE-FT)	Peak Storage:	0.0 (ACRE-FT)
Discharge Volume:	0.3 (ACRE-FT)	Peak Elevation:	453.3 (FT)

Project: 2025 Skyline Simulation Run: North Post Two

Reservoir: I-09

Start of Run:	11Jul2025, 00:00	Basin Model:	North Post Two
End of Run:	16Jul2025, 00:00	Meteorologic Model:	25-Years
Compute Time:	01Oct2025, 09:45:42	Control Specifications:	Control 01

Volume Units: ACRE-FT

Computed Results

Peak Inflow:	5.5 (CFS)	Date/Time of Peak Inflow:	11Jul2025, 12:35
Peak Discharge:	5.3 (CFS)	Date/Time of Peak Discharge:	11Jul2025, 12:35
Inflow Volume:	0.9 (ACRE-FT)	Peak Storage:	0.0 (ACRE-FT)
Discharge Volume:	0.9 (ACRE-FT)	Peak Elevation:	421.5 (FT)

Project: 2025 Skyline Simulation Run: North Post Two

Reservoir: I-11

Start of Run:	11Jul2025, 00:00	Basin Model:	North Post Two
End of Run:	16Jul2025, 00:00	Meteorologic Model:	25-Years
Compute Time:	01Oct2025, 09:45:42	Control Specifications:	Control 01

Volume Units: ACRE-FT

Computed Results

Peak Inflow:	50.1 (CFS)	Date/Time of Peak Inflow:	11Jul2025, 12:25
Peak Discharge:	44.3 (CFS)	Date/Time of Peak Discharge:	11Jul2025, 12:35
Inflow Volume:	6.8 (ACRE-FT)	Peak Storage:	0.5 (ACRE-FT)
Discharge Volume:	6.8 (ACRE-FT)	Peak Elevation:	433.4 (FT)

Project: 2025 Skyline Simulation Run: North Post Two

Reservoir: I-12

Start of Run:	11Jul2025, 00:00	Basin Model:	North Post Two
End of Run:	16Jul2025, 00:00	Meteorologic Model:	25-Years
Compute Time:	01Oct2025, 09:45:42	Control Specifications:	Control 01

Volume Units: ACRE-FT

Computed Results

Peak Inflow:	61.2 (CFS)	Date/Time of Peak Inflow:	11Jul2025, 12:25
Peak Discharge:	61.0 (CFS)	Date/Time of Peak Discharge:	11Jul2025, 12:25
Inflow Volume:	7.7 (ACRE-FT)	Peak Storage:	0.0 (ACRE-FT)
Discharge Volume:	7.7 (ACRE-FT)	Peak Elevation:	437.4 (FT)

Project: 2025 Skyline Simulation Run: North Post Two

Reservoir: I-16

Start of Run:	11Jul2025, 00:00	Basin Model:	North Post Two
End of Run:	16Jul2025, 00:00	Meteorologic Model:	25-Years
Compute Time:	01Oct2025, 09:45:42	Control Specifications:	Control 01

Volume Units: ACRE-FT

Computed Results

Peak Inflow:	426.7 (CFS)	Date/Time of Peak Inflow:	11Jul2025, 12:25
Peak Discharge:	378.4 (CFS)	Date/Time of Peak Discharge:	11Jul2025, 12:35
Inflow Volume:	59.9 (ACRE-FT)	Peak Storage:	2.5 (ACRE-FT)
Discharge Volume:	59.7 (ACRE-FT)	Peak Elevation:	455.1 (FT)

Project: 2025 Skyline Simulation Run: North Post Two

Reservoir: I-19

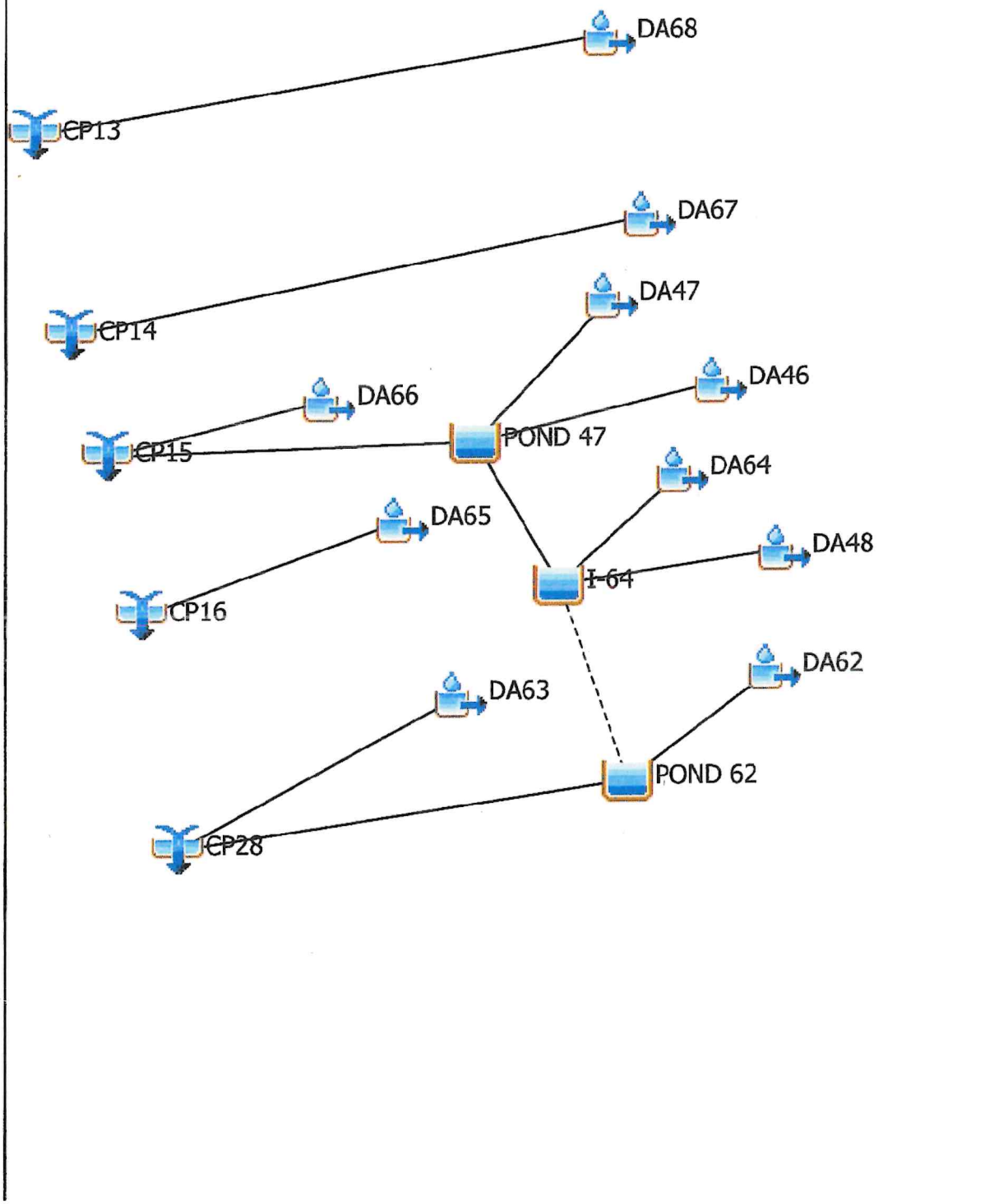
Start of Run:	11Jul2025, 00:00	Basin Model:	North Post Two
End of Run:	16Jul2025, 00:00	Meteorologic Model:	25-Years
Compute Time:	01Oct2025, 09:45:42	Control Specifications:	Control 01

Volume Units: ACRE-FT

Computed Results

Peak Inflow:	268.8 (CFS)	Date/Time of Peak Inflow:	11Jul2025, 12:20
Peak Discharge:	243.3 (CFS)	Date/Time of Peak Discharge:	11Jul2025, 12:30
Inflow Volume:	33.8 (ACRE-FT)	Peak Storage:	1.1 (ACRE-FT)
Discharge Volume:	33.8 (ACRE-FT)	Peak Elevation:	473.2 (FT)

WEST POSTDEVELOPED PERMITTED SCHEMATIC



Project:	2025 Skyline	Simulation Run:	West Post
Start of Run:	11Jul2025, 00:00	Basin Model:	West Post
End of Run:	16Jul2025, 00:00	Meteorologic Model:	25-Year
Compute Time:	16Dec2025, 09:35:44	Control Specifications	Control 1

Hydrologic Element	Drainage Area (MI^2)	Peak Discharge (CFS)	Time of Peak	Volume (ACRE-FT)
CP13	0.0013	3.6	11 July 2025, 12:20	0.4
CP14	0.0068	16.8	11 July 2025, 12:20	2
CP15	0.0907	122.1	11 July 2025, 12:25	22.3
CP16	0.0063	12.3	11 July 2025, 12:35	1.9
CP28	0.007	26.7	11 July 2025, 12:35	8.3
DA46	0.0301	74.8	11 July 2025, 12:20	9.4
DA47	0.0061	13.4	11 July 2025, 12:30	2
DA48	0.0312	77.5	11 July 2025, 12:20	9.7
DA62	0.007	14.5	11 July 2025, 12:30	2.1
DA64	0.009	16.1	11 July 2025, 12:45	3.1
DA65	0.0063	12.3	11 July 2025, 12:35	1.9
DA66	0.0143	33	11 July 2025, 12:25	4.3
DA67	0.0068	16.8	11 July 2025, 12:20	2
DA68	0.0013	3.6	11 July 2025, 12:20	0.4
I-64	0.0402	7.9	11 July 2025, 13:25	6.6
POND 47	0.0764	89	11 July 2025, 12:25	18

Project: 2025 Skyline Simulation Run: West Post

Reservoir: POND 47

Start of Run:	11Jul2025, 00:00	Basin Model:	West Post
End of Run:	16Jul2025, 00:00	Meteorologic Model:	25-Years
Compute Time:	16Dec2025, 09:35:44	Control Specifications:	Control 01

Volume Units: ACRE-FT

Computed Results

Peak Inflow:	92.5 (CFS)	Date/Time of Peak Inflow:	11Jul2025, 12:20
Peak Discharge:	89.0 (CFS)	Date/Time of Peak Discharge:	11Jul2025, 12:25
Inflow Volume:	18.0 (ACRE-FT)	Peak Storage:	0.4 (ACRE-FT)
Discharge Volume:	18.0 (ACRE-FT)	Peak Elevation:	495.9 (FT)

Project: 2025 Skyline Simulation Run: West Post

Reservoir: I-64

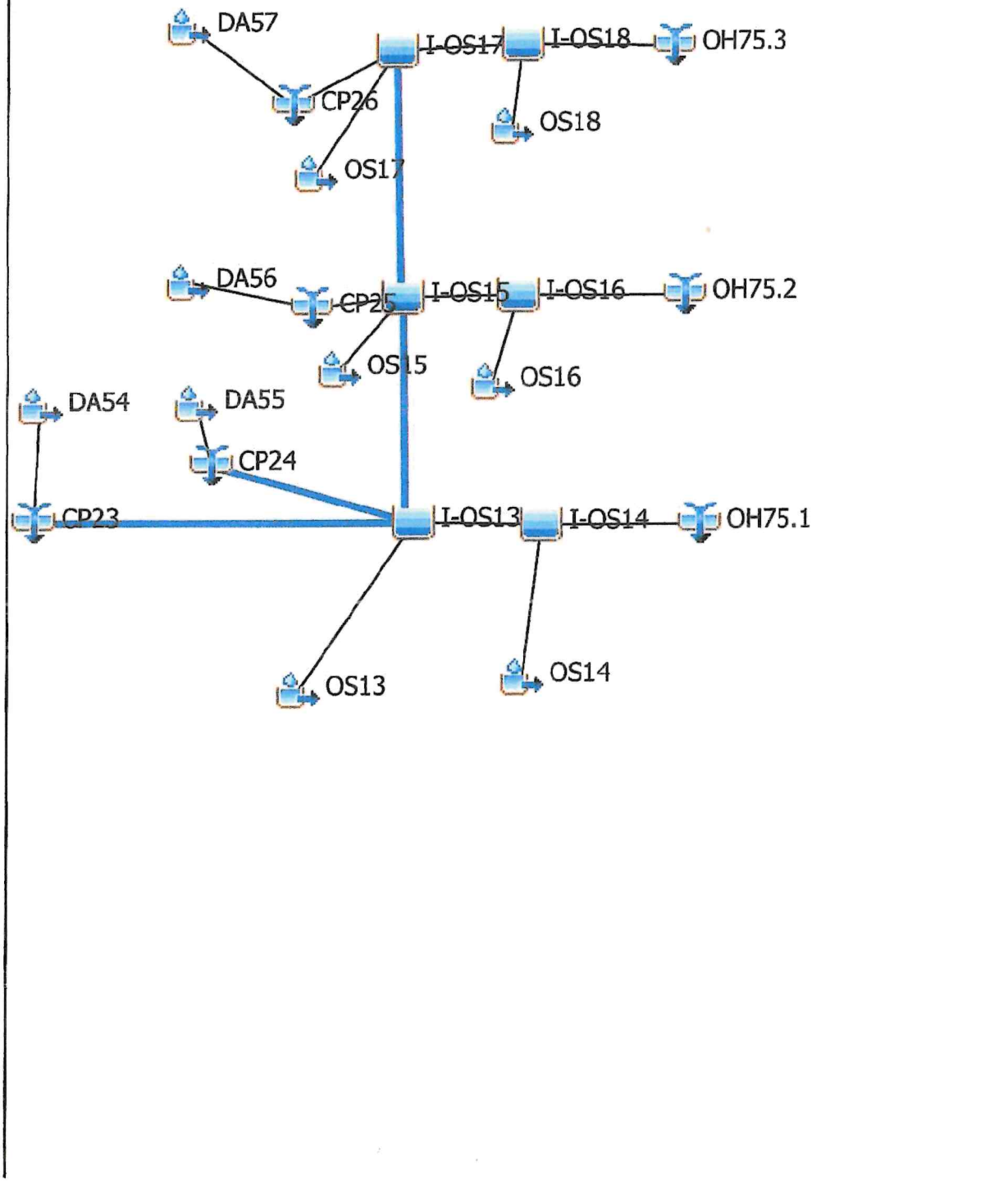
Start of Run:	11Jul2025, 00:00	Basin Model:	West Post
End of Run:	16Jul2025, 00:00	Meteorologic Model:	25-Years
Compute Time:	16Dec2025, 09:35:44	Control Specifications:	Control 01

Volume Units: ACRE-FT

Computed Results

Peak Inflow:	88.2 (CFS)	Date/Time of Peak Inflow:	11Jul2025, 12:20
Peak Discharge:	7.9 (CFS)	Date/Time of Peak Discharge:	11Jul2025, 13:25
Inflow Volume:	12.8 (ACRE-FT)	Peak Storage:	5.7 (ACRE-FT)
Discharge Volume:	6.6 (ACRE-FT)	Peak Elevation:	505.9 (FT)

EAST POSTDEVELOPED PERMITTED SCHEMATIC



	Project:	2025 Skyline	Simulation Run:	East Post
	Start of Run:	11Jul2025, 00:00	Basin Model:	East Post
	End of Run:	16Jul2025, 00:00	Meteorologic Model:	25-Year
	Compute Time:	15Sep2025, 10:44:06	Control Specifications	Control 1

Hydrologic Element	Drainage Area (MI^2)	Peak Discharge (CFS)	Time of Peak	Volume (ACRE-FT)
CP23	0.0058	14.5	11 July 2025, 12:20	1.7
CP24	0.0075	18.4	11 July 2025, 12:20	2.2
CP25	0.0203	40.3	11 July 2025, 12:30	6.1
CP26	0.0025	5.6	11 July 2025, 12:30	0.7
DA54	0.0058	14.5	11 July 2025, 12:20	1.7
DA55	0.0075	18.4	11 July 2025, 12:20	2.2
DA56	0.0203	40.3	11 July 2025, 12:30	6.1
DA57	0.0025	5.6	11 July 2025, 12:30	0.7
I-OS13	0.0387	59.6	11 July 2025, 12:35	11.1
I-OS14	0.0415	65.5	11 July 2025, 12:35	11.9
I-OS15	0.0225	45	11 July 2025, 12:45	7.2
I-OS16	0.025	49.9	11 July 2025, 12:45	7.9
I-OS17	0.0033	7.3	11 July 2025, 12:30	1
I-OS18	0.0056	11.9	11 July 2025, 12:35	1.7
OH75.1	0.0415	65.5	11 July 2025, 12:35	11.9
OH75.2	0.025	49.9	11 July 2025, 12:45	7.9
OH75.3	0.0056	11.9	11 July 2025, 12:35	1.7
OS13	0.0254	54.4	11 July 2025, 12:25	7.6
OS14	0.0028	5.6	11 July 2025, 12:30	0.8
OS15	0.0022	4	11 July 2025, 12:40	0.7
OS16	0.0025	5.3	11 July 2025, 12:30	0.7
OS17	0.0008	1.8	11 July 2025, 12:30	0.2
OS18	0.0023	4.7	11 July 2025, 12:30	0.7
R-OS13.1	0.0058	14.3	11 July 2025, 12:25	1.7
R-OS13.2	0.0075	18.4	11 July 2025, 12:25	2.2
R-OS15	0	14.9	11 July 2025, 12:40	0.5
R-OS17	0	4.2	11 July 2025, 12:50	0

Project: 2025 Skyline Simulation Run: East Post

Reservoir: I-OS13

Start of Run:	11Jul2025, 00:00	Basin Model:	East Post
End of Run:	16Jul2025, 00:00	Meteorologic Model:	25-Years
Compute Time:	15Sep2025, 12:44:06	Control Specifications:	Control 01

Volume Units: ACRE-FT

Computed Results

Peak Inflow:	87.1 (CFS)	Date/Time of Peak Inflow:	11Jul2025, 12:25
Peak Discharge:	59.6 (CFS)	Date/Time of Peak Discharge:	11Jul2025, 12:35
Inflow Volume:	11.6 (ACRE-FT)	Peak Storage:	0.9 (ACRE-FT)
Discharge Volume:	11.1 (ACRE-FT)	Peak Elevation:	448.7 (FT)

Project: 2025 Skyline Simulation Run: East Post

Reservoir: I-OS14

Start of Run:	11Jul2025, 00:00	Basin Model:	East Post
End of Run:	16Jul2025, 00:00	Meteorologic Model:	25-Years
Compute Time:	15Sep2025, 12:44:06	Control Specifications:	Control 01

Volume Units: ACRE-FT

Computed Results

Peak Inflow:	65.2 (CFS)	Date/Time of Peak Inflow:	11Jul2025, 12:35
Peak Discharge:	65.5 (CFS)	Date/Time of Peak Discharge:	11Jul2025, 12:35
Inflow Volume:	11.9 (ACRE-FT)	Peak Storage:	0.1 (ACRE-FT)
Discharge Volume:	11.9 (ACRE-FT)	Peak Elevation:	443.4 (FT)

Project: 2025 Skyline Simulation Run: East Post

Reservoir: I-OS15

Start of Run:	11Jul2025, 00:00	Basin Model:	East Post
End of Run:	16Jul2025, 00:00	Meteorologic Model:	25-Years
Compute Time:	15Sep2025, 12:44:06	Control Specifications:	Control 01

Volume Units: ACRE-FT

Computed Results

Peak Inflow:	54.8 (CFS)	Date/Time of Peak Inflow:	11Jul2025, 12:40
Peak Discharge:	45.0 (CFS)	Date/Time of Peak Discharge:	11Jul2025, 12:45
Inflow Volume:	7.2 (ACRE-FT)	Peak Storage:	0.4 (ACRE-FT)
Discharge Volume:	7.2 (ACRE-FT)	Peak Elevation:	438.3 (FT)

Project: 2025 Skyline Simulation Run: East Post

Reservoir: I-OS16

Start of Run:	11Jul2025, 00:00	Basin Model:	East Post
End of Run:	16Jul2025, 00:00	Meteorologic Model:	25-Years
Compute Time:	15Sep2025, 12:44:06	Control Specifications:	Control 01

Volume Units: ACRE-FT

Computed Results

Peak Inflow:	49.0 (CFS)	Date/Time of Peak Inflow:	11Jul2025, 12:45
Peak Discharge:	49.9 (CFS)	Date/Time of Peak Discharge:	11Jul2025, 12:45
Inflow Volume:	7.9 (ACRE-FT)	Peak Storage:	0.0 (ACRE-FT)
Discharge Volume:	7.9 (ACRE-FT)	Peak Elevation:	430.2 (FT)

Project: 2025 Skyline Simulation Run: East Post

Reservoir: I-OS17

Start of Run:	11Jul2025, 00:00	Basin Model:	East Post
End of Run:	16Jul2025, 00:00	Meteorologic Model:	25-Years
Compute Time:	15Sep2025, 12:44:06	Control Specifications:	Control 01

Volume Units: ACRE-FT

Computed Results

Peak Inflow:	8.5 (CFS)	Date/Time of Peak Inflow:	11Jul2025, 12:50
Peak Discharge:	7.3 (CFS)	Date/Time of Peak Discharge:	11Jul2025, 12:30
Inflow Volume:	1.0 (ACRE-FT)	Peak Storage:	0.0 (ACRE-FT)
Discharge Volume:	1.0 (ACRE-FT)	Peak Elevation:	431.3 (FT)

Project: 2025 Skyline Simulation Run: East Post

Reservoir: I-OS18

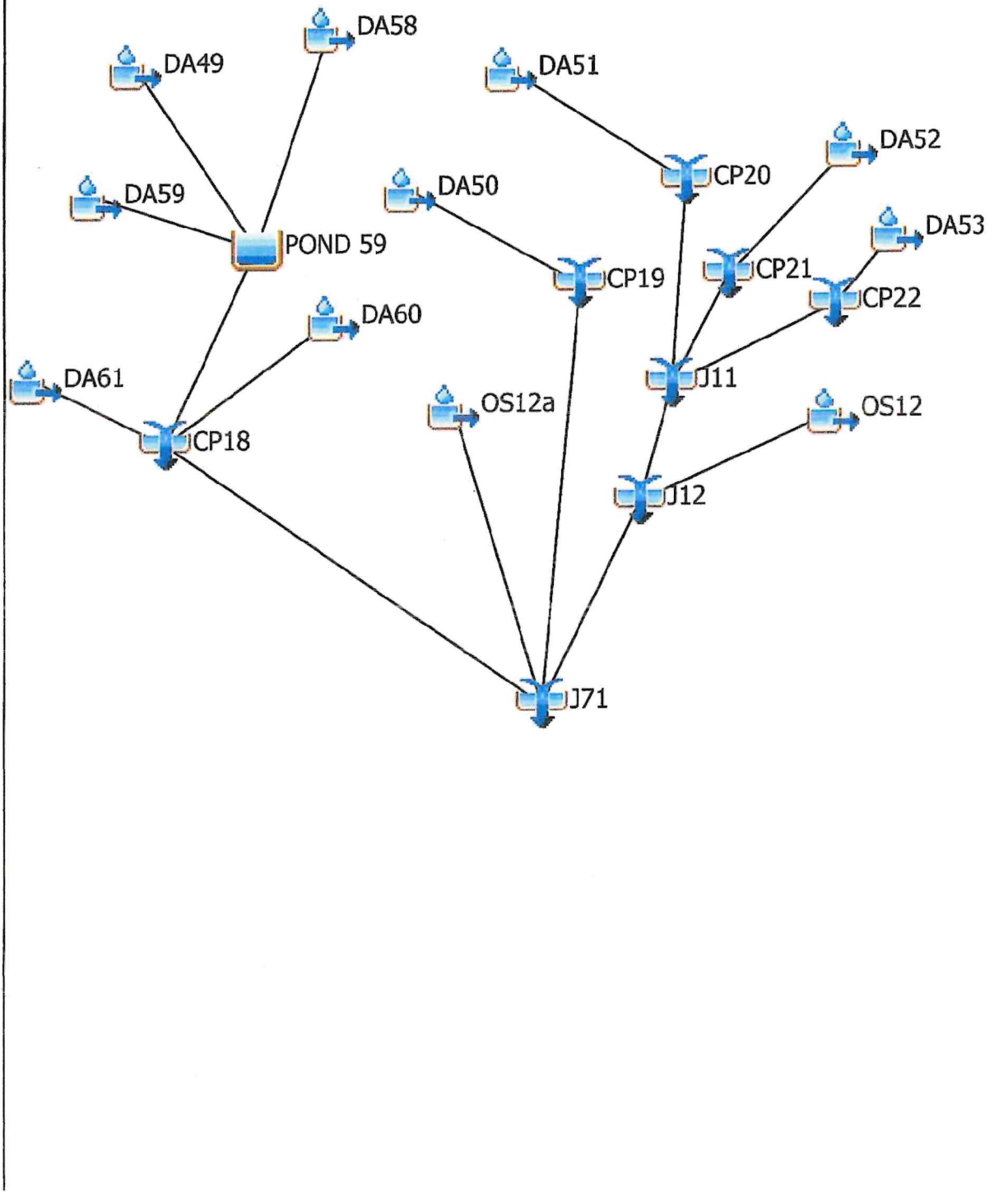
Start of Run:	11Jul2025, 00:00	Basin Model:	East Post
End of Run:	16Jul2025, 00:00	Meteorologic Model:	25-Years
Compute Time:	15Sep2025, 12:44:06	Control Specifications:	Control 01

Volume Units: ACRE-FT

Computed Results

Peak Inflow:	12.0 (CFS)	Date/Time of Peak Inflow:	11Jul2025, 12:30
Peak Discharge:	11.9 (CFS)	Date/Time of Peak Discharge:	11Jul2025, 12:35
Inflow Volume:	1.7 (ACRE-FT)	Peak Storage:	0.1 (ACRE-FT)
Discharge Volume:	1.7 (ACRE-FT)	Peak Elevation:	425.1 (FT)

SOUTH POSTDEVELOPED PERMITTED SCHEMATIC



	Project:	2025 Skyline	Simulation Run:	South Post
	Start of Run:	11Jul2024, 00:00	Basin Model:	South Post
	End of Run:	16Jul2024, 00:00	Meteorologic Model:	25-Year
	Compute Time:	16Dec2025, 08:51:36	Control Specifications	Control 1

Hydrologic Element	Drainage Area (MI^2)	Peak Discharge (CFS)	Time of Peak	Volume (ACRE-FT)
CP18	0.1029	110.6	11 July 2025, 12:35	32.2
CP19	0.0047	10.4	11 July 2025, 12:25	1.4
CP20	0.0117	25.3	11 July 2025, 12:25	3.5
CP21	0.0012	3.1	11 July 2025, 12:20	0.4
CP22	0.0139	37.6	11 July 2025, 12:20	4.2
DA49	0.0245	64.9	11 July 2025, 12:20	7.8
DA50	0.0047	10.4	11 July 2025, 12:25	1.4
DA51	0.0117	25.3	11 July 2025, 12:25	3.5
DA52	0.0012	3.1	11 July 2025, 12:20	0.4
DA53	0.0139	37.6	11 July 2025, 12:20	4.2
DA58	0.031	86.5	11 July 2025, 12:20	9.9
DA59	0.0251	50.1	11 July 2025, 12:35	8.1
DA60	0.0083	16.9	11 July 2025, 12:30	2.5
DA61	0.014	29.6	11 July 2025, 12:30	4.2
J11	0.0268	63.9	11 July 2025, 12:20	8
J12	0.1172	209.7	11 July 2025, 12:30	35.1
J71	0.2251	328.8	11 July 2025, 12:30	68.8
OS12	0.0904	157.9	11 July 2025, 12:35	27.1
OS12a	0.0003	0.7	11 July 2025, 12:30	0.1
POND 59	0.0806	74.9	11 July 2025, 13:00	25.6

Project: 2025 Skyline Simulation Run: South Post

Reservoir: POND 59

Start of Run:	11Jul2025, 00:00	Basin Model:	South Post
End of Run:	16Jul2025, 00:00	Meteorologic Model:	25-Years
Compute Time:	15Sep2025, 12:46:28	Control Specifications:	Control 01

Volume Units: ACRE-FT

Computed Results

Peak Inflow:	191.9 (CFS)	Date/Time of Peak Inflow:	11Jul2025, 12:20
Peak Discharge:	74.9 (CFS)	Date/Time of Peak Discharge:	11Jul2025, 13:00
Inflow Volume:	25.8 (ACRE-FT)	Peak Storage:	11.5 (ACRE-FT)
Discharge Volume:	25.6 (ACRE-FT)	Peak Elevation:	485.3 (FT)

POSTDEVELOPED VELOCITY SUMMARY

WASTE MANAGEMENT OF TEXAS, INC.
SKYLINE LANDFILL
Postdeveloped 25-Year Velocity Calculations at Permit Boundary Comparison Points

Required: Determine the 25-year flow depths and velocities at the permit boundary.

Method: Calculate the flow depths and velocities using Manning's Equation.

Solution:

		Velocity Calculations						
Comparison Point	Q (cfs)	Width[1] (ft)	Bottom Slope[2] (%)	Side Slopes[3] (h:v)	Manning's n	Depth (ft)	Velocity (fps)	Shear Stress (psf)
CP01	61.9	500	10.0	0.0	0.030	**0.05**	**2.26**	**0.34**
CP02	15.1	120	14.0	0.0	0.030	**0.05**	**2.52**	**0.44**
CP03	5.8	200	12.0	0.0	0.030	**0.02**	**1.34**	**0.16**
CP04	316.2	100	9.0	2.0	0.030	**0.39**	**7.95**	**2.22**
CP05	85.0	370	5.0	0.0	0.030	**0.10**	**2.35**	**0.31**
CP06	82.2	365	2.0	0.0	0.030	**0.13**	**1.77**	**0.16**
CP07	191.0	40	3.0	2.0	0.030	**0.70**	**6.59**	**1.31**
CP08	5.6	200	20.0	0.0	0.030	**0.02**	**1.53**	**0.23**
CP09	13.1	15	6.0	0.0	0.030	**0.21**	**4.19**	**0.78**
CP10	320.5	200	11.0	0.0	0.030	**0.25**	**6.47**	**1.70**
CP11	97.4	750	2.0	0.0	0.030	**0.09**	**1.42**	**0.11**
CP12	21.2	250	2.0	0.0	0.030	**0.07**	**1.20**	**0.09**
CP13	3.6	200	6	0	0.030	**0.02**	**0.90**	**0.08**
CP14	16.8	100	7.0	0.0	0.030	**0.07**	**2.29**	**0.32**
CP15	122.1	120	5.0	0.0	0.030	**0.24**	**4.26**	**0.75**
CP16	12.3	500	1.0	0.0	0.030	**0.04**	**0.59**	**0.03**
CP18	110.6	30	2.0	10.0	0.030	**0.65**	**4.69**	**0.81**
CP19	10.4	15	3.0	5.0	0.030	**0.22**	**2.97**	**0.41**
CP20	25.3	125	2.6	0.0	0.030	**0.11**	**1.83**	**0.18**
CP21	3.1	50	5.0	0.0	0.030	**0.04**	**1.39**	**0.14**
CP22	37.6	600	3.0	0.0	0.030	**0.05**	**1.20**	**0.10**
CP23	14.5	10	10.0	6.0	0.030	**0.23**	**5.47**	**1.45**
CP24	18.4	10	12.0	10.0	0.030	**0.25**	**5.98**	**1.85**
CP25	40.3	10	8.0	2.0	0.030	**0.47**	**7.89**	**2.33**
CP26	5.6	20	5.0	0.0	0.030	**0.11**	**2.53**	**0.34**
CP27	0.3	25	1.0	0.0	0.030	**0.03**	**0.44**	**0.02**
CP28	26.7	500	1.0	0.0	0.030	**0.07**	**0.81**	**0.04**

Notes:

1. Comparison points where surface water runoff enters or exits the permit boundary in established natural or constructed channels; width refers to the bottom width of the channel.
   Comparison points where surface water runoff enters or exits the permit boundary as sheet flow or not well established channels; width refers to the sheet flow width.
2. For channels, bottom slope is the slope of the channel bottom where surface water enters or exits the permit boundary.
   For sheet flow, bottom slope is the slope of the ground where surface water enters or exits the permit boundary.
3. For channels, side slope is the average side slope of the channel where surface water enters or exits the permit boundary.
   For sheet flow, there are no side slopes and are represented by "0" in this table.

POSTDEVELOPED FLOW AND BOUNDARY ANALYSIS SUMMARY

WASTE MANAGEMENT OF TEXAS, INC.
SKYLINE LANDFILL
Postdeveloped Flow Summary

Watershed Name	Drainage Area (Ac)	Drainage Area (mi^2)	25-Year Peak Flow (cfs)	25-Year Volume (Ac-ft)
DA01	21.8	0.0341	61.9	10.2
DA02	4.0	0.0062	15.1	1.9
DA03	1.2	0.0019	5.8	0.6
DA04	12.9	0.0202	49.1	6.1
DA05	10.5	0.0164	42.5	5.4
DA06	14.3	0.0224	57.3	7.3
DA07	0.7	0.0010	2.2	0.3
DA08	6.4	0.0100	20.6	3.2
DA09	1.9	0.0029	5.5	0.9
DA10	4.7	0.0073	24.2	2.5
DA11	14.5	0.0227	50.1	6.8
DA12	16.4	0.0257	61.2	7.7
DA13	19.1	0.0299	61.5	9.1
DA14	1.8	0.0028	9.2	0.9
DA15	16.1	0.0252	72.1	8
DA16	19.5	0.0305	67.8	9.3
DA17	19.3	0.0302	87.8	9.6
DA18	15.4	0.0240	50.4	7.2
DA19	10.0	0.0156	30	4.8
DA20	20.7	0.0323	93.9	10.3
DA21	18.8	0.0293	81.7	9.3
DA22	19.1	0.0298	81.3	9.5
DA23	11.1	0.0174	41.1	5.2
DA24	3.7	0.0058	17.3	2
DA25	20.1	0.0315	89.3	10
DA26	26.7	0.0417	82.2	12.5
DA27	7.0	0.0109	32.2	4
DA28	15.4	0.0240	53.8	7.2
DA29	6.1	0.0096	26	3.2
DA30	20.1	0.0314	78	9.8
DA31	21.0	0.0329	84.9	10.3
DA32	20.5	0.0321	82.9	10
DA33	20.9	0.0326	74.8	10
DA34	22.0	0.0344	85.9	10.5
DA35	3.7	0.0057	19.3	2
DA36	1.1	0.0018	5.6	0.5
DA37	3.3	0.0051	13.1	1.5
DA38	43.9	0.0687	138.2	20.6
DA39	28.3	0.0442	93.9	13.8

WASTE MANAGEMENT OF TEXAS, INC.
SKYLINE LANDFILL
Postdeveloped Flow Summary

DA40	21.5	0.0336	77.1	10.3
DA41	20.2	0.0315	73.6	9.6
DA42	19.4	0.0303	69.6	9.3
DA43	18.8	0.0294	78.5	9.4
DA45	18.8	0.0294	73	9.2
DA46	19.3	0.0301	74.8	9.4
DA47	3.9	0.0061	13.4	2
DA48	20.0	0.0312	77.5	9.7
DA49	15.7	0.0245	64.9	7.8
DA50	3.0	0.0047	10.4	1.4
DA51	7.5	0.0117	25.3	3.5
DA52	0.7	0.0012	3.1	0.4
DA53	8.9	0.0139	37.6	4.2
DA54	3.7	0.0058	14.5	1.7
DA55	4.8	0.0075	18.4	2.2
DA56	13.0	0.0203	40.3	6.1
DA57	1.6	0.0025	5.6	0.7
DA58	19.8	0.0310	86.5	9.9
DA59	16.1	0.0251	50.1	8.1
DA60	5.3	0.0083	16.9	2.5
DA61	9.0	0.0140	29.6	4.2
DA62	4.5	0.0070	14.5	2.1
DA64	5.7	0.0090	16.1	3.1
DA65	4.0	0.0063	12.3	1.9
DA66	9.2	0.0143	33	4.3
DA67	4.4	0.0068	16.8	2
DA68	0.8	0.0013	3.6	0.4
DA69	5.3	0.0083	21.2	2.5
DA70	30.1	0.0471	97.2	14.1
OS03	4.2	0.0066	16	2.0
OS12	57.8	0.0904	157.9	27.1
OS12.A	0.2	0.0003	0.7	0.1
OS13	16.2	0.0254	59.6	11.1
OS14	1.8	0.0028	65.5	11.9
OS15	1.4	0.0022	45	7.2
OS16	1.6	0.0025	49.9	7.9
OS17	0.5	0.0008	7.3	1
OS18	1.5	0.0023	11.9	1.7

Postdeveloped Boundary Analysis Summary

Comparison Point	Total Contributing Drainage Area (mi^2)	25-Year Flow Rate (cfs)	25-Year Volume (ac-ft)	25-Year Velocity (fps)
CP1	0.0341	61.9	10.2	2.3
CP2	0.0062	15.1	1.9	2.5
CP3	0.0019	5.8	0.6	1.3
CP4	0.3782	316.2	94.3	8.0
CP5	0.0547	85	17.2	2.3
CP6	0.0417	82.2	12.5	1.8
CP7	0.2136	191	66.8	6.6
CP8	0.0018	5.6	0.5	1.5
CP9	0.0051	13.1	1.5	4.2
CP10	0.2671	320.5	82	6.5
CP11	0.0471	97.4	14.1	1.4
CP12	0.0083	21.2	2.5	1.2
CP13	0.0013	3.6	0.4	0.9
CP14	0.0068	16.8	2	2.3
CP15	0.0907	122.1	22.3	4.3
CP16	0.0063	12.3	1.9	0.6
CP18	0.1029	110.6	32.2	4.7
CP19	0.0047	10.4	1.4	3.0
CP20	0.0117	25.3	3.5	1.8
CP21	0.0012	3.1	0.4	1.4
CP22	0.0139	37.6	4.2	1.2
CP23	0.0058	14.5	1.7	5.5
CP24	0.0075	18.4	2.2	6.0
CP25	0.0203	40.3	6.1	7.9
CP26	0.0025	5.6	0.7	2.5
CP27	0	0.3	0	0.4
CP28	0.007	26.7	8.3	0.8

ATTACHMENT C1
APPENDIX C1D

PERIMETER DRAINAGE SYSTEM DESIGN

CONTENTS

Narrative C1D.1

Perimeter Drainage Plan C1D.3

Perimeter Channel Design Calculations C1D.5

NARRATIVE

30 TAC §§330.303 and 330.305

This appendix presents the design of the Skyline landfill perimeter drainage channels and detention ponds in accordance with §330.305(a)-(d).

PERIMETER DRAINAGE PLAN

Drawing C1D.1 depicts the perimeter drainage channels (ditches), detention ponds, and surface water impoundments at the Skyline landfill. The plan reflects the perimeter channel design and stationing. The perimeter channel hydraulic analysis is included for the 25-year rainfall event.

PERIMETER CHANNEL DESIGN SUMMARY

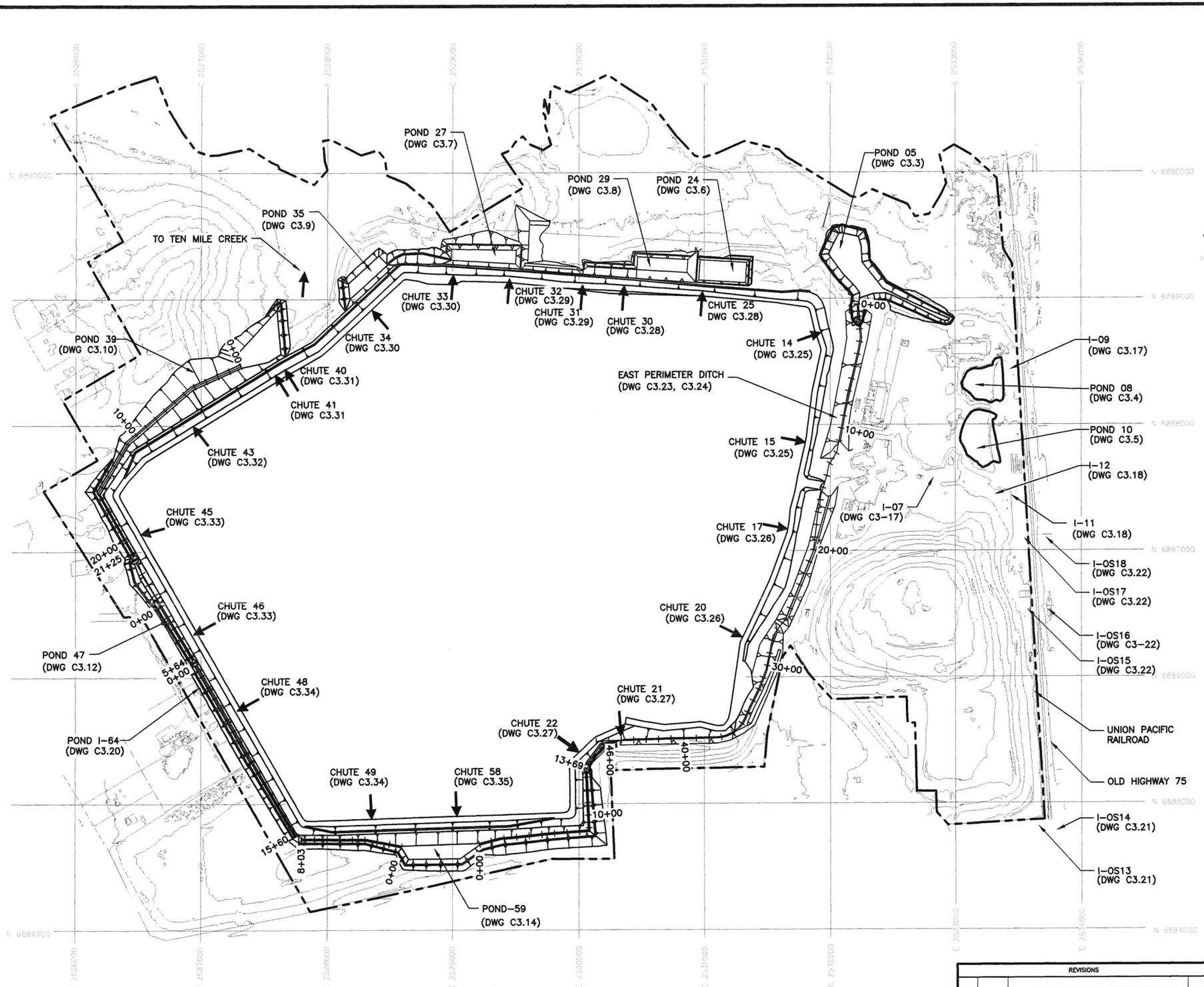
The perimeter channels are designed for peak discharge resulting from the 25-year storm event. The perimeter channel depths and calculated normal depths are summarized in the table below. In several locations along the perimeter channel, the depths are much greater than necessary to convey the predicted stormwater flow rates; however, minimum channel slopes were maintained to help prevent excessive velocity and erosion. The perimeter channel design calculations are shown on page C1D.6. Perimeter channel profiles are included in Attachment C3.

DETENTION POND ANALYSIS

The detention pond was designed to provide the necessary storage and outlet control to mitigate impacts to the receiving channels downstream of the Skyline landfill. The hydraulic design parameter for the detention pond are provided on pages C1C.11 through C1C.13. Detention pond design information is included in Attachment C3. The following table provides storage volume and surface elevation for the 25-year storm event.

Detention Pond	25-Year Water Surface Elevation (feet-msl)	Exterior Berm		Interior Berm/Road	
		Perimeter Pond Berm Elevation (feet-msl)	Freeboard (feet)	Access Road Elevation (feet-msl)	Freeboard (feet)
Pond 05 Post	418	419	1	419	1
Pond 08 Post	420.3	422	1.7	422	1.7
Pond 10 Post	429.4	432	1.7	432	1.7
Pond 24 Post	432.9	436	3.1	438	5.1
Pond 27 Post	423.1	427	3.9	440	16.9
Pond 29 Post	419.1	420	0.9	436	16.9
Pond 35 Post	426.7	431.94	5.24	435	8.3
Pond 39 Post	426.9	428	1.1	434	7.1
Pond 47 Post	495.1	496	0.1	512	16.9
Pond 59 Post	485.3	490	4.7	506	20.7

PERIMETER DRAINAGE PLAN



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SCALE IN FEET

LEGEND

PERMIT BOUNDARY

STATE PLANE GRID NAD 83

NOTE:

1. EXISTING CONTOURS COMPILED BY HYDREX DRONE DIVISION, FROM AERIAL SURVEY FLOWN MARCH 5, 2025.
2. REFER TO DRAINAGE SYSTEM CALLOUTS FOR PONDS, CHANNELS, CHUTES, AND CULVERT DETAILS.

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DRAINAGE STRUCTURE PLAN (DRAINAGE SYSTEM LAYOUT)

WASTE MANAGEMENT OF TEXAS, INC. SKYLINE LANDFILL

BIGGS & MATHEWS ENVIRONMENTAL
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TBPELS FIRM NO. F-256 AND NO. 10194895
TBPG FIRM NO. 50222

DRAWING C1D.1

REVISIONS			
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PERIMETER CHANNEL DESIGN CALCULATIONS

WASTE MANAGEMENT OF TEXAS, INC.
WASTE MANAGEMENT SKYLINE LANDFILL
Depth and Velocity Calculations for the Perimeter Channels for the 25-Year Peak Runoff

Required: Determine the velocity and depth for the perimeter channels and compare to the permissible non-erodible flow velocity.

Method: Manning's Equation for flow velocity.

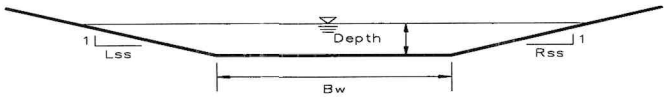
References:

1. Texas Department of Transportation, *Hydraulic Design Manual,* March 2004.

Solution:

Manning's Equation $V = (k/n)(R^{2/3})(S^{1/2})$

V = Velocity (fps)
k = Conversion Factor = 1.486
n = Manning's Roughness Coefficient = 0.03 Grass lined channel
R = Hydraulic Radius = A/Pw
A = Cross-Sectional Area (ft^2)
Pw = Wetted Perimeter (ft)
S = Channel Slope (ft/ft)
Bw = Bottom Width (ft)



Channel	Channel Station		Q (cfs)	S (ft/ft)	BW (ft)	Rss (H:V)	Lss (H:V)	D (ft)	R (ft)	A (sf)	PW (ft)	V (fps)	Shear Stress (psf)
East Channel	0+00	1+09	422.5	0.015	10	5.0	5.0	2.39	1.53	52.52	34.39	8.04	2.24
East Channel	1+09	11+46	419.6	0.016	14	5.0	5.0	2.12	1.46	52.12	35.61	8.05	2.10
East Channel	11+46	16+29	378.8	0.042	14	5.0	5.0	1.57	1.14	34.18	29.97	11.08	4.10
East Channel	16+29	18+58	359.6	0.023	19	5.0	5.0	1.57	1.20	42.13	35.00	8.54	2.27
East Channel	18+58	27+11	280.2	0.026	25	5.0	5.0	1.16	0.97	35.78	36.84	7.83	1.88
East Channel	27+11	28+53	280.2	0.021	10	5.0	5.0	1.81	1.21	34.50	28.47	8.12	2.35
East Channel	28+05	44+98	186.3	0.021	10	5.0	5.0	1.47	1.02	25.58	25.02	7.28	1.93
East Channel	44+98	48+41	81.3	0.060	10	5.0	5.0	0.72	0.57	9.80	17.35	8.29	2.70
Pond 39 Channel	0+00	6+01	238.1	0.040	30	5.0	5.0	0.85	0.75	29.07	38.66	8.19	2.12
Pond 39 Channel	6+01	21+25	73.0	0.029	30	5.0	5.0	0.47	0.44	15.13	34.77	4.83	0.84
Pond 47 Channel	0+00	4+00	96.1	0.009	12	5.0	5.0	1.21	0.90	21.94	24.38	4.38	0.68
Pond 47 Channel	4+00	5+64	16.9	0.009	12	5.0	5.0	0.46	0.40	6.65	16.74	2.54	0.26
Pond 59 Channel	0+00	0+05	64.9	0.010	12	5.0	5.0	0.96	0.74	16.05	21.75	4.04	0.60
Pond 59 Channel	0+05	8+03	15.0	0.010	12	5.0	5.0	0.42	0.36	5.94	16.29	2.53	0.26

ATTACHMENT C1
APPENDIX C1E

FINAL COVER DRAINAGE STRUCTURE DESIGN

CONTENTS

Narrative C1E.1

Final Cover Plans C1E.3

Erosion Layer Evaluation C1E.6

Sheet Flow C1E.14

Drainage Swale Design C1E.16

Drainage Letdown (or Chute) Design C1E.19

Chute Profile C1E.23

NARRATIVE

30 TAC §§330.303 and 330.305

This appendix presents the supporting documentation for evaluation of the final cover erosion layer and drainage structures. Appendix C1E addresses the requirements of 30 TAC §330.305(d) and (e) related to the final condition of final cover areas. The requirements of 30 TAC §330.305(d) and (e) related to intermediate phases are addressed in Appendix C1G.

FINAL COVER PLAN

The final cover plans depict the final cover drainage system consisting of a series of swales and chutes. The drainage area for the largest area contributing to a side slope swale is shown on Drawing C1E.1. Drainage areas for each downchute are shown on Drawing C1E.2. Final cover details are included in Attachment C3.

EROSION LAYER EVALUATION

The erosion layer evaluation is based on the Universal Soil Loss Equation (USLE) following Soil Conservation Service (SCS) procedures. The evaluation is based on a 25-year event. The 36-inch-thick Subtitle D layer is sufficient. Calculations are included beginning on page C1E.6.

SHEET FLOW VELOCITY

The sheet flow velocity calculations are presented for the 5.25 percent top slope and the 25 percent side slope configurations. The procedures outlined in the TxDOT *Hydraulic Design Manual*, September 2019, were used to determine velocities. Maximum lengths of runoff for both final cover conditions were evaluated. Calculations are shown on page C1E.14.

DRAINAGE SWALE DESIGN

The drainage swale design calculations are presented for the typical swale flowline slope of 1 percent. The procedures in the TxDOT *Hydraulic Design Manual*, September 2019, were used to determine the flow depth, swale capacity, and contributing drainage area. Calculations are shown beginning on page C1E.16.

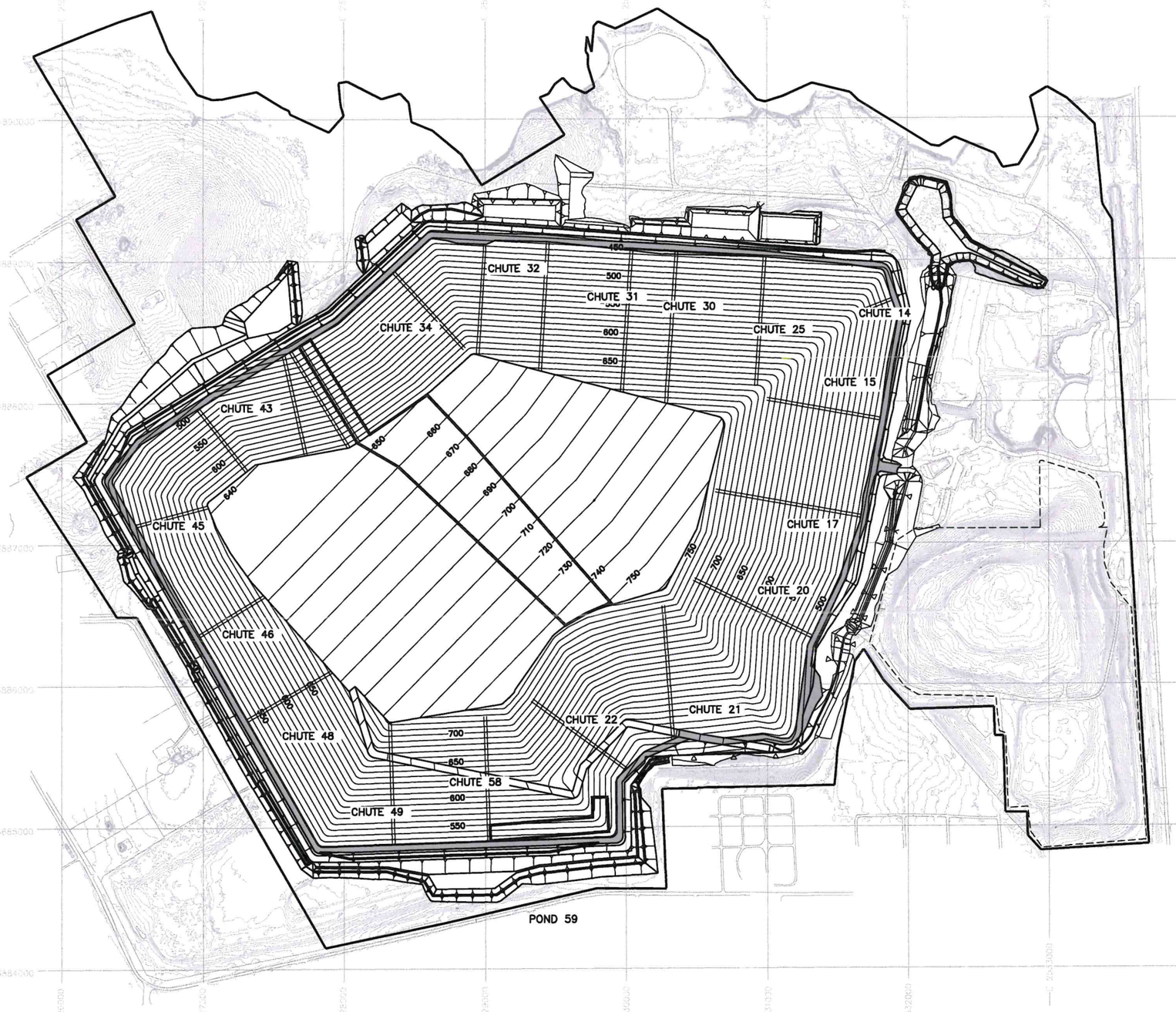
CHUTE DESIGN

The drainage letdown or chutes have been evaluated to determine critical velocities, flow depths in the chute, and receiving perimeter channel. Calculations are shown beginning on page C1E.19. Erosion protection within each chute is provided by 40-mil textured FML. Erosion protection at low-water crossings will be 12-inch-thick concrete. The erosion

protection after the low-water crossings will be reno mattress (gabion). Profiles of each drainage chute are included in Attachment C3.

Chutes and low-water crossings are designed to provide sufficient flow depth for the peak flow rate from the design storm. The design storm for chutes and low-water crossing is the 25-year, 24-hour rainfall event. Chutes are designed to provide 2 feet of flow depth. The maximum calculated flow depth for any chute is 0.32 feet; therefore, the chutes provide a minimum of 1.68 feet of freeboard. Low-water crossings are designed to provide 1 foot of flow depth. The maximum calculated flow depth for any low-water crossing is 0.66 feet; therefore, the low-water crossings provide a minimum of 0.34 feet of freeboard. After the low-water crossing, the flow width is initially 20-feet with 1 foot of flow depth provided and gradually transitions to a 44-foot flow width and ties into the channel sideslope. The maximum calculated flow depth after the low-water crossing is 0.27 feet which provides 0.73 feet of freeboard. Refer to Drawing C1E.3, page C1E.24, for a depiction of the depth of flow for a typical drainage letdown or chutes. The drawing depicts Chute 22 which is the chute with the maximum flow depth within the chute.

FINAL COVER PLANS



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SCALE IN FEET

LEGEND

- PERMIT BOUNDARY
- 460 EXISTING 10' GROUND CONTOUR
- 500 PROPOSED 10' FINAL COVER CONTOUR
- DRAINAGE AREA BOUNDARY

NOTES:

1. EXISTING CONTOURS COMPILED BY HYDREX DRONE DIVISION, FROM AERIAL SURVEY FLOWN MARCH 5, 2025.
2. CONTOURS WITHIN THE LANDFILL FOOTPRINT DEPICT POSTDEVELOPED FINAL CONTOURS.
3. DRAINAGE AREA BOUNDARY NOT SHOWN WHERE COINCIDENTAL WITH PERMIT BOUNDARY.

CHUTE DRAINAGE AREA	
CHUTE DRAINAGE AREA	CHUTE AREA (AC)
14	1.8
15	16.1
17	19.3
20	20.7
21	18.8
22	19.1
25	20.1
30	20.1
31	21.0
32	20.5
33	20.9
34	22.0
40	21.5
41	20.2
42	19.4
43	18.8
45	18.8
46	19.3
48	20.0
49	15.7
58	19.8

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CHUTE AREAS

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TBPELS FIRM NO. F-256 AND NO. 10194895
TBPG FIRM NO. 50222

DRAWING C1E.1

REVISIONS			
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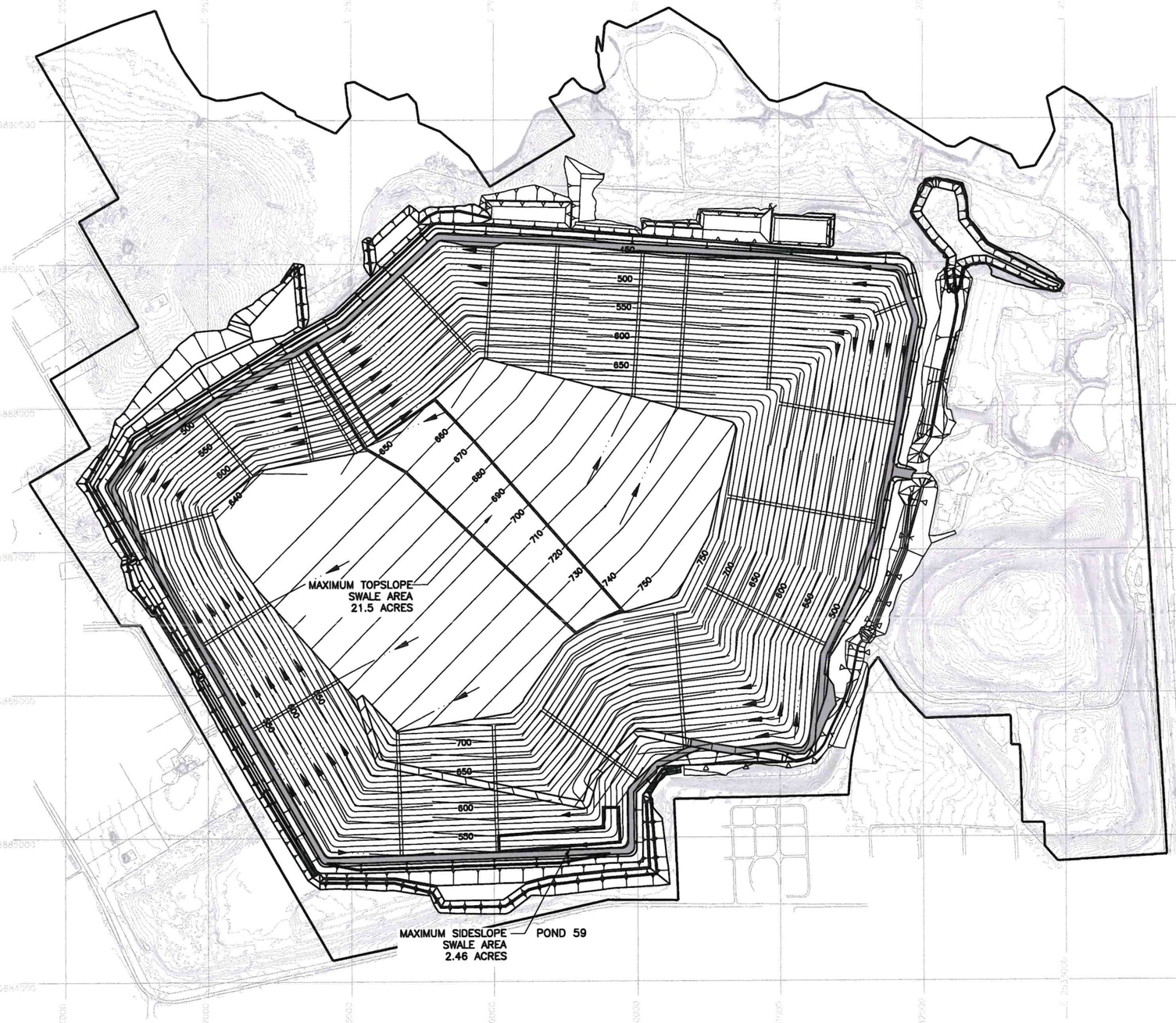

0 400 800
SCALE IN FEET

LEGEND

- PERMIT BOUNDARY
- 460 EXISTING 10' GROUND CONTOUR
- 500 PROPOSED 10' FINAL COVER CONTOUR
- DRAINAGE AREA BOUNDARY

NOTES:

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2. CONTOURS WITHIN THE LANDFILL FOOTPRINT DEPICT POSTDEVELOPED FINAL CONTOURS.
3. DRAINAGE AREA BOUNDARY NOT SHOWN WHERE COINCIDENTAL WITH PERMIT BOUNDARY.

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MAXIMUM SWALE AREA

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SKYLINE LANDFILL

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TBPG FIRM NO. 50222

DRAWING
C1E.2

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EROSION LAYER EVALUATION

EROSION LAYER EVALUATION

This appendix presents the supporting documentation for evaluation of the thickness of the erosion layer for the final cover system at the Skyline Landfill. The evaluation is based on the premise of adding excess soil to increase the time required before maintenance is needed as recommended in the EPA Solid Waste Disposal Facility Criteria Technical Manual (EPA 530-R-93-017, November 1993).

The design procedure is as follows:

1. The minimum thickness of the erosion layer is based on the depth of frost penetration, or 10 inches, whichever is greater. For Dallas and Ellis Counties, the approximate depth of frost penetration is less than 10 inches.

2. Soil loss is calculated using the Universal Soil Loss Equation (USLE) by following SCS procedures. In accordance with regulatory guidance, the calculated soil loss from final cover will not exceed 3 tons per acre per year. Soil loss thickness is calculated by multiplying the soil loss by the postclosure year period (30 years), multiplying by a safety factor of 2, and then converting the soil loss to a thickness. The USLE, with a safety factor of 2, calculates the soil loss of the 5.25 percent top slopes to be 0.16 inches and the side slopes to be 0.79 inches. These thicknesses are then compared to the actual soil thickness of the erosion layer, which is 36 inches. These calculations begin on page C1E.8.

3. Sheet flow velocities for a 25-year storm event are calculated to be less than permissible nonerodible velocities. The supporting calculations are presented on page C1E.15.

4. Vegetation for the site will be native and introduced grasses with root depths of 6 inches to 8 inches.

5. Native and introduced grasses will be hydroseeded with fertilizer on the disked (parallel to contours) erosion layer upon final grading. Temporary cold weather vegetation will be established if needed. Irrigation may be employed for 6 to 8 weeks or until vegetation is well established. Erosion control measures, such as silt fences and straw bales, will be used to minimize erosion until the vegetation is established. Areas that experience erosion or do not readily vegetate after hydroseeding will be reseeded until vegetation is established.

6. Slope stability information is included in Attachment D5 – Geotechnical Design.

WASTE MANAGEMENT OF TEXAS, INC.
WASTE MANAGEMENT SKYLINE LANDFILL
Erosion Loss Evaluation

Required: Determine the sheet flow velocity for the final cover system design and compare to the permissable non-erodible flow velocity.

Method: Expected soil loss is calculated using the Universal Soil Loss Equation. Minimum erosion layer thickness is determined by adding the minimum thickness allowed by TCEQ to the expected thickness of soil loss.

References:
1. TNRCC, *Use of the Universal Soil Loss Equation in Final Cover/Configuration Design Procedural Handbook,* October 1993.

Solution: Annual Soil Loss in tons/acre/year (A) = RKLSCP

Design Parameters	Top Slope (5.25%)	Perimeter Slope (25%)	
Rainfall Factor (R) =	310	310	Ellis County
Soil Erodibility Factor (K) =	0.25	0.25	(clay)
Longest Run =	2180	120	ft
Slope =	5.25	25	%
Topographic Factor (LS) =	2.65	6.45	
Crop Management Factor (C) =	0.006	0.006	(tall grass with 85% cover)
Erosion Control Practice Factor (P) =	0.50	1.00	(Contouring)
Soil Loss (A) =	0.62	3.00	tons/acre/yr.

Erosion Layer Thickness Evaluation:

Required Thickness (T) = AYF/w

	Top Slope (5.25%)	Perimeter Slope (25%)	
Soil Loss (A) =	0.62	3.00	tons/acre/yr.
Postclosure Period =	30	30	years
Factor of Safety (F) =	2	2	
Specific Weight of Soil (w) =	125	125	pcf
Required Soil Thickness (T)	**0.16**	**0.79**	**inches**
Actual Soil Thickness	36.00	36.00	inches

Summary: As noted in the permit drawings, the erosion layer will be a minimum of 36 inches thick. As shown above, this is a conservative design considering the maximum expected soil loss for a 30 year period is 0.79 inches.

WASTE MANAGEMENT OF TEXAS, INC.
WASTE MANAGEMENT SKYLINE LANDFILL
LS Factor Calculations

Required: Determine the length slope factor based on slope length and slope gradient.

References: 1. TNRCC, *Use of the Universal Soil Loss Equation in Final Cover/Configuration Design Procedural Handbook,* October 1993.

Solution: Length/Slope Factor (LS) = $((L/72.6)^{m})*((65.41*\sin^2(S))+(4.56*\sin(S))+0.065)$

LS = Length Slope Factor
L = Slope Length (ft)
S = Slope (%)
m = exponent dependent on the slope gradient

m =	0.2	for S <= 1.0%
	0.3	for 1.0% < S <= 3.5%
	0.4	for 3.5% < S < 5.0%
	0.5	for S => 5.0%

L (ft)	S (%)	S (ft/ft)	S (radians)	S (degrees)	m	LS
2180	5.3	19.05	0.052	3.005	0.5	2.651
120	25	4	0.245	14.036	0.5	6.452

Reproduced from: Texas Natural Resource Conservation Commission, Municipal Solid Waste Division,
Use of the Universal Soil Loss Equation in Final Cover/Configuration Design: Procedural Handbook, 1993.

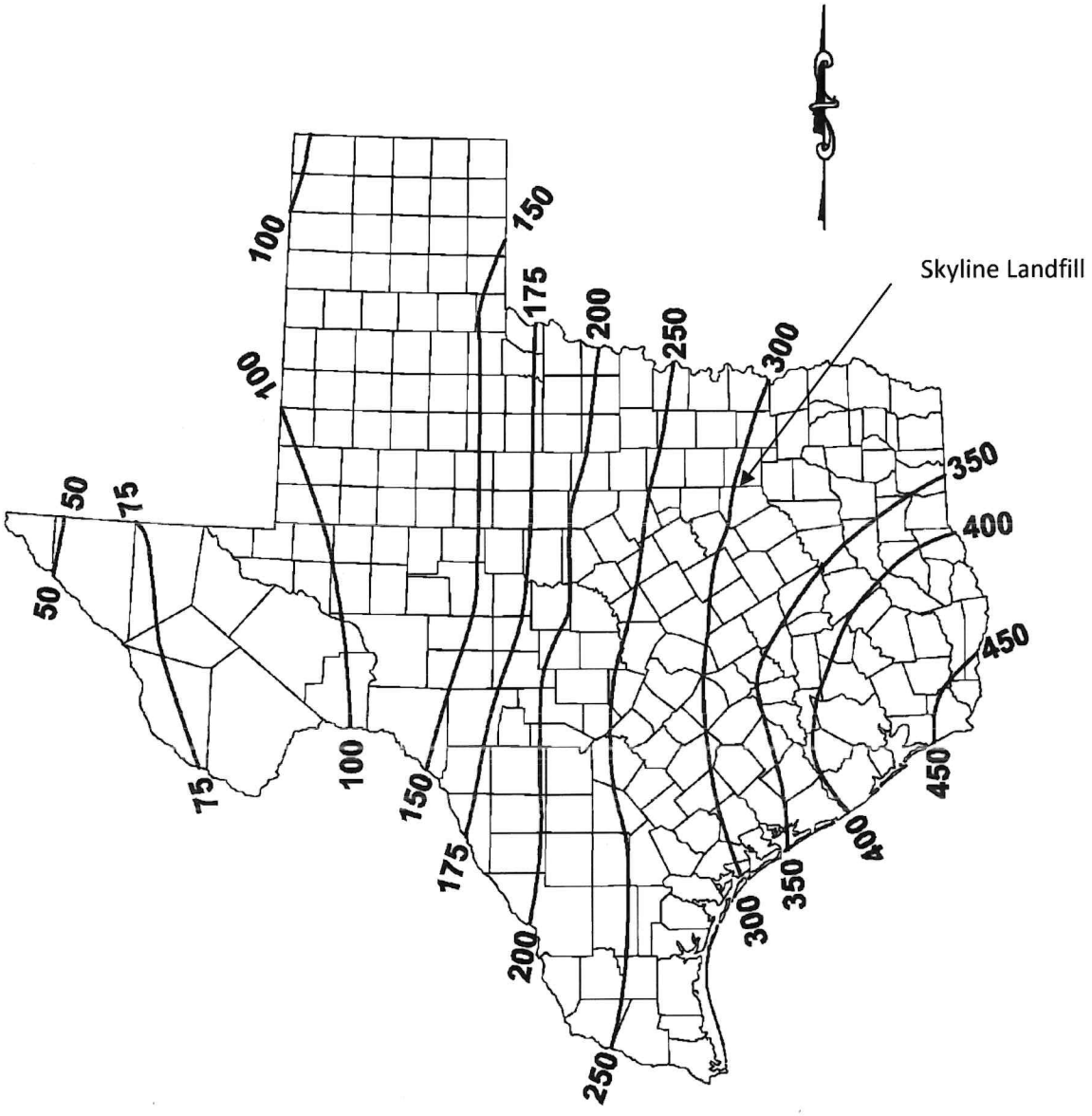


FIGURE 1 - AVERAGE ANNUAL VALUES OF THE RAINFALL EROSION INDEX

Table 1: Approximate Values of Factor K for USDA Textural Classes

Reproduced from: Texas Natural Resource Conservation Commission, Municipal Solid Waste Division, Use of the Universal Soil Loss Equation in Final Cover/Configuration Design: Procedural Handbook, 1993.

Texture Class	Organic Matter Content		
	<0.5%	2%	4%
	K	K	K
Sand	0.05	0.03	0.02
Fine Sand	0.16	0.14	0.10
Very Fine Sand	0.42	0.36	0.28
Loamy Sand	0.12	0.10	0.08
Loamy Fine Sand	0.24	0.20	0.16
Loamy Very Fine Sand	0.44	0.38	0.30
Sandy Loam	0.27	0.24	0.19
Fine Sandy Loam	0.35	0.30	0.24
Very Fine Sandy Loam	0.47	0.41	0.33
Loam	0.38	0.32	0.29
Silt Loam	0.48	0.42	0.33
Silt	0.60	0.52	0.42
Sandy Clay Loam	0.27	0.25	0.21
Clay Loam	0.28	0.25	0.21
Silty Clay Loam	0.37	0.32	0.26
Sandy Clay	0.14	0.13	0.12
Silty Clay	0.25	0.23	0.19
Clay	0.13 - 0.29		

The values shown are estimated averages of broad ranges of specific soil values. When a texture is near the borderline of two texture classes, use the average of the two K values.

Table 2: Factor C for Permanent Pasture, Range, and Idle Land[1]

Reproduced from: Texas Natural Resource Conservation Commission, Municipal Solid Waste Division, Use of the Universal Soil Loss Equation in Final Cover/Configuration Design: Procedural Handbook, 1993.

Vegetative Canopy		Cover that Contacts the Soil Surface					
Type and Height[2]	Percent Cover[3]	Percent Ground Cover					
		0	20	40	60	80	95+
No Appreciable Canopy		0.45	0.20	0.10	0.042	0.013	0.003
Tall weeds or short brush with average drop fall height of 20 in.	25	0.36	0.17	0.09	0.038	0.013	0.011
	50	0.26	0.13	0.07	0.035	0.012	0.003
	75	0.17	0.10	0.06	0.032	0.011	0.003

Extracted from: United States Department of Agriculture, AGRICULTURE HANDBOOK NUMBER 537

[1] The listed C values assume that the vegetation and mulch are randomly distributed over the entire area.

[2] Canopy height is measured as the average fall height of water drops falling from the canopy to the ground. Canopy effect is inversely proportional to drop fall height and is negligible if fall height exceeds 33 feet.

[3] Portions of total-area surface that would be hidden from view by canopy in a vertical projection (a bird's eye view).

Table 3: P Factors for Contouring, Contour Stripcropping and Terracing

Reproduced from: Texas Natural Resource Conservation Commission, Municipal Solid Waste Division, Use of the Universal Soil Loss Equation in Final Cover/Configuration Design: Procedural Handbook, 1993.

Land Slope	P Values		
%	Contouring†	Contour Stripcropping	Terracing†
2.0 to 7	0.50	0.25	0.50
8.0 to 12	0.60	0.30	0.60
13.0 to 18	0.80	0.40	0.80
19.0 to 24	0.90	0.45	0.90

(This table appeared in SCS (5), p.9)

† Contouring and terracing columns are suitable for MSWLF cover. Contour stripcropping is not suitable for the type of vegetative cover normally practiced at municpal landfills.

Table 4: Guide for Assigning Soil Loss Tolerance Values (T) to Solid Having Different Rooting Depths

Rooting Depth	Soil Loss Tolerance Values Annual Soil Loss (Tons/Acre)	
Inches	Renewable Soil a/	Renewable Soil b/
0 - 10	1	1
10 - 20	2	1
20 - 40	3	2
40 - 60	4	3
60	5	4

(This table appeared in SCS (6), p.4)

a/ Soil with favorable substrata that can be renewed by tillage, fertilizer, organic matter, and other management practices. This column does not represent MSWLF final covers under normal conditions.

b/ Soil with unfavorable substrata such as rock or soft rock that cannot be renewed by economical means. Most of the MSWLF covers with constructed clay cap and/or flexible membrane should use this performance criteria.

SHEET FLOW

WASTE MANAGEMENT OF TEXAS, INC.
WASTE MANAGEMENT SKYLINE LANDFILL
Sheet Flow Velocity

Required: Determine the sheet flow velocity for the final cover system design and compare to the permissable non-erodible flow velocity.

Method:
1. Determine the 25-year peak flow rate using the Rational Method.
2. Calculate flow depth using Manning's Equation.
3. Calculate sheet flow velocity and compare to permissible non-erodible velocity.

References:
1. Texas Department of Transportation, *Hydraulic Design Manual*, Revised September 2019.
2. NOAA Atlas 14, Precipitation-Frequency Atlas of the United States, Volume 11 Version 2.0: Texas, 2018.

Solution:

1. Determine the 25-year peak flow rate (Q) using the Rational Method.

25-Year Rainfall Depth (Pd) =	1.34	in	(ref 2)
Time of Concentration (tc) =	10.0	min	(conservative minimum value)
Rainfall Intensity (I) =	8.0	in/hr	(ref 1, I = Pd/tc)
Runoff Coefficient (C) =	0.70		(typical value for final cover systems)
25-Year Peak Flow Rate (Q) =	CIA	cfs	

	Top Slope (5.25%)	Perimeter Slope (25%)		
Longest Run =	2180	120	ft	(longest sheet flow distance to swale)
Width =	1.00	1.00	ft/ft	(unit width of flow)
Area =	0.0500	0.0028	acre	
Q	0.282	0.016	cfs	

2. Calculate the flow depth using Manning's Equation.
- Rearrange Manning's Equation for wide and shallow flow to calculate flow depth:

$$y = (Qn/1.49S^{0.5})^{0.6}$$

Manning's Roughness (n) =	0.03		(typical value for vegetated final cover)

Slope =	0.0525	0.250	ft/ft	(final cover design slopes)
Depth (y) =	0.1089	0.0120	ft	

3. Calculate sheet flow velocity and compare to permissible non-erodible velocity.
- A permissible non-erodible velocity of 5 ft/sec is typical for vegetated final covers.
- Refer to page C1-E-7 for soil loss calculations.

$$V = Q / (y * width)$$

Sheet flow velocity	**2.59**	**1.30**	**ft/sec**

Summary: Permissable non-erodible velocity is 5.0 ft/sec with vegetated final cover. Therefore, the expected sheet flow velocity is acceptable on the final cover system top and side slopes with vegetation provided.

DRAINAGE SWALE DESIGN

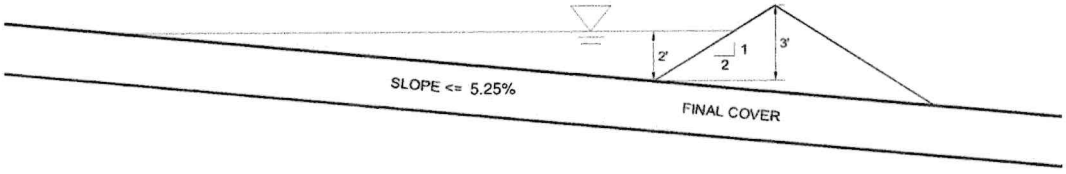
WASTE MANAGEMENT OF TEXAS, INC.
WASTE MANAGEMENT SKYLINE LANDFILL
Drainage Swale Analysis - Topslopes

Required: Determine the topslope drainage swale capacity.

Method:
1. Calculate the topslope swale's flow capacity using Manning's Equation.
2. Determine the maximum allowable topslope drainage area using the Rational Method.
3. Provide the maximum proposed topslope drainage area for comparison.

References:
1. Texas Department of Transportation, *Hydraulic Design Manual*, Revised September 2019.
2. NOAA Atlas 14, Precipitation-Frequency Atlas of the United States, Volume 11 Version 2.0: Texas, 2018.

Solution:
1. Calculate flow capacity using Manning's Equation.
- Swale Characteristics:



Max swale flow depth (D) =	2.00 ft	
Running swale slope (S) =	1.0 %	
Manning's Roughness (n) =	0.03	(typical value for vegetated final cover)
Left slope (LS) =	19.05 :1	
Right slope (RS) =	2 :1	
Flow Area (A) =	((LS+RS)*D^2)/2	
Wetted Perimeter (WP) =	((LS*D)^2+D^2)^(0.5) + ((RS*D)^2+D^2)^(0.5)	
Hydraulic Radius (R) =	A / WP	
Flow Area (A) =	42.095 sf	
Wetted Perimeter (WP) =	42.620 ft	
Hydraulic Radius (R) =	0.988 ft	

- Use Manning's Equation to determine the flow velocity in the swale.

Velocity (V) =	1.49*R^(2/3)*S^(1/2)/n
Velocity (V) =	4.926 ft/sec

- Calculate the swale's flow capacity.

Swale capacity (Q) =	V * A
Q =	207.4 cfs

2. Determine the maximum allowable drainage area using the Rational Method.

25-Year Rainfall Depth (Pd) =	1.34 in	(Ref. 2)
Time of Concentration (tc) =	10 min	(conservative minimum value)
Rainfall Intensity (I) =	8.0 in/hr	(ref 1, I = Pd/tc)
Runoff Coefficient (C) =	0.70	(typical value for final cover systems)
25-Year Peak Flow Rate (Q) =	CIA cfs	

- Rearrange the Rational Formula to calculate allowable drainage area:

Drainage Area = Q / (CI)

Maximum Allowable Swale Drainage Area = 37.03 acres

3. Provide the maximum proposed topslope drainage area for comparison.

Maximum Proposed Swale Drainage Area = 21.50 acres

Summary: The maximum proposed topslope swale drainage area is 21.5 acres. This is less than the maximum allowable drainage area of 37.03 acres for the proposed swale configuration.

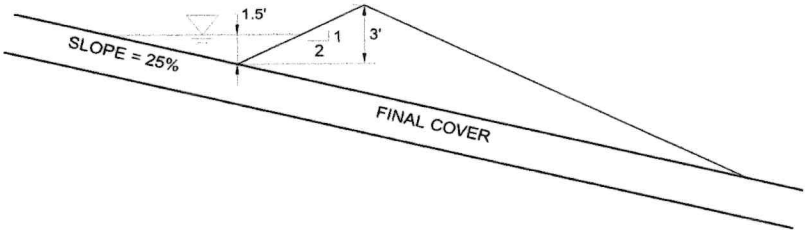
WASTE MANAGEMENT OF TEXAS, INC.
WASTE MANAGEMENT SKYLINE LANDFILL
Drainage Swale Analysis - Sideslopes

Required: Determine the sideslope drainage swale capacity.

Method:
1. Calculate the sideslope swale's flow capacity using Manning's Equation.
2. Determine the maximum allowable sideslope drainage area using the Rational Method.
3. Provide the maximum proposed sideslope drainage area for comparison.

References:
1. Texas Department of Transportation, *Hydraulic Design Manual*, Revised September 2019.
2. NOAA Atlas 14, Precipitation-Frequency Atlas of the United States, Volume 11 Version 2.0: Texas, 2018.

Solution:
1. Calculate flow capacity using Manning's Equation.
- Swale Characteristics:



Max swale flow depth (D) =	1.50	ft	
Running swale slope (S) =	1.0	%	
Manning's Roughness (n) =	0.03		(typical value for vegetated final cover)
Left slope (LS) =	4.00	:1	
Right slope (RS) =	2	:1	
Flow Area (A) =	((LS+RS)*D^2)/2		
Wetted Perimeter (WP) =	((LS*D)^2+D^2)^(0.5) + ((RS*D)^2+D^2)^(0.5)		
Hydraulic Radius (R) =	A / WP		

Flow Area (A) =	6.750	sf
Wetted Perimeter (WP) =	9.539	ft
Hydraulic Radius (R) =	0.708	ft

- Use Manning's Equation to determine the flow velocity in the swale.

Velocity (V) =	1.49*R^(2/3)*S^(1/2)/n	
Velocity (V) =	3.944	ft/sec

- Calculate the swale's flow capacity.

Swale capacity (Q) =	V * A	
Q =	26.6	cfs

2. Determine the maximum allowable drainage area using the Rational Method.

25-Year Rainfall Depth (Pd) =	1.34	in	(ref 2)
Time of Concentration (tc) =	10	min	(conservative minimum value)
Rainfall Intensity (I) =	8.0	in/hr	(ref 1, I = Pd/tc)
Runoff Coefficient (C) =	0.70		(typical value for final cover systems)
25-Year Peak Flow Rate (Q) =	CIA	cfs	

- Rearrange the Rational Formula to calculate allowable drainage area:

Drainage Area = Q / (CI)

Maximum Allowable Swale Drainage Area = 4.75 acres

3. Provide the maximum proposed sideslope drainage area for comparison.

Maximum Proposed Swale Drainage Area = 2.46 acres

Summary: The maximum proposed sideslope swale drainage area is 2.46 acres. This is less than the maximum allowable drainage area of 4.75 acres for the proposed swale configuration.

DRAINAGE LETDOWN (OR CHUTE) DESIGN

WASTE MANAGEMENT OF TEXAS, INC.
WASTE MANAGEMENT SKYLINE LANDFILL

Chute Design

Required: Determine final cover collection channel and chute flowrates.

Method:

1. Determine the flow from each chute drainage area using the Rational Method

References:

1. Texas Department of Transportation, *Hydraulic Design Manual*, Revised May 2014.
   (Note: The Hydraulic Design Manual, Revised September 2019, uses a different equation to calculate rainfall intensity which is not consistent with Reference 2.)
2. NOAA Atlas 14, Precipitation-Frequency Atlas of the United States, Volume 11 Version 2.0: Texas, 2018.

Solution:

1. Determine the 25-Year Peak Flow Rate using the Rational Method.

25-Year Rainfall Depth (Pd) =	1.34	in	(Ref. 2)
Time of Concentration (tc) =	10	min	(conservative minimum value)
Rainfall Intensity (I) =	8.0	in/hr	(ref 1, I = Pd/tc)
Runoff Coefficient (C) =	0.70		(typical value for final cover systems)
25-Year Peak Flow Rate (Q) =	CIA	cfs	

Chute	Chute Area (acre)	25-Year Peak Flow Rate (cfs)
14	1.8	10
15	16.1	91
17	19.3	109
20	20.7	116
21	18.8	106
22	19.1	107
25	20.1	113
30	20.1	113
31	21.0	118
32	20.5	115
33	20.9	118
34	22.0	124
40	21.5	121
41	20.2	114
42	19.4	109
43	18.8	106
45	18.8	106
46	19.3	109
48	20.0	113
49	15.7	88
58	19.8	111

WASTE MANAGEMENT OF TEXAS, INC.
WASTE MANAGEMENT SKYLINE LANDFILL
Downchute Calculations

Required: Determine the flow depth and velocity in the downchutes and low-water crossings.

Method: Calculate the flow depth and velocity using Manning's Equation.

Solution:

		Chute						Low-Water Crossing						Erosion Protection after Low-Water Crossing					
Chute	Q (cfs)	Width (ft)	Slope (%)	Side Slopes (h:v)	Manning's n	Depth (ft)	Velocity (fps)	Width (ft)	Slope (%)	Side Slopes (h:v)	Manning's n	Depth (ft)	Velocity (fps)	Width (ft)	Slope (%)	Side Slopes (h:v)	Manning's n	Depth (ft)	Velocity (fps)
14	10	20	25	4	0.013	**0.06**	**8.55**	20	2	12	0.020	**0.16**	**2.91**	20	20	12	0.013	**0.06**	**7.84**
15	91	20	25	4	0.013	**0.22**	**20.04**	20	2	12	0.020	**0.56**	**6.11**	20	20	12	0.013	**0.23**	**17.61**
17	109	20	25	4	0.013	**0.24**	**21.46**	20	2	12	0.020	**0.61**	**6.47**	20	20	12	0.013	**0.25**	**18.76**
20	116	20	25	4	0.013	**0.25**	**22.04**	20	2	12	0.020	**0.64**	**6.61**	20	20	12	0.013	**0.26**	**19.22**
21	106	12	25	4	0.013	**0.32**	**25.00**	20	2	12	0.020	**0.61**	**6.42**	24	20	12	0.013	**0.22**	**17.69**
22	107	12	25	4	0.013	**0.32**	**25.14**	20	2	12	0.020	**0.61**	**6.45**	24	20	12	0.013	**0.23**	**17.79**
25	113	20	25	4	0.013	**0.25**	**21.80**	20	2	12	0.020	**0.63**	**6.55**	20	20	12	0.013	**0.26**	**19.02**
30	113	20	25	4	0.013	**0.25**	**21.80**	20	2	12	0.020	**0.63**	**6.55**	20	20	12	0.013	**0.26**	**19.02**
31	118	20	25	4	0.013	**0.25**	**22.16**	20	2	12	0.020	**0.64**	**6.64**	20	20	12	0.013	**0.26**	**19.31**
32	115	20	25	4	0.013	**0.25**	**21.96**	20	2	12	0.020	**0.63**	**6.59**	20	20	12	0.013	**0.26**	**19.15**
33	118	20	25	4	0.013	**0.25**	**22.12**	20	2	12	0.020	**0.64**	**6.63**	20	20	12	0.013	**0.26**	**19.28**
34	124	20	25	4	0.013	**0.26**	**22.55**	20	2	12	0.020	**0.66**	**6.73**	20	20	12	0.013	**0.27**	**19.62**
40	121	20	25	4	0.013	**0.26**	**22.36**	20	2	12	0.020	**0.65**	**6.68**	20	20	12	0.013	**0.27**	**19.47**
41	114	20	25	4	0.013	**0.25**	**21.84**	20	2	12	0.020	**0.63**	**6.56**	20	20	12	0.013	**0.26**	**19.05**
42	109	20	25	4	0.013	**0.24**	**21.51**	20	2	12	0.020	**0.62**	**6.48**	20	20	12	0.013	**0.25**	**18.79**
43	106	20	25	4	0.013	**0.24**	**21.25**	20	2	12	0.020	**0.61**	**6.42**	20	20	12	0.013	**0.25**	**18.59**
45	106	20	25	4	0.013	**0.24**	**21.25**	20	2	12	0.020	**0.61**	**6.42**	20	20	12	0.013	**0.25**	**18.59**
46	109	20	25	4	0.013	**0.24**	**21.46**	20	2	12	0.020	**0.61**	**6.47**	20	20	12	0.013	**0.25**	**18.76**
48	113	20	25	4	0.013	**0.25**	**21.75**	20	2	12	0.020	**0.63**	**6.54**	20	20	12	0.013	**0.26**	**18.99**
49	88	20	25	4	0.013	**0.21**	**19.85**	20	2	12	0.020	**0.55**	**6.07**	20	20	12	0.013	**0.22**	**17.45**
58	111	20	25	4	0.013	**0.25**	**21.67**	20	2	12	0.020	**0.62**	**6.52**	20	20	12	0.013	**0.26**	**18.92**

Notes:

1. Flow rates are from HEC-HMS 25-year, 24-hour rainfall event.
2. The energy dissipation at the chute and low-water crossing confluence is accomplished via a hydraulic jump and was designed in accordance with *Hydraulic Design of Stilling Basins and Energy Dissipators*, A. J. Peterka, United States Department of the Interior, Bureau of Reclamation, 1978.
   The length of the hydraulic jump is approximately five times the flow depth in the low-water crossing.
3. Erosion protection on downchute will be 40-mil textured flexible membrane liner (FML).
   Erosion protection at low-water crossing will be 12-inch-thick concrete.
4. Erosion protection after low-water crossing will be reno mattress (gabions) or articulating concrete blocks.
   See table below for thickness and rock fill gradation.
5. Chute discharge structures are located at the bottom of each chute.

Erosion Protection at Perimeter Channel Entrance		
Permissible Velocity (fps)	Thickness (in)	Rock Fill Gradation (in)
6	6	3 - 6
12	6 - 10	3 - 6
15	10 - 12	3 - 6
18	12 - 18	4 - 6
22	> 18	5 - 9

ATTACHMENT C1
APPENDIX C1F

INTERMEDIATE COVER
EROSION AND SEDIMENTATION CONTROL PLAN

CONTENTS

Narrative C1F.1

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Erosion and Sediment Control Landfill Cover Phases C1F.2

Best Management Practices C1F.3

Soil Stabilization and Vegetation Schedule C1F.4

Stormwater System Maintenance Plan C1F.5

Intermediate Cover Erosion Control Features C1F.7

Temporary Erosion Control Structures C1F.8

Temporary Erosion Control Structures C1F.9

Temporary Erosion Control Structures C1F.10

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NARRATIVE

This appendix presents temporary erosion and sediment control structures for the intermediate cover phase of landfill development. Temporary means the time between the construction of intermediate cover and the construction of final cover or the placement of additional waste, as the case may be. Appendix C1F addresses the requirements of 30 TAC §330.305(d) and (e) related to the intermediate cover phase of the landfill.

As defined in the guidance document issued by TCEQ titled "Surface Water Drainage and Erosional Stability Guidelines for a Municipal Solid Waste Landfill" dated May 2018; intermediate topslope surfaces and external sideslopes, for the purposes of compliance with 30 TAC §330.305(d), are:

a) those above grade slopes that directly drain to the site perimeter stormwater management system (i.e., areas where the stormwater directly flows to a perimeter channel or detention pond).

b) those that have received intermediate or final cover.

c) those that have either reached their permitted elevation, or will subsequently remain inactive for longer than 180 days.

Slopes that drain to ongoing waste placement, pre-excavated areas, areas that have received only daily cover, or areas under construction that have not received waste are not covered under this appendix. Areas that have received final cover are not covered in this appendix. This appendix addresses only intermediate cover slopes.

EXISTING CONDITIONS SUMMARY

Drawing C1F.1 – Intermediate Cover Erosion Control Features shows the areas where final cover has been constructed. The remaining areas in the existing disposal unit have received daily or intermediate cover.

Fill operations are ongoing in the existing disposal unit. Areas where fill operations are currently ongoing will receive daily cover. Areas that have been inactive longer than 180 days have received intermediate cover. Temporary erosion control measures may need to be installed on existing intermediate cover areas to control erosion and minimize soil loss if these areas have less than 60 percent vegetative cover. Intermediate cover areas that have existing well established vegetation (at least 60 percent coverage) will not be disturbed to construct temporary erosion control features.

Areas that reach their permitted elevation or plan to remain inactive for longer than 180 days will receive intermediate cover. As areas receive intermediate cover, temporary erosion control measures will be constructed. Temporary erosion and sediment control features will be placed within 180 days from construction of intermediate cover. All intermediate cover areas will be managed to control erosion and achieve predicted soil loss of less than 50 tons per acre per year. Temporary and permanent drainage structures will be constructed as the landfill develops intermediate and final cover slopes.

The Skyline Landfill has an active stormwater pollution prevention plan (SWPPP), Permit No. TXR05U147, prepared consistent with the TPDES general permit. The SWPPP is up to date and maintained in the Site Operating Record. The SWPPP provides detailed Best Management Practices (BMPs) including training and implementation strategies to reduce the potential of pollutants in stormwater discharge. The plan also includes detailed stormwater and erosion control measures for current landfill construction activities.

EROSION AND SEDIMENT CONTROL LANDFILL COVER PHASES

The purpose of this section is to define the landfill cover phases and where they are addressed throughout the Skyline Landfill permit:

Daily Cover – Daily cover is defined in §330.165(a). Daily cover consists of 6 inches of well compacted earthen material not previously mixed with garbage, rubbish, or other solid waste applied at the end of each operating day. The placement and erosion control practices for daily cover areas are defined in Part IV – Site Operating Plan and in the Best Management Practices Section of this appendix.

Intermediate Cover – Intermediate cover is defined in §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. The placement requirements and erosion control practices for intermediate cover areas are defined in this appendix.

Final Cover – Final cover is defined in Subchapter K. The placement and erosion control practices for final cover areas are defined in Attachment C1, Appendix C1E. Final cover at the Skyline Landfill will be managed as provided for in the closure and postclosure plan required by 30 TAC 330 Subchapter K, Closure and Post-Closure.

BEST MANAGEMENT PRACTICES

Vegetation and temporary erosion control structures provide the most effective means to reduce the amount of soil loss during operation of the landfill. Best management practices utilized for erosion and sediment control may be broadly categorized as nonstructural and structural controls. Nonstructural controls addressing erosion include the following:

- Minimization of the disruption of the natural features, drainage, topography, or vegetative cover features.
- Phased development to minimize the area of bare soil exposed at any given time.
- Plans to disturb only the smallest area necessary to perform current activities.
- Plans to confine sediment to the construction area during the construction phase.
- Scheduling of construction activities during the time of year with the least erosion potential, when applicable.
- Specific plans for the stabilization of exposed surfaces in a timely manner.

Structural controls are preventative and also mitigative since they control erosion and sediment movement. Structural controls addressing erosion include the following:

- Vegetative and Non-Vegetative Stabilization. A soil stabilization and vegetation schedule is provided in this appendix.
- Check Dams. Check dams may be constructed using gravel, rock, gabions, compost socks, or sandbags to reduce flow velocity and therefore erosion in a perimeter channel or detention pond.
- Filter Berms. Filter berms may be constructed of mulch, woodchips, brush, compost, shredded woodwaste, or synthetic filter materials. Mesh socks may be filled with compost, mulch, woodchips, brush, or shredded woodwaste. Filter berms or filled mesh socks may be installed at the bottom of slopes, throughout the perimeter drainage system, and on sideslopes. The maximum drainage area to the filter berm or filled mesh sock will not exceed 2 acres. Specifications for the filter berms are provided on Drawing C1F.3, Detail TD11.
- Baled Hay. Hay bales, straw bales, or baled hay shall be approximately 30 inches in length and be composed entirely of vegetable matter. Hay bales shall be embedded in the soil a minimum of 4 inches and where possible one-half the height of the hay bale.
- Sediment Traps. Sediment traps are small, excavated areas that function as a sediment basin. Sediment traps allow for the settling of suspended sediment in stormwater runoff. Sediment traps may be constructed in perimeter channels,

temporary internal channels, and at entrances to detention ponds. The maximum drainage area contributing to a sediment trap will not exceed 10 acres.

- Temporary Sediment Control Fence or Silt Fence. Silt fences or fabric filter fences may be used where there is sheet flow. The maximum drainage area to the silt fence will not exceed the manufacturer's specification, but in no case be greater than 0.5 acre per 100 feet of fence. To ensure sheet flow, a gravel collar or level spreader may be used upslope of the silt fence.

- Swales. These structures will be constructed of a material with the top 6 inches capable of sustaining native plant growth. Rolled erosion control mats or blankets made from natural materials or synthetic fiber, grass, or compost/mulch/straw may be used as erosion protection along the flowline. These structures direct the flow to the drainage system. These structures decrease downslope velocities of runoff that could cause erosion on the intermediate cover slopes.

- Letdown Chutes. Letdown chutes are bermed conveyance structures constructed on the intermediate cover slopes. Flow will be directed to the letdown chutes via swales, then conveyed to the perimeter drainage system. The letdown chutes will be lined with an FML geomembrane, turf reinforcement mats, riprap, concrete, gabions, crushed concrete, or stone.

Erosion will be controlled by vegetation on topslopes, sideslopes, swales, and in drainage conveyance structures with flow velocities less than or equal to 5 fps. For drainage conveyance structures with flow velocities greater than 5 fps, turf reinforcement, rock riprap, concrete, gabions, or other appropriate materials will be used for surface reinforcement.

Intermediate cover erosion and sediment control structures are shown on Drawings C1F.1 through C1F.4. During site development, both structural and non-structural BMPs will be employed to control erosion.

The potential for wind erosion of the intermediate cover surface will be mitigated through the placement of temporary intermediate cover erosion control measures and establishment of vegetative cover. Temporary erosion control measures include surface roughening, surface wetting, application of tackifiers, or hydromulching the intermediate cover surface.

SOIL STABILIZATION AND VEGETATION SCHEDULE

The soil stabilization and vegetation schedule is as follows:

- Areas that will remain inactive for periods greater than 180 days will receive intermediate cover.

- Intermediate cover on slopes will be stabilized by tracking into the slope. Soil stabilization can be enhanced by mulching, the addition of soil tackifiers, soil treatment, or any combination of these measures. The intermediate cover will be graded to provide positive drainage.

- Temporary erosion control structures will be installed within 180 days from when intermediate cover is constructed.

- The intermediate cover area will be seeded or sodded as soon as practical, following placement of intermediate cover and will be documented in the site operating record. All intermediate cover areas will be managed to control erosion and achieve a predicted soil loss of less than 50 tons per acre per year. A 60 percent vegetative cover will be established over the intermediate cover areas within 180 days from intermediate cover construction unless prevented by climatic events (e.g., drought, rainfall, etc.). Additional temporary erosion control measures will be implemented during these events to facilitate the establishment of vegetative cover.

- Mulch, woodchips, or compost may be used as a layer placed over the intermediate cover to protect the exposed soil surface from erosive forces and conserve soil moisture until vegetation can be established. The mulch, woodchips, or compost will be used to stabilize recently graded or seeded areas. The mulch, woodchips, or compost will be spread evenly over a recently seeded area and tracked into the surface to protect the soil from erosion and moisture loss, if required to promote the establishment of vegetation. These materials are not required for the establishment of vegetation on the intermediate cover; however, they may be used if the Skyline Landfill determines they are needed to promote vegetative growth or to provide additional erosional stability to the intermediate cover surface. These materials will vary in thickness but will not be placed to a thickness to inhibit vegetative growth.

- The intermediate cover and temporary erosion control structures will be maintained as detailed in the Stormwater System Maintenance Plan.

- Final cover will be constructed as the site develops. Temporary erosion control features will be removed as permanent erosion control structures are constructed.

STORMWATER SYSTEM MAINTENANCE PLAN

The Skyline Landfill will restore and repair temporary stormwater systems such as channels, drainage swales, chutes, and flood control structures in the event of wash-out or failure. In addition, the BMPs discussed in this appendix will also be replaced or repaired in the event of failure. Excessive sediment will be removed, as needed, so that the drainage structures function as designed. Site inspections by landfill personnel will be performed weekly or within 48 hours of a rainfall event of 0.5 inches or more.

The following items will be evaluated during the inspections:

- Erosion of intermediate cover areas, perimeter ditches, temporary chutes, swales, detention ponds, berms, and other drainage features.

- Settlement of intermediate cover areas, final cover areas, perimeter ditches, chutes, swales, and other drainage features.

- Silt and sediment build-up in perimeter ditches, chutes, swales, and detention ponds.
- Presence of ponded water on intermediate cover or behind temporary erosion control structures.
- Obstructions in drainage features.
- Presence of erosion or sediment discharge at offsite stormwater discharge locations.
- 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. The time frame for correction of damaged or deficient items will vary based on weather, ground conditions, and other site-specific conditions.

Maintenance activities will consist of the following, as needed:

- Placement of additional temporary or permanent vegetation.
- Placement, grading, and stabilization of additional soils in eroded areas or in areas which have settled.
- Replacement of riprap or other structural lining.
- Removal of obstructions from drainage features.
- Removal of silt and sediment build-up from the temporary erosion control structures.
- Removal of ponded water on the intermediate cover or behind temporary erosion control structures.
- Repairs to erosion and sedimentation controls.
- Installation of additional erosion and sedimentation controls.

Documentation and training requirements are discussed below:

- Site inspections by landfill personnel will be performed weekly or within 48 hours of a rainfall event of 0.5 inches or more.
- 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 temporary erosion control structures.

BENCH AND BERM/SWALE SPACING

SLOPE (%)	MAXIMUM SURFACE FLOW LENGTH (FT)	MAXIMUM DRAINAGE AREA (ACRES)
5.25	550	22.14
25	250	7.1

TD16 C1F.5 TEMPORARY LOW WATER CROSSING

TD17 C1F.5 TEMPORARY CHUTE DISCHARGE STRUCTURE

TD1 C1F.2 TEMPORARY SIDESLOPE SWALE (TYP)

POND 27

POND 29

POND 24

POND 05

LANDFILL ACCESS ROAD

EAST PERIMETER DITCH

POND 08

INTERNAL STORMWATER CONTROL SYSTEM

POND 10

SWALE/CHUTE TOPSLOPE CONFLUENCE TD14 C1F.4

WEST PERIMETER DITCH

TEMPORARY DIVERSION CHANNEL TD3 C1F.2

TD13 C1F.4 SWALE/CHUTE CONFLUENCE

TD12 C1F.4 TEMPORARY CHUTE

19

20

WORKING FACE

TEMPORARY DIVERSION BERM TD4 C1F.2

TEMPORARY STORMWATER SUMP

150 500 550 600 650 670 680 690 700 710 720 730 740 750 750 700 650 600 550 500

N 6890000 N 6889000 N 6888000 N 6887000 N 6886000 N 6885000

E 2532600 E 2532800 E 2532900 E 2533000 E 2531000 E 2532000

0 400 800

SCALE IN FEET

LEGEND

PERMIT BOUNDARY

460 EXISTING 10' GROUND CONTOUR

500 PROPOSED 10' FINAL COVER CONTOUR

NOTE:

1. EXISTING CONTOURS COMPILED BY HYDREX DRONE DIVISION, FROM AERIAL SURVEY FLOWN MARCH 5, 2025.
2. THIS PLAN IS FOR GENERAL CONDITIONS AND MAY NOT REFLECT THE EXACT CONFIGURATION OF THE LANDFILL. THE ACTUAL SIZE OF THE INCREMENTS FOR EXCAVATION, LINING, OR FINAL COVER MAY VARY WITH SITE OPERATIONS.
3. THE LANDFILL ACCESS AND HAUL ROADS WILL BE SURFACED TO PROVIDE ALL WEATHER ACCESS. ROAD LOCATIONS TO BE DETERMINED DURING SITE OPERATIONS AND LOCATIONS WILL VARY.
4. THE STORMWATER RUN-OFF CONTROL SYSTEM WILL CONSIST OF THE PERIMETER DRAINAGE CHANNEL, AND STORMWATER DETENTION PONDS.
5. REFER TO PART III, ATTACHMENT C-DRAINAGE DESIGN REPORT FOR STORMWATER SYSTEMS AND EROSION AND SEDIMENT CONTROL PLAN. REFER TO PART III, ATTACHMENT D6-LEACHATE AND CONTAMINATED WATER MANAGEMENT PLAN FOR CONTAINMENT BERM CALCULATIONS.
6. UNCONTAMINATED STORMWATER COLLECTED IN SUMPS WILL BE PERIODICALLY REMOVED FROM EXCAVATED AREAS BY PUMPING TO PERIMETER DRAINAGE CHANNELS OR USED IN SITE OPERATIONS (DUST CONTROL, IRRIGATIONS, ROAD AND LINER CONSTRUCTION).
7. DEVELOPMENT DEPICTS ONGOING WASTE DISPOSAL OPERATIONS IN CELLS 1 THROUGH 18 TO MAXIMUM WASTE FILL ELEVATION EQUAL TO TOP OF PERIMETER BERMS. FUTURE EXCAVATION AND LINER CONSTRUCTION WILL BE DEVELOPED IN SEQUENTIAL ORDER.
8. WASTE FILL GENERALLY NORTH TO SOUTH IN DIRECTION.

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103826
LICENSED PROFESSIONAL ENGINEER

3/31/2026

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INTERMEDIATE COVER EROSION CONTROL FEATURES

WASTE MANAGEMENT OF TEXAS, INC. SKYLINE LANDFILL

BIGGS & MATHEWS ENVIRONMENTAL
1700 ROBERT ROAD, STE. 100
MANSFIELD, TEXAS 76063
817-563-1144

TBPELS FIRM NO. F-256 AND NO. 10194895
TBPG FIRM NO. 50222

DRAWING C1F.1

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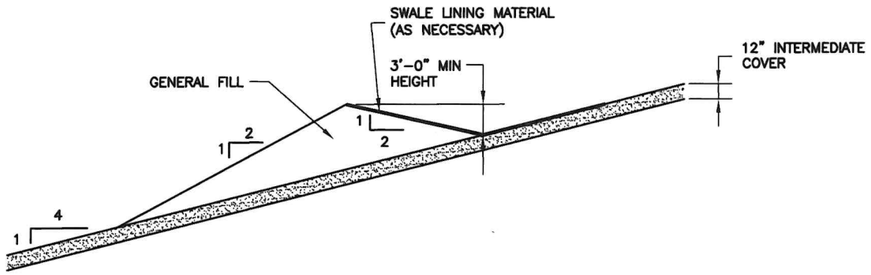
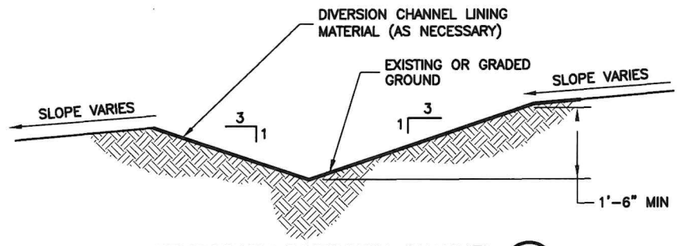
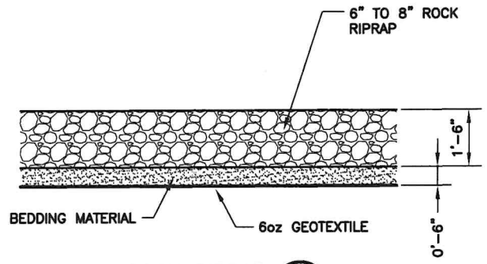


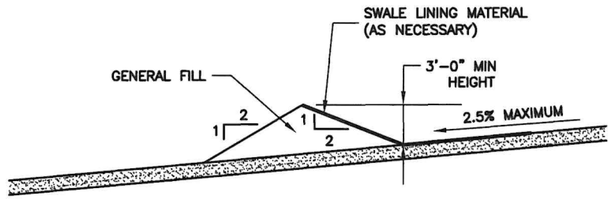
TEMPORARY SIDESLOPE SWALE TD1
NTS C1F.2



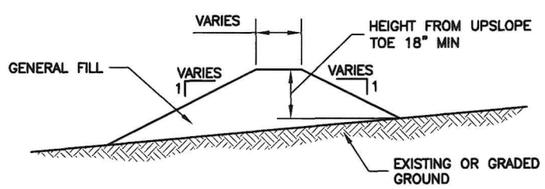
TEMPORARY DIVERSION CHANNEL TD3
NTS C1F.2



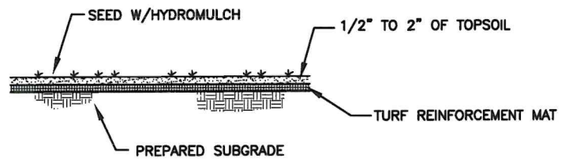
ROCK RIPRAP TD5
NTS C1F.2



TEMPORARY TOPSLOPE SWALE TD2
NTS C1F.2



TEMPORARY DIVERSION BERM TD4
NTS C1F.2



TEMPORARY TURF REINFORCEMENT MATTING TD6
NTS C1F.2

NOTE:

1. LINING MATERIAL, IF NECESSARY, FOR THE TEMPORARY DRAINAGE SWALES WILL BE TURF REINFORCEMENT MATTING OR OTHER SUITABLE MATERIALS.

TEMPORARY EROSION CONTROL STRUCTURES

1. TEMPORARY EROSION CONTROL STRUCTURE DETAILS DEPICT VARIOUS TYPES OF EROSION CONTROL FEATURES FOR CURRENT AND FUTURE DEVELOPMENT.
2. ALL TEMPORARY EROSION CONTROL STRUCTURES SHOWN MAY NOT BE CONSTRUCTED DEPENDING ON SITE CONDITIONS.
3. LANDFILL WILL SELECT EROSION CONTROL DETAILS TO BE USED FOR SITE SPECIFIC CONDITIONS.
4. ACTUAL DIMENSIONS OF TEMPORARY EROSION CONTROL STRUCTURES MAY VARY BASED ON SITE CONDITIONS.

STATE OF TEXAS
FELIPE ANTONIO WESCOUP
103826
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PROFESSIONAL ENGINEER
3/31/2026

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TEMPORARY EROSION CONTROL STRUCTURES

WASTE MANAGEMENT OF TEXAS, INC.
SKYLINE LANDFILL

BIGGS & MATHEWS ENVIRONMENTAL
1700 ROBERT ROAD, STE. 100
MANSFIELD, TEXAS 76063
817-563-1144

TBPELS FIRM NO. F-256 AND NO. 10194895
TBPG FIRM NO. 50222

DRAWING C1F.2

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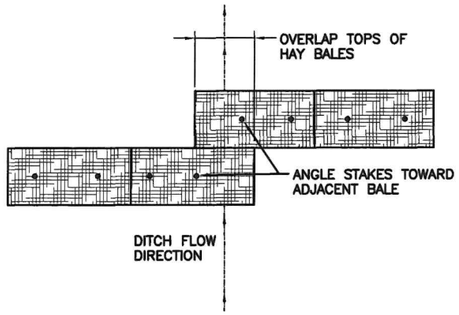
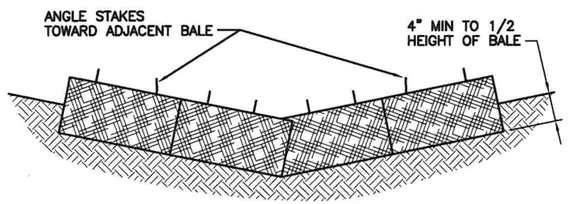


PLAN VIEW

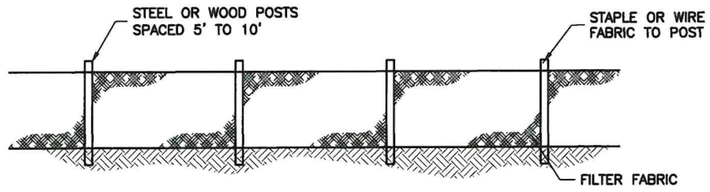


PROFILE VIEW

BALED HAY FOR EROSION CONTROL (TD7)

NTS C1F.3

HAY BALE NOTE:
1. HAY BALES SHALL BE EMBEDDED IN THE SOIL A MINIMUM OF 4" AND WHERE POSSIBLE 1/2 THE HEIGHT OF THE BALE.

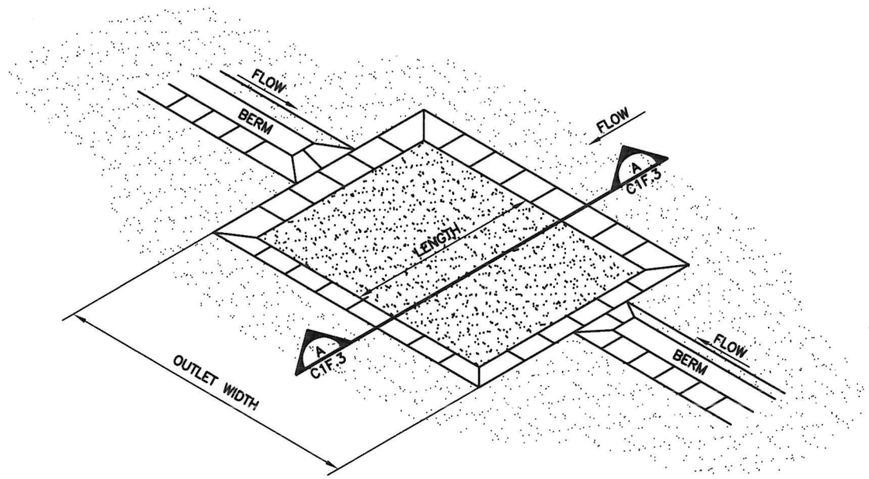


TEMPORARY SEDIMENT CONTROL (SILT) FENCE (TD9)

NTS C1F.3

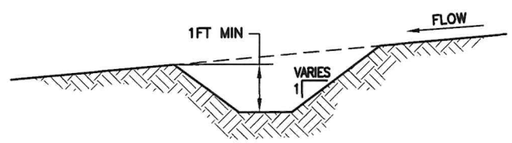
SILT FENCE NOTES:

1. MAXIMUM DRAINAGE AREA TO THE FENCE SHOULD NOT EXCEED THE MANUFACTURER'S SPECIFICATION BUT IN NO CASE BE GREATER THAN 0.5 ACRE PER 100 FEET OF FENCE.
2. TO ENSURE SHEET FLOW, A GRAVEL COLLAR OR LEVEL SPREADER MAY BE USED UPSLOPE OF THE SILT FENCE.



SEDIMENT TRAP PLAN

NTS



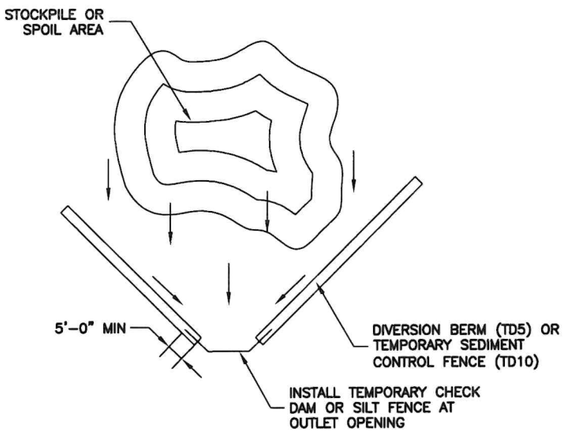
SEDIMENT TRAP SECTION (A–A)

NTS C1F.3

SEDIMENT TRAP (TD10)

NTS C1F.3

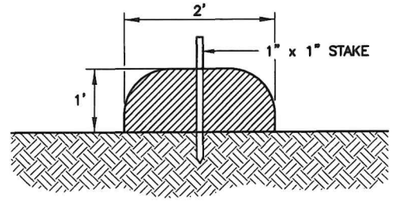
NOTE:
1. OUTLET INTO STABILIZED AREA (VEGETATION, ROCK, ETC.)
2. THE MAXIMUM AREA CONTRIBUTING TO A SEDIMENT TRAP SHOULD BE LESS THAN 10 ACRES.



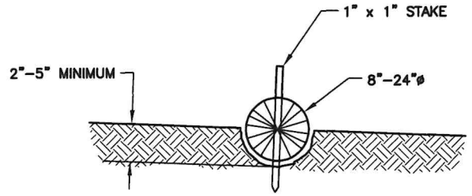
STOCKPILE EROSION CONTROL (TD8)

NTS C1F.3

NOTE:
1. CONSTRUCT DIVERSION DIKE TO DIVERT STORMWATER RUN–OFF FROM STOCKPILE OR SPOIL AREA THROUGH CHECK DAM, HAY BALES, OR SILT FENCE.



OPTION 1



OPTION 2

FILTER BERM (TD11)

NTS C1F.3

FILTER BERM NOTES:

1. FILTER BERMS MAY BE CONSTRUCTED OF MULCH, WOODCHIPS, BRUSH, COMPOST, SHREDDED WOODWASTE, OR SIMILAR MATERIALS.
2. FILTER BERMS MAY ALSO CONSIST OF MESH SOCKS FILLED WITH MULCH, WOOHCHIPS, BRUSH, COMPOST, SHREDDED WOODWASTE, OR SIMILAR MATERIALS.
3. RUNOFF MUST NOT BE ALLOWED TO RUN UNDER OR AROUND THE COMPOST FILTER BERM.
4. STAKES WILL BE PLACED 2–5" DEEP.
5. MAXIMUM DRAINAGE AREA TO THE FILTER BERM SHOULD NOT EXCEED 2 ACRES.

TEMPORARY EROSION CONTROL STRUCTURES

1. TEMPORARY EROSION CONTROL STRUCTURE DETAILS DEPICT VARIOUS TYPES OF EROSION CONTROL FEATURES FOR CURRENT AND FUTURE DEVELOPMENT.
2. ALL TEMPORARY EROSION CONTROL STRUCTURES SHOWN MAY NOT BE CONSTRUCTED DEPENDING ON SITE CONDITIONS.
3. LANDFILL WILL SELECT EROSION CONTROL DETAILS TO BE USED FOR SITE SPECIFIC CONDITIONS.
4. ACTUAL DIMENSIONS OF TEMPORARY EROSION CONTROL STRUCTURES MAY VARY BASED ON SITE CONDITIONS.

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TEMPORARY EROSION CONTROL STRUCTURES

WASTE MANAGEMENT OF TEXAS, INC.
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TBPELS FIRM NO. F–256 AND NO. 10194895
TBPG FIRM NO. 50222

DRAWING C1F.3

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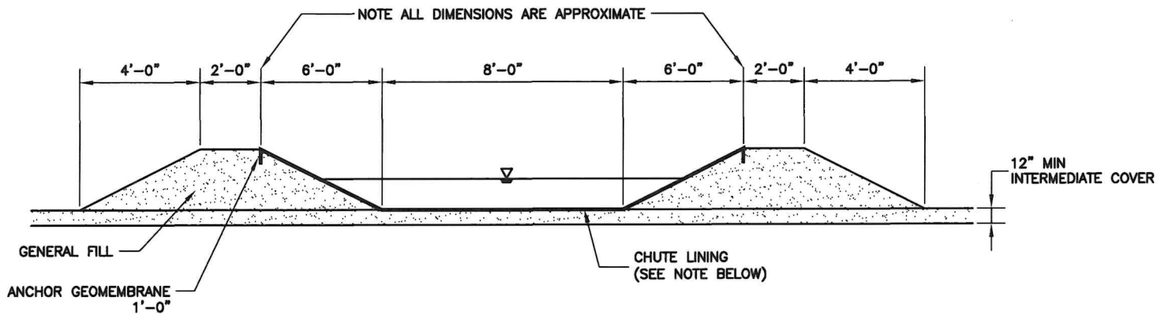
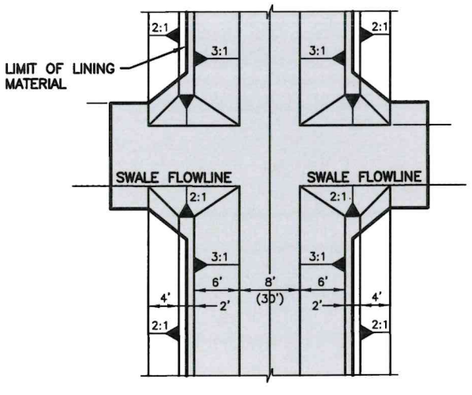


TEMPORARY CHUTE LETDOWN (TD12) C1F.4

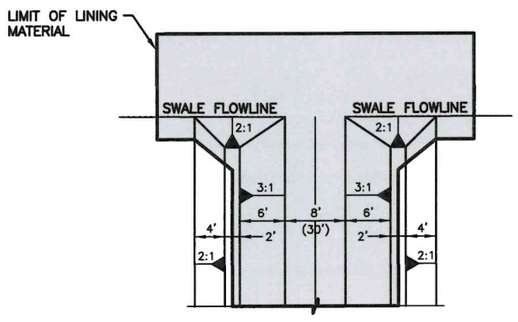
NTS

NOTE: CHUTE LINING WILL CONSIST OF ONE OF THE FOLLOWING: TURF REINFORCEMENT, SACRIFICIAL GEOMEMBRANE, GABIONS, ROCK RIPRAP, CONCRETE, CRUSHED CONCRETE, OR STONE.



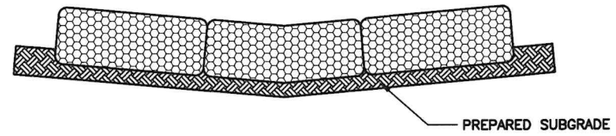
SWALE/CHUTE CONFLUENCE (TD13) C1F.4

NTS



SWALE/CHUTE TOPSLOPE CONFLUENCE (TD14) C1F.4

NTS



CHECK DAM (TD15) C1F.4

NTS

CHECK DAM NOTES:

1. MAY BE CONSTRUCTED USING GRAVEL, ROCK, GABIONS, COMPOST SOCKS, OR SAND BAGS.
2. PLACED ON PREPARED SUBGRADE OR BEDDING MATERIAL ALONG THE CONTOUR AT 0% GRADE OR AS NEAR AS POSSIBLE.
3. TOP WIDTH OF TWO FEET MINIMUM.
4. SIDESLOPES 2H:1V OR FLATTER.
5. MAY BE USED WHEN CONTRIBUTING DRAINAGE AREAS ARE LESS THAN 10 ACRES. MULTIPLE CHECK DAMS MAY BE INSTALLED IF DRAINAGE AREAS ARE GREATER THAN 10 ACRES.
6. CHECK DAMS SHOULD BE USED WHEN THE VOLUME OF RUNOFF IS TOO GREAT FOR OTHER EROSION CONTROL FEATURES (i.e. SILT FENCES, HAY BALES).

TEMPORARY EROSION CONTROL STRUCTURES

1. TEMPORARY EROSION CONTROL STRUCTURE DETAILS DEPICT VARIOUS TYPES OF EROSION CONTROL FEATURES FOR CURRENT AND FUTURE DEVELOPMENT.
2. ALL TEMPORARY EROSION CONTROL STRUCTURES SHOWN MAY NOT BE CONSTRUCTED DEPENDING ON SITE CONDITIONS.
3. LANDFILL WILL SELECT EROSION CONTROL DETAILS TO BE USED FOR SITE SPECIFIC CONDITIONS.
4. ACTUAL DIMENSIONS OF TEMPORARY EROSION CONTROL STRUCTURES MAY VARY BASED ON SITE CONDITIONS.

STATE OF TEXAS
FELIPE ANTONIO WESCOUP
103826
LICENSED
PROFESSIONAL ENGINEER

3/31/2026

REVISIONS			
REV	DATE	DESCRIPTION	DWN BY

TEMPORARY EROSION CONTROL STRUCTURES

WASTE MANAGEMENT OF TEXAS, INC.
SKYLINE LANDFILL

BIGGS & MATHEWS ENVIRONMENTAL
1700 ROBERT ROAD, STE. 100
MANSFIELD, TEXAS 76063
817-563-1144

TBPELS FIRM NO. F-256 AND NO. 10194895
TBPG FIRM NO. 50222

DRAWING
C1F.4

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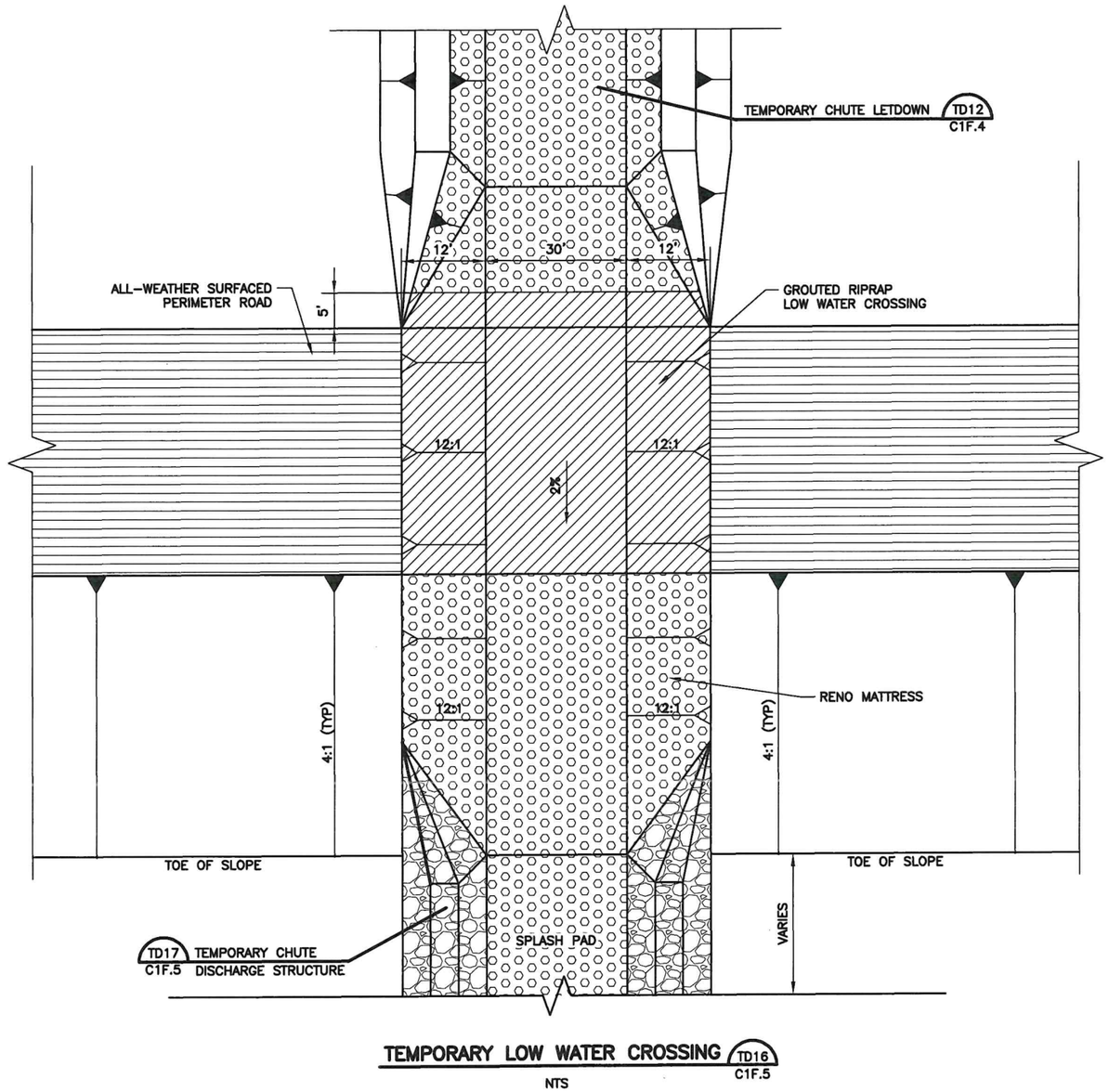
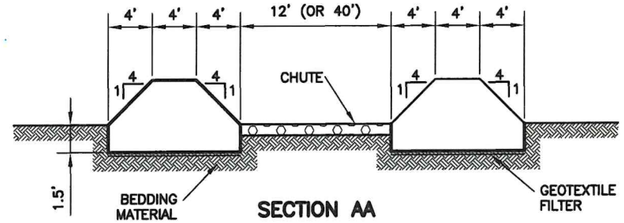
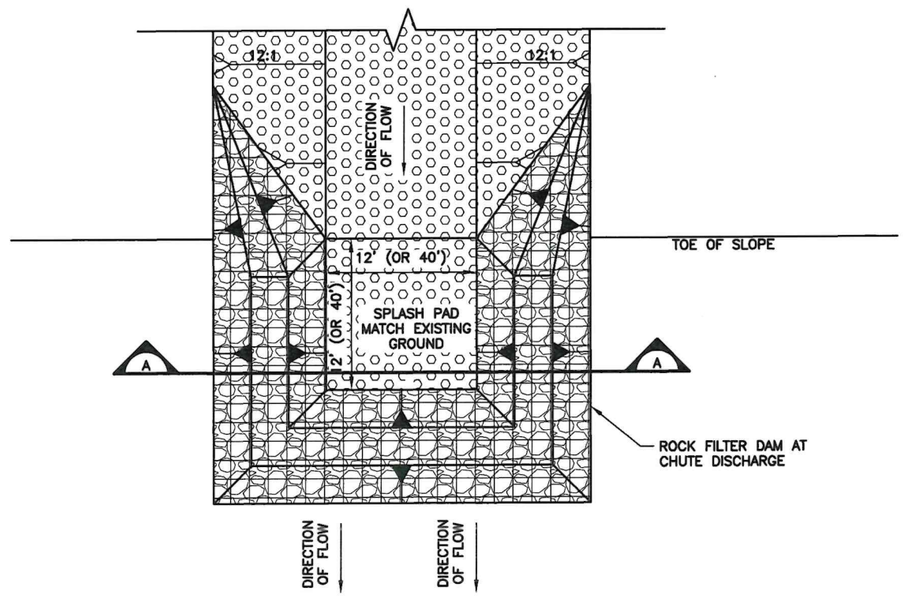


TEMPORARY LOW WATER CROSSING TD16 C1F.5

NTS



SECTION AA



TEMPORARY CHUTE DISCHARGE STRUCTURE TD17 C1F.5

NTS

STATE OF TEXAS
FELIPE ANTONIO WESCOUP
103826
LICENSED
PROFESSIONAL ENGINEER

3/31/2026

REVISIONS			
REV	DATE	DESCRIPTION	DWN BY

PERIMETER ROAD LOW WATER CROSSING

WASTE MANAGEMENT OF TEXAS, INC. SKYLINE LANDFILL

BIGGS & MATHEWS ENVIRONMENTAL
1700 ROBERT ROAD, STE. 100
MANSFIELD, TEXAS 76063
817-563-1144

TBPELS FIRM NO. F-256 AND NO. 10194895
TBPG FIRM NO. 50222

DRAWING C1F.5

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ATTACHMENT C1
APPENDIX C1G

INTERMEDIATE COVER
EROSION CONTROL STRUCTURE DESIGN

CONTENTS

Narrative C1G.1

Intermediate Cover Evaluation C1G.3

Sheet Flow C1G.12

Temporary Drainage Swale Design C1G.14

Temporary Diversion Channel Design C1G.18

Temporary Drainage Letdown Design C1G.23

Design Summary C1G.28

NARRATIVE

This appendix presents the supporting documentation to evaluate and design temporary erosion and sediment control structures for the intermediate cover phase of landfill development. Appendix C1G addresses the requirements of 30 TAC §330.305(d) and (e) and provides the evaluation and design of temporary erosion and sediment control structures for intermediate cover slopes.

INTERMEDIATE COVER PLAN

As intermediate cover is constructed, temporary chutes and swales will be constructed to prevent erosion and sedimentation. Erosion control features (i.e., filter berms, rock check dams, hay bales, or equivalent) may be constructed at the toe of filled areas to minimize erosion and prevent disturbance of the existing grassed slopes. Otherwise, temporary erosion and sediment control features will be installed within 180 days from when the intermediate cover is constructed. An existing conditions summary and Best Management Practices are included in Appendix C1F. Example intermediate cover drainage calculations are included in this appendix for use in site operations.

INTERMEDIATE COVER EVALUATION

The intermediate cover evaluation is based on the Universal Soil Loss Equation (USLE) following Soil Conservation Service (SCS) procedures. The evaluation is based on a 12-inch thick intermediate cover layer with 60 percent vegetated cover. Calculations for the soil loss for intermediate cover on external 5.25 percent and 25 percent slopes have been provided on pages C1G.6 through C1G.7.

SHEET FLOW DESIGN

The sheet flow calculations are presented for external 5.25 percent and 25 percent slope configurations. The permissible non-erodible velocities should be less than 5 ft/sec (clayey soil) or 4 ft/sec (sandy soil) on vegetated intermediate cover. The Manning's Equation and Rational Method were used to calculate sheet flow velocity.

TEMPORARY DRAINAGE SWALE DESIGN

The temporary drainage swales are designed for typical drainage areas and flowline slopes. The procedures in the TxDOT Hydraulic Design Manual, September 2019, were used to determine peak flow, flow depth, flow velocity, and swale capacity. The Rational Method and the Manning's Equation were used to calculate the design parameters.

TEMPORARY DIVERSION CHANNEL DESIGN

The temporary diversion channels are designed for typical drainage areas and flowline slopes. The procedures in the TxDOT Hydraulic Design Manual, September 2019, were used to determine peak flow, flow depth, flow velocity, and diversion channel capacity. The Rational Method and the Manning's Equation were used to calculate the design parameters.

TEMPORARY DRAINAGE LETDOWN DESIGN

The temporary drainage letdowns are designed for typical drainage areas on a 25 percent external side slope. The procedures in the TxDOT Hydraulic Design Manual, September 2019, were used to determine peak flow, flow depth, flow velocity, and letdown capacity. The Rational Method and the Manning's Equation were used to calculate the design parameters.

INTERMEDIATE COVER EVALUATION

INTERMEDIATE COVER EVALUATION

SOIL LOSS

This section presents the supporting documentation for evaluation of the potential for intermediate cover soil erosion loss at the Skyline Landfill. The evaluation is based on the premise of adding excess soil to increase the time required before maintenance is needed as recommended in the EPA Solid Waste Disposal Facility Criteria Technical Manual (EPA 530-R-93-017, November 1993).

The design procedure is as follows:

1. Minimum thickness of the intermediate cover is evaluated based on the maximum soil loss of 50 tons per acre per year.

	5.25% slope	25% slope
Maximum Sheet Flow Length	550 ft	250 ft
Soil Loss	1.33 tons/acre/year	25.10 tons/acre/year

2. Soil loss is calculated using the Universal Soil Loss Equation (USLE) by following SCS procedures. The soil loss is based on 60 percent vegetative cover as recommended in the TNRCC, "Use of the Universal Soil Loss Equation in Final Cover/Configuration Design Procedural Handbook" (October 1993). These calculations are provided on pages C1G.6 and C1G.7.

3. Sheet flow velocities for a 25-year storm event are calculated to be less than permissible non-erodible velocities. The supporting calculations are presented on page C1G.13.

4. Temporary vegetation for the intermediate cover areas will be native and introduced grasses with root depths of 6 inches to 8 inches.

5. Native and introduced grasses will be hydroseeded, drill seeded, or broadcast seeded with fertilizer on the disked (parallel to contours) intermediate cover layer as soon as practical following placement of intermediate cover and will be documented in the site operating record. All intermediate cover areas will be managed to control erosion and achieve a predicted soil loss of less than 50 tons per acre per year. Temporary erosion and sediment control features (including at least 60 percent vegetative cover) will be installed within 180 days from when the intermediate cover is constructed. Areas that experience erosion or do not readily vegetate will be reseeded until vegetation is established or the soil will be replaced with soil that will support the grasses.

SOIL LOSS FOR EXISTING INTERMEDIATE COVER AREAS

This section presents the supporting documentation for evaluation of the potential for intermediate cover soil erosion loss on the existing intermediate cover slopes at the Skyline Landfill. These areas have existing well established vegetation (at least 60 percent coverage) and will not be disturbed to construct temporary erosion control features.

	5.25% slope	25% slope
Maximum Sheet Flow Length	550 ft	250 ft
Soil Loss	1.33 tons/acre/year	25.10 tons/acre/year

SHEET FLOW VELOCITY

The sheet flow velocity calculations are presented for external 5.25 percent and 25 percent slope configurations. The procedures outlined in the TxDOT Hydraulic Manual were used to determine velocities. Maximum sheet flow lengths for all three conditions were evaluated. Calculations are provided on page C1G.13.

WASTE MANAGEMENT OF TEXAS, INC.
WASTE MANAGEMENT SKYLINE LANDFILL
Intermediate Cover Erosion Loss Evaluation

Required: 1. Determine the erosion loss for the intermediate cover design based on a maximum soil loss of 50 tons/acre/year.

Method: Expected soil loss is calculated using the Universal Soil Loss Equation.

References: 1. TNRCC, *Use of the Universal Soil Loss Equation in Final Cover/Configuration Design Procedural Handbook,* October 1993.

Solution: Annual Soil Loss in tons/acre/year (A) = RKLSCP

Design Parameters	External Top Slope (5.25%)	External Side Slope (25%)	
Rainfall Factor (R) =	310	310	Dallas/Ellis Counties[1]
Soil Erodibility Factor (K) =	0.23	0.23	(Clay)
Longest Run =	550	250	ft
Slope =	5.25	25	%
Topographic Factor (LS) =	1.33	9.31	
Crop Management Factor (C) =	0.042	0.042	(60% vegetative cover)
Erosion Control Practice Factor (P) =	0.50	0.90	
Soil Loss (A) =	1.99	25.10	tons/acre/year

Summary: As noted in the permit drawings, the intermediate cover will be a minimum of 12 inches thick. As shown above, the maximum soil loss is 25.10 tons/acre/year, which is less than the maximum allowable soil loss of 50 tons/acre/year.

Note: [1]The Dallas/Ellis county line crosses the landfill footprint.

WASTE MANAGEMENT OF TEXAS, INC.
WASTE MANAGEMENT SKYLINE LANDFILL
Intermediate Cover LS Factor Calculations

Required: 1. Determine the Length/Slope Factor based on slope length and slope gradient.

References: 1. TNRCC, *Use of the Universal Soil Loss Equation in Final Cover/Configuration Design Procedural Handbook,* October 1993.

Solution: Length/Slope Factor (LS) = ((L/72.6)m)*((65.41*sin2(S))+(4.56*sin(S))+0.065)

LS = Length/Slope Factor
L = Slope Length (ft)
S = radians
m = exponent dependent on the slope gradient

m = 0.2 for S <= 1.0%
0.3 for 1.0% < S <= 3.5%
0.4 for 3.5% < S < 5.0%
0.5 for S => 5.0%

Length, L (ft)	Slope, S %	Slope, S (ft/ft)	θ (radians)	θ (degrees)	m	LS
550	5.25	19	0.052	3.005	0.5	1.33
250	25	4	0.245	14.036	0.5	9.31

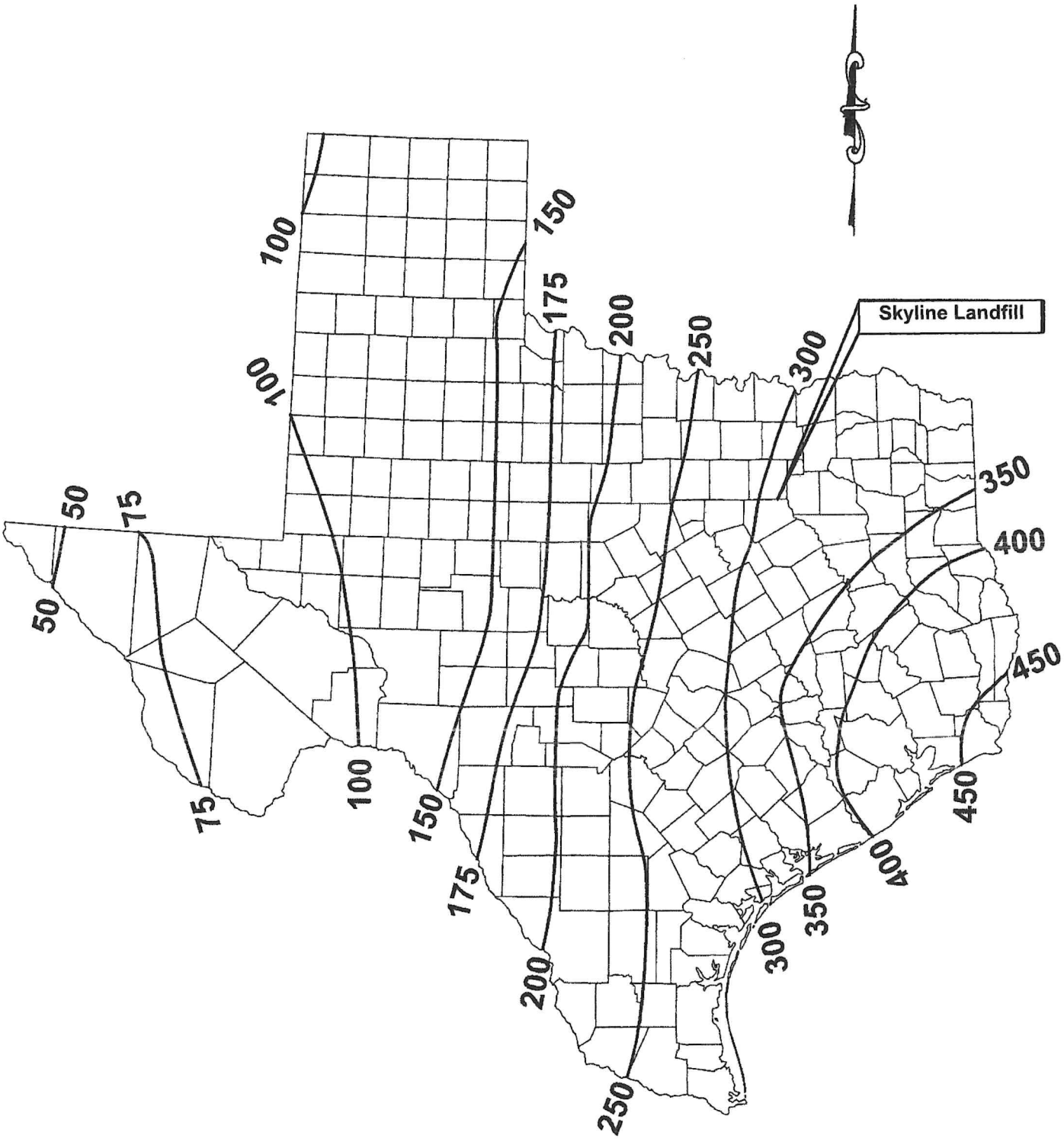


FIGURE 1 - AVERAGE ANNUAL VALUES OF THE RAINFALL EROSION INDEX

Table 1: Approximate Values of Factor K for USDA Textural Classes

Reproduced from: Texas Natural Resource Conservation Commission, Municipal Solid Waste Division, Use of the Universal Soil Loss Equation in Final Cover/Configuration Design: Procedural Handbook, 1993.

Texture Class	Organic Matter Content		
	<0.5%	2%	4%
	K	K	K
Sand	0.05	0.03	0.02
Fine Sand	0.16	0.14	0.10
Very Fine Sand	0.42	0.36	0.28
Loamy Sand	0.12	0.10	0.08
Loamy Fine Sand	0.24	0.20	0.16
Loamy Very Fine Sand	0.44	0.38	0.30
Sandy Loam	0.27	0.24	0.19
Fine Sandy Loam	0.35	0.30	0.24
Very Fine Sandy Loam	0.47	0.41	0.33
Loam	0.38	0.32	0.29
Silt Loam	0.48	0.42	0.33
Silt	0.60	0.52	0.42
Sandy Clay Loam	0.27	0.25	0.21
Clay Loam	0.28	0.25	0.21
Silty Clay Loam	0.37	0.32	0.26
Sandy Clay	0.14	0.13	0.12
Silty Clay	0.25	0.23	0.19
Clay	0.13 - 0.29		

The values shown are estimated averages of broad ranges of specific soil values. When a texture is near the borderline of two texture classes, use the average of the two K values.

Table 2: Factor C for Permanent Pasture, Range, and Idle Land[1]

Reproduced from: Texas Natural Resource Conservation Commission, Municipal Solid Waste Division, Use of the Universal Soil Loss Equation in Final Cover/Configuration Design: Procedural Handbook, 1993.

Vegetative Canopy		Cover that Contacts the Soil Surface					
Type and Height[2]	Percent Cover[3]	Percent Ground Cover					
		0	20	40	60	80	95+
No Appreciable Canopy		0.45	0.20	0.10	0.042	0.013	0.003
Tall weeds or short brush with average drop fall height of 20 in.	25	0.36	0.17	0.09	0.038	0.013	0.011
	50	0.26	0.13	0.07	0.035	0.012	0.003
	75	0.17	0.10	0.06	0.032	0.011	0.003

Extracted from: United States Department of Agriculture, AGRICULTURE HANDBOOK NUMBER 537

[1] The listed C values assume that the vegetation and mulch are randomly distributed over the entire area.

[2] Canopy height is measured as the average fall height of water drops falling from the canopy to the ground. Canopy effect is inversely proportional to drop fall height and is negligible if fall height exceeds 33 feet.

[3] Portions of total-area surface that would be hidden from view by canopy in a vertical projection (a bird's eye view).

Table 3: P Factors for Contouring, Contour Stripcropping and Terracing

Reproduced from: Texas Natural Resource Conservation Commission, Municipal Solid Waste Division, Use of the Universal Soil Loss Equation in Final Cover/Configuration Design: Procedural Handbook, 1993.

Land Slope	P Values		
%	Contouring†	Contour Stripcropping	Terracing†
2.0 to 7	0.50	0.25	0.50
8.0 to 12	0.60	0.30	0.60
13.0 to 18	0.80	0.40	0.80
19.0 to 24	0.90	0.45	0.90

(This table appeared in SCS (5), p.9)

† Contouring and terracing columns are suitable for MSWLF cover. Contour stripcropping is not suitable for the type of vegetative cover normally practiced at municpal landfills.

Table 4: Guide for Assigning Soil Loss Tolerance Values (T) to Solid Having Different Rooting Depths

Rooting Depth	Soil Loss Tolerance Values Annual Soil Loss (Tons/Acre)	
Inches	Renewable Soil a/	Renewable Soil b/
0 - 10	1	1
10 - 20	2	1
20 - 40	3	2
40 - 60	4	3
60	5	4

(This table appeared in SCS (6), p.4)

a/ Soil with favorable substrata that can be renewed by tillage, fertilizer, organic matter, and other management practices. This column does not represent MSWLF final covers under normal conditions.

b/ Soil with unfavorable substrata such as rock or soft rock that cannot be renewed by economical means. Most of the MSWLF covers with constructed clay cap and/or flexible membrane should use this performance criteria.

SHEET FLOW

WASTE MANAGEMENT OF TEXAS, INC.
WASTE MANAGEMENT SKYLINE LANDFILL
Intermediate Cover Sheet Flow Velocity

Required: Determine the sheet flow velocity for the intermediate cover design and compare to the permissable non-erodible flow velocity.

Method:
1. Determine the 25-year peak flow rate using the Rational Method.
2. Calculate flow depth using Manning's Equation.
3. Calculate sheet flow velocity and compare to permissible non-erodible velocity.

References:
1. Texas Department of Transportation, *Hydraulic Design Manual*, Revised September 2019.
2. NOAA Atlas 14, Precipitation-Frequency Atlas of the United States, Volume 11 Version 2.0: Texas, 2018.

Solution:

1. Determine the 25-year peak flow rate (Q) using the Rational Method

25-Year Rainfall Depth (Pd) =	1.34	in	(Ref. 2)
Time of Concentration (tc) =	10.0	min	(conservative minimum value)
Rainfall Intensity (I) =	8.0	in/hr	(ref 1, I = Pd/tc)
Runoff Coefficient (C) =	0.70		(typical value for intermediate cover)
25-Year Peak Flow Rate (Q) =	CIA	cfs	

	External Top Slope (5.25%)	External Side Slope (25%)		
Longest Run =	550	250	ft	(longest sheet flow distance to swale)
Width =	1.00	1.00	ft/ft	(unit width of flow)
Area =	0.0126	0.0057	acre	
Q	0.071	0.032	cfs	

2. Calculate the flow depth using Manning's Equation.
- Rearrange Manning's Equation for wide and shallow flow to calculate flow depth:

$$y = (Qn/1.49S^{0.5})^{0.6}$$

Manning's Roughness (n) =	0.03		(typical value for vegetated intermediate cover)
Slope =	0.025	0.250	ft/ft
Depth (y) =	0.059	0.019	ft

3. Calculate sheet flow velocity and compare to permissible non-erodible velocity.
- A permissible non-erodible velocity of 5 ft/sec (clayey soil) or 4 ft/sec (sandy soil) is typical for vegetated intermediate covers. Refer to page C1-G-6 for soil loss calculations.

$$V = Q / (y * width)$$

Sheet flow velocity	**1.19**	**1.73**	**ft/sec**

Summary: The permissable non-erodible velocity should be less than 5.0 ft/sec (clayey soil) or 4.0 ft/sec (sandy soil) on vegetted intermediate cover. Therefore, the expected sheet flow velocity is acceptable on the external intermediate cover slopes with 60% vegetative cover.

TEMPORARY DRAINAGE SWALE DESIGN

TEMPORARY DRAINAGE SWALE DESIGN

The temporary drainage swale design for intermediate cover areas is presented for the typical swale flowline of 1.0 percent. The procedures in the TxDOT Hydraulic Design Manual were used to determine peak flow, flow depth, flow velocity, and swale capacity. The temporary swales will be located on the intermediate cover to prevent erosion as follows:

Slope (%)	Maximum Sheet Flow Length (ft)	Maximum Drainage Area (acres)	Maximum Swale Length (ft)
5.25	550	22.14	2,925
25	250	7.12	1,779

All temporary swales shall be designed to minimize erosion and provide a maximum flow depth of 2 feet. The total height of the swales at the flowline is a minimum of 3 feet, as depicted in Appendix C1F on page C1F.2. As noted in the calculations, the velocities in the swales are less than permissible non-erodible velocities. If sustained erosion is observed, facility management will evaluate and construct additional temporary drainage swales. Example drainage swale calculations for a grassed intermediate cover are provided on pages C1G.16 and C1G.17.

WASTE MANAGEMENT OF TEXAS, INC.
WASTE MANAGEMENT SKYLINE LANDFILL
Drainage Swale Analysis - External Intermediate Cover Topslopes

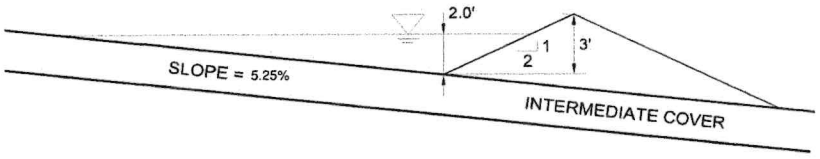
Required: Determine the inermediate cover topslope drainage swale capacity.

Method:
1. Calculate the intermediate cover topslope swale's flow capacity using Manning's Equation.
2. Determine the maximum allowable topslope drainage area using the Rational Method.
3. Determine the maximum swale length based on the maximum sheet flow length.

References:
1. Texas Department of Transportation, *Hydraulic Design Manual*, Revised September 2019.
2. NOAA Atlas 14, Precipitation-Frequency Atlas of the United States, Volume 11 Version 2.0: Texas, 2018.

Solution:

1. Calculate flow capacity using Manning's Equation.
- Swale Characteristics:



Max swale flow depth (D) =	2.00	ft	
Running swale slope (S) =	1.0	%	
Manning's Roughness (n) =	0.03		(typical value for vegetated intermediate cover)
Left slope (LS) =	19.05	:1	
Right slope (RS) =	2	:1	
Flow Area (A) =	((LS+RS)*D^2)/2		
Wetted Perimeter (WP) =	((LS*D)^2+D^2)^(0.5) + ((RS*D)^2+D^2)^(0.5)		
Hydraulic Radius (R) =	A / WP		

Flow Area (A) =	42.095	sf
Wetted Perimeter (WP) =	42.620	ft
Hydraulic Radius (R) =	0.988	ft

- Use Manning's Equation to determine the flow velocity in the swale.

Velocity (V) =	1.49*R^(2/3)*S^(1/2)/n	
Velocity (V) =	4.913	ft/sec

- Calculate the swale's flow capacity.

Swale capacity (Q) =	V * A	
Q =	206.8	cfs

2. Determine the maximum allowable drainage area using the Rational Method.

25-Year Rainfall Depth (Pd) =	1.34	in	(Ref. 2)
Time of Concentration (tc) =	10	min	(conservative minimum value)
Rainfall Intensity (I) =	8.0	in/hr	(ref 1, I = Pd/tc)
Runoff Coefficient (C) =	0.70		(typical value for intermediate cover)
25-Year Peak Flow Rate (Q) =	CIA	cfs	

- Rearrange the Rational Formula to calculate allowable drainage area:

Drainage Area = Q / (CI)

Maximum Allowable Swale Drainage Area = 36.9 acres

3. Determine the maximum swale length based on the maximum sheet flow length.

Maximum Sheet Flow Length = 550 ft

$$\text{Maximum Swale Length} = \frac{\text{Maximum Swale Drainage Area} * 43560}{\text{Maximum Sheet Flow Length}}$$

Maximum Swale Length = 2925

Summary: The maximum sheet flow length will be 550 feet and maximum drainage area is 36.9 acres. The calculated velocity is less than the permissible non-erodible velocity.

WASTE MANAGEMENT OF TEXAS, INC.
WASTE MANAGEMENT SKYLINE LANDFILL
Drainage Swale Analysis - External Intermediate Cover Sideslopes

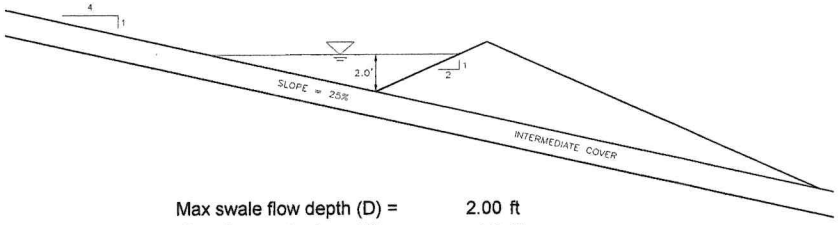
Required: Determine the inermediate cover sideslope drainage swale capacity.

Method:
1. Calculate the intermediate cover sideslope swale's flow capacity using Manning's Equation.
2. Determine the maximum allowable sideslope drainage area using the Rational Method.
3. Determine the maximum swale length based on the maximum sheet flow length.

References:
1. Texas Department of Transportation, *Hydraulic Design Manual*, Revised September 2019.
2. NOAA Atlas 14, Precipitation-Frequency Atlas of the United States, Volume 11 Version 2.0: Texas, 2018.

Solution:

1. Calculate flow capacity using Manning's Equation.
- Swale Characteristics:



Max swale flow depth (D) =	2.00	ft	
Running swale slope (S) =	1.0	%	
Manning's Roughness (n) =	0.03		(typical value for vegetated intermediate cover)
Left slope (LS) =	4.00	:1	
Right slope (RS) =	2	:1	
Flow Area (A) =	((LS+RS)*D^2)/2		
Wetted Perimeter (WP) =	((LS*D)^2+D^2)^(0.5) + ((RS*D)^2+D^2)^(0.5)		
Hydraulic Radius (R) =	A / WP		

Flow Area (A) =	12.000	sf
Wetted Perimeter (WP) =	12.718	ft
Hydraulic Radius (R) =	0.944	ft

- Use Manning's Equation to determine the flow velocity in the swale.

Velocity (V) =	1.49*R^(2/3)*S^(1/2)/n	
Velocity (V) =	4.778	ft/sec

- Calculate the swale's flow capacity.

Swale capacity (Q) =	V * A	
Q =	57.3	cfs

2. Determine the maximum allowable drainage area using the Rational Method.

25-Year Rainfall Depth (Pd) =	1.34	in	(ref 2, extrapolated for 10 minutes)
Time of Concentration (tc) =	10	min	(conservative minimum value)
Rainfall Intensity (I) =	8.0	in/hr	(ref 1, I = Pd/tc)
Runoff Coefficient (C) =	0.70		(typical value for intermediate cover)
25-Year Peak Flow Rate (Q) =	CIA	cfs	

- Rearrange the Rational Formula to calculate allowable drainage area:

Drainage Area = Q / (CI)

Maximum Allowable Swale Drainage Area = 10.2 acres

3. Determine the maximum swale length based on the maximum sheet flow length.

Maximum Sheet Flow Length = 250 ft

$$\text{Maximum Swale Length} = \frac{\text{Maximum Swale Drainage Area} * 43560}{\text{Maximum Sheet Flow Length}}$$

Maximum Swale Length = 1779 ft

Summary: The maximum sheet flow length will be 250 feet and maximum drainage area is 10.2 acres. The calculated velocity is less than the permissible non-erodible velocity.

TEMPORARY DIVERSION CHANNEL DESIGN

TEMPORARY DIVERSION CHANNEL DESIGN

The temporary diversion channel design for preventing surface water from entering excavated areas is presented for three typical slopes of 0.5 percent, 1 percent and 2 percent and three typical drainage areas of 1, 5, and 10 acres. The procedures in the TxDOT Hydraulic Design Manual were used to determine peak flow, flow depth, flow velocity, and diversion channel capacity. Temporary diversion channels will be designed to minimize erosion and sedimentation. Temporary diversion channels will be excavated only in areas of in-situ soil or soil stockpile areas. They will not be used over lined areas or areas that have received waste.

WASTE MANAGEMENT OF TEXAS, INC.
WASTE MANAGEMENT SKYLINE LANDFILL
Temporary Diversion Channel

Diversion channel drainage areas were based on the typical size that may occur during the development of the site. The diversion channels are intended to prevent surface water from entering the excavated areas. 1-, 5-, and 10-acre drainage areas were considered:

Diversion Channel Slope	Diversion Channel Area (Acres)	Flow (cfs)	Bottom Width (ft)	Side Slopes (H:V)	Manning's number (n)	Normal Depth (ft)	Flow Area (ft^2)	Velocity (ft/s)	Energy Head (ft)
0.5	1	6.0	0	3	0.03	0.98	2.86	2.10	1.05
0.5	5	29.8	0	3	0.03	1.78	9.52	3.13	1.93
0.5	10	59.6	0	3	0.03	2.31	16.01	3.72	2.52
1	1	6.0	0	3	0.03	0.86	2.21	2.72	0.97
1	5	29.8	0	3	0.03	1.56	7.34	4.06	1.82
1	10	59.6	0	3	0.03	2.03	12.35	4.83	2.39
2	1	6.0	0	3	0.03	0.75	1.70	3.53	0.95
2	5	29.8	0	3	0.03	1.37	5.66	5.26	1.80
2	10	59.6	0	3	0.03	1.78	9.52	6.26	2.39

Notes:

1. The calculations shown in the table above are normal depths from the 25-year rainfall event.
2. The required diversion channel depth will have 0.5 foot of freeboard.
3. Diversion channels shall be grassed. Erosion control features will be provided for velocities exceeding 5 fps.
4. During operation of the site different configurations of diversion channels may be used to prevent surface water from entering excavated areas. The landfill operator will determine the sizing of diversion channels if different lining materials is used.
5. The shading represents sample calculation presented on pages C1-G-20 and C1-G-21.

WASTE MANAGEMENT OF TEXAS, INC.
WASTE MANAGEMENT SKYLINE LANDFILL
Temporary Diversion Channel
Example Calculations

Required: Determine the necessary dimensions of the temporary diversion channel for routing surface water around excvations.

Methods:
1. Calculate the 25-year peak flow rate (Q) for a 1-acre drainage area using the Rational Method.
2. Calculate the normal depth for the temporary diversion channel for a drainage area of 1 acre with a slope of 2%.

References:
1. Texas Department of Transportation, *Hydraulic Design Manual*, Revised September 2019.
2. NOAA Atlas 14, Precipitation-Frequency Atlas of the United States, Volume 11 Version 2.0: Texas, 2018.

Solution:

1. Calculate the 25-year peak flow rate (Q) for a 1-acre drainage area using the Rational Method.

25-Year Rainfall Depth (Pd) =	1.34	in	(Ref. 2)
Time of Concentration (tc) =	10.0	min	(conservative minimum value)
Rainfall Intensity (I) =	8.0	in/hr	(ref 1, I = Pd/tc)
Runoff Coefficient (C) =	0.70		(ref 1, Table 4-11)
Area (A) =	1	acre	
25-Year Peak Flow Rate (Q) =	CIA	cfs	
Q =	(0.7)(8.0)(1)		
Q =	5.6	cfs	

2. Calculate the normal depth for the temporary diversion channel for a drainage area of 1 acre with a slope of 2%.

List of Symbols:

Q_d = design flow rate for channel, cfs
R = hydraulic radius, ft
n = Manning's roughness coefficient
S = channel slope, ft/ft
b = bottom width of channel, ft
z_r = z-ratio (ratio of run to rise for channel sideslope) for right sideslope of diversion channel
z_l = z-ratio (ratio of run to rise for channel sideslope) for left sideslope of diversion channel
A_f = flow area, sf
g = gravitational acceleration = 32.2 ft/s^2
T = top width of flow, ft
d = normal depth of diversion channel, ft

Design Inputs:

Q_d =	6.0	cfs (from page C1-G-20)
S =	0.02	ft/ft
b =	0	ft
z_r =	3	(H) : 1 (V)
z_l =	3	(H) : 1 (V)
n =	0.03	

WASTE MANAGEMENT OF TEXAS, INC.
WASTE MANAGEMENT SKYLINE LANDFILL
Temporary Diversion Channel
Example Calculations

Step A - Based on the geometry of the swale cross section, solve for R and A_f.

$$R = \frac{bd + 1/2d^2(z_r + z_l)}{b + d((z_l^2 + 1)^{0.5} + (z_r^2 + 1)^{0.5})}$$

$$A_f = bd + 1/2d^2(z_r + z_l)$$

Assume: $d = 0.75$ ft

$R = 0.357$ ft

$A_f = 1.70$ sf

Solve for Q: $Q = 6.0$

If Q is not equal to Q_d, select a new d and repeat calculations.

The program uses an iterative process to calculate the normal depth of the diversion channel to satisfy Manning's Equation.

$$Q = \frac{1.486}{n} A R^{0.67} S^{0.5}$$

Step B - solve for velocity, T, Froude number, velocity head, and energy head.

$Q = VA \Rightarrow V = Q/A$

$V = 3.53$ ft/s

$T = b + d(z_l + z_r)$

$T = 4.52$ ft

$$F_r = \frac{V}{(gA/T)^{0.5}}$$

$F_r = 1.01$

$$\text{Velocity Head} = \frac{V^2}{2g}$$

Velocity Head = 0.19 ft

Energy Head = depth + velocity head

Energy Head = 0.95 ft

TEMPORARY DRAINAGE LETDOWN DESIGN

TEMPORARY DRAINAGE LETDOWN DESIGN

Temporary sideslope swales will collect and route surface water runoff from intermediate cover sideslope areas to temporary drainage letdowns on the intermediate cover sideslopes. Temporary topslope swales will collect and route surface water runoff from intermediate cover top dome areas to temporary drainage letdowns on the intermediate cover sideslopes. Temporary topslope chutes are not required as topslope areas will not exceed the limit of sheet flow of 550 feet.

The temporary letdowns design is applicable for external sideslopes of the landfill with intermediate cover. Temporary letdown chutes will typically consist of channels lined with erosion control material. The temporary flow depth provided is 2-feet. The design flow depth for geomembrane lined letdowns is 0.25 feet which provide a freeboard of 1.75 feet.

The flow capacity of the letdown structures was determined based on the Manning's Equation. The maximum flow calculated from the Manning's Equation is used to determine the maximum drainage area based on the Rational Method. The design calculations presented on pages C1G.25 through C1G.27 represent typical calculations for letdown chutes lined with geomembrane liner on a 25 percent slope. If sustained erosion is observed, facility management will evaluate the use and construction of temporary letdowns.

WASTE MANAGEMENT OF TEXAS, INC.
WASTE MANAGEMENT SKYLINE LANDFILL
Temporary Letdown/Chute Flow Evaluation

Required:

1. Determine the capacity of a variety of letdown chutes with different lining materials.

Method:

1. Use Manning's Equation to calculate the temporary chute capacity for a variety of lining materia
2. Use the Rational Method to determine the maximum drainage area for a variety of temporary chute lining materials and temporary chute bottom widths.

References:

1. Texas Department of Transportation, *Hydraulic Design Manual*, Revised September 2019.
2. NOAA Atlas 14, Precipitation-Frequency Atlas of the United States, Volume 11 Version 2.0: Texas, 2018.

Solution:

1. Chutes will be designed to function during the 25-year storm event.

Where: Q = Chute capacity (cfs)
n = Manning's Coefficient (unitless)[(1)]
A = Cross sectional area (ft^2)
WP = Wetted Perimeter (ft)
R = Hydraulic Radius (ft)
S = Letdown slope (ft/ft)
d = Normal Depth (ft)
b = Bottom Width of Chute (ft)
z = Chute Side Slope (ft/ft)

$$A = bd + zd^2$$

$$WP = b + 2\left[(zd)^2 + d^2\right]^{0.5}$$

$$R = A / WP$$

$$Q = \frac{1.486(A)(R^{2/3})(S^{1/2})}{n}$$

[(1)] The Manning's Coefficient was selected from the references for the applicable lining material.

WASTE MANAGEMENT OF TEXAS, INC.
WASTE MANAGEMENT SKYLINE LANDFILL
Temporary Letdown/Chute Flow Evaluation

HDPE Geomembrane Lined Chute

Depth d (ft)	Bottom Width b (ft)	Letdown Slope S (ft/ft)	Chute Side Slope z (ft/ft)	Manning's Coefficient* n	Area A (sf)	Wetted Perimeter WP (ft)	Hydraulic Radius R (ft)	Velocity V (fps)	Flow Rate Q (cfs)
0.25	8	0.25	3	0.013	2.19	9.58	0.228	21.35	46.7
0.25	30	0.25	3	0.013	7.69	31.58	0.243	22.28	171.3

* Manning's coefficient selected for a temporary HDPE geomembrane lined chute.

WASTE MANAGEMENT OF TEXAS, INC.
WASTE MANAGEMENT SKYLINE LANDFILL
Temporary Letdown/Chute Flow Evaluation

2. Use the Rational Method to determine the maximum drainage area for a variety of temporary chute lining materials and temporary chute bottom widths.

25-Year Rainfall Depth (Pd) =	1.34	in	(Ref. 2)
Time of Concentration (tc) =	10.0	min	(conservative minimum value)
Rainfall Intensity (I) =	8.0	in/hr	(ref 1, I = Pd/tc)
Runoff Coefficient (C) =	0.70		(ref 1, Table 4-11)

- Rearranging the rational formula, the maximum drainage area is determined as follows:

Q = Flow Rate
A = Maximum Drainage Area
A = Q/(CI)
A = 46.7/(0.7*8)
A = 8.3 acres

HDPE Geomembrane Lined Chute

Bottom Width (ft)	Flow Rate (cfs)	Maximum Drainage Area (acres)
8	46.7	8.3
30	171.3	30.6

DESIGN SUMMARY

The Skyline Landfill will implement the erosion and sediment control features on the intermediate cover as the landfill develops. The following items will be implemented as filling operations are ongoing:

- Intermediate cover will be established on all areas that have received waste but will remain inactive for periods greater than 180 days.
- Sufficient permanent and temporary erosion and sediment control features shall be constructed to redirect surface water and prevent erosion.
- Temporary erosion and sediment control features shall be constructed within 180 days of placement of intermediate cover.
- Temporary erosion control structures (e.g., rock check dams, filter berms) may be established along the toe of existing vegetated intermediate cover areas with approximately 70-90 percent coverage.
- Final cover will be constructed as the site develops. Temporary erosion control features will be removed as permanent erosion controls are constructed.
- The erosion and sediment control plan and temporary erosion and sediment control details for the intermediate cover are included in Attachment C, Appendix C1F, Intermediate Cover Erosion and Sediment Control Plan.

WASTE MANAGEMENT SKYLINE LANDFILL
DALLAS AND ELLIS COUNTIES, TEXAS
TCEQ PERMIT APPLICATION NO. MSW 42E

PERMIT AMENDMENT APPLICATION

PART III – FACILITY INVESTIGATION AND DESIGN
ATTACHMENT C2
FLOOD CONTROL ANALYSIS

Prepared for

WASTE MANAGEMENT

Waste Management of Texas, Inc.

March 2026

STATE OF TEXAS
FELIPE ANTONIO WESCOUP
103826
LICENSED
PROFESSIONAL ENGINEER
3/31/2026

Biggs & Mathews Environmental, Inc.
Firm Registration No. F-256

Prepared by

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

TEXAS BOARD OF PROFESSIONAL ENGINEERS
FIRM REGISTRATION NO. F-256 AND NO. 10194895

TEXAS BOARD OF PROFESSIONAL GEOSCIENTISTS
FIRM REGISTRATION NO. 50222

NARRATIVE

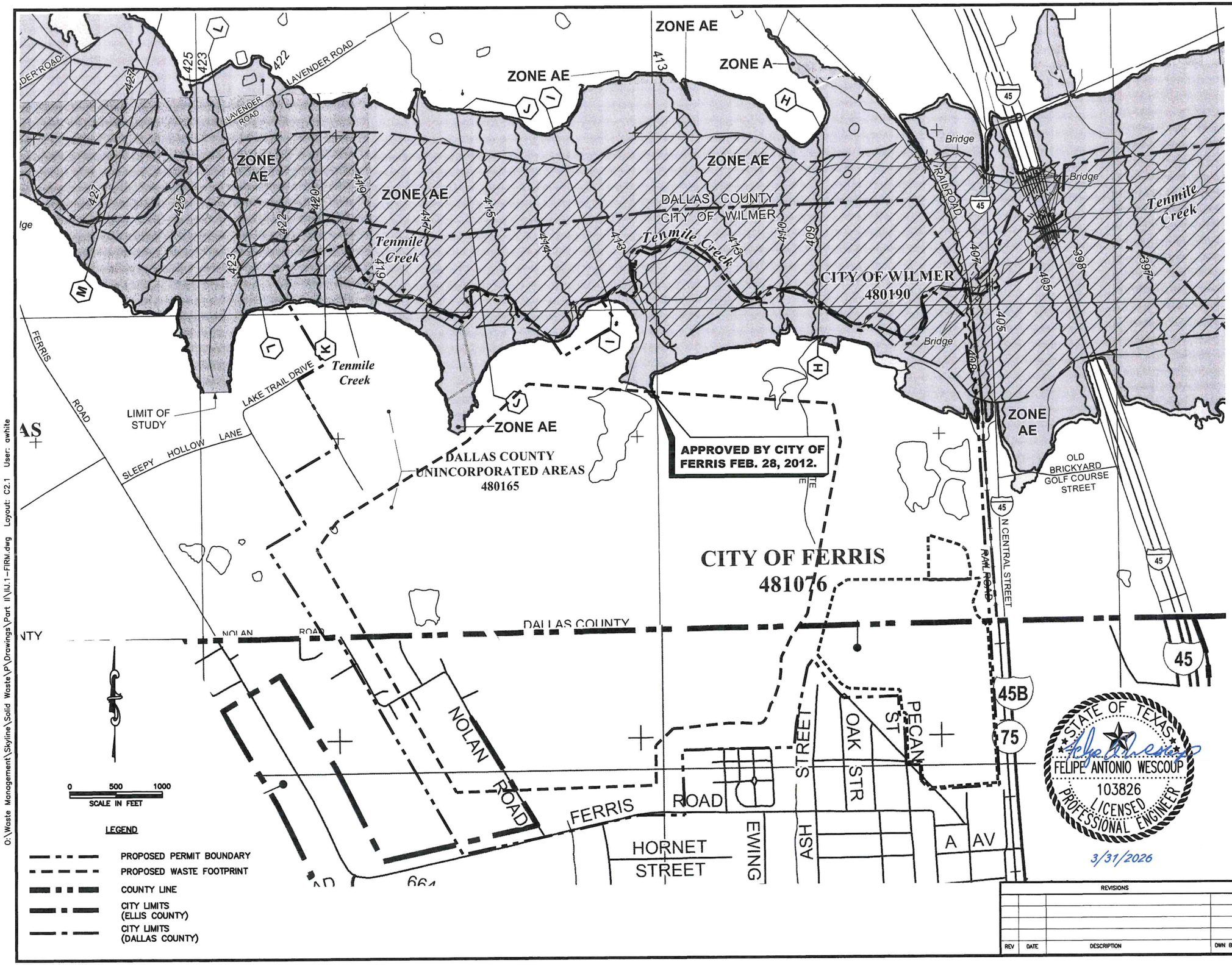
30 TAC §§330.63(c) and 330.547

The flood control analysis includes the demonstrations consistent with the requirements of §§330.63(c)(2), 330.301-307, and 330.547. The proposed expansion of the Skyline Landfill waste disposal footprint (waste disposal units) is not located within the 100-year floodplain. A portion of the proposed landfill permit boundary will be located within the 100-year floodplain.

Drawing C2.1, using the FEMA Flood Insurance Rate Map (FIRM) for the area as the FIRM Community Panel Numbers 48113C0670K, 48113C0665K, 48113C0655 and 48113C0660K, effective July 7, 2014 and FIRM Community Panel Numbers 48139C0100F, effective June 6, 2013 shows that a portion of the waste disposal footprint is within the 100-Year Special Flood Hazard Area. The currently approved MSW Permit No. 42D, Technically Complete April 15, 2015, addressed this encroachment into the FEMA-defined 100-year floodplain along Ten Mile Creek.

The City of Ferris, which serves as the FEMA-designated Floodplain Administrator for the area granted approval for the landfill to place approximately 2,500 cubic yards (1.55 acre-feet) of fill within the 100-year floodplain, contingent upon providing approximately 2,600 cubic yards (1.61 acre-feet) of compensating floodplain storage volume through excavation as part of the permit condition. This approval, documented in correspondence dated February 28, 2012, was based on hydraulic analysis demonstrating that the proposed development would not adversely impact Ten Mile Creek's flooding conditions, would not restrict flood flow, and would not reduce the temporary water storage capacity of the floodplain. The 42D analysis included comprehensive HEC-RAS modeling comparing current permitted and post-development conditions for both 25-year and 100-year storm events, confirming that the landfill expansion met all applicable TCEQ regulations under 30 TAC §330.63(c) and §330.547. The floodplain modifications were completed after the TCEQ approval of 42D.

In accordance with §330.63(c)(2), the Skyline Landfill is not located within a 100-year floodplain. Since the Skyline Landfill is not located within a 100-year floodplain, flood protection levees are not required and §330.307 is not applicable. In accordance with §330.547(a), the Skyline Landfill's waste disposal operations will not be located in the 100-year floodway. In accordance with §330.547(b), the Skyline Landfill's municipal solid waste disposal units are not located in the 100-year floodplain, will not restrict the flow of the 100-year flood, will not reduce the temporary water storage capacity of the floodplain, and will not result in the washout of solid waste. Further, in accordance with §330.547(c), the Skyline Landfill's processing and/or storage units are not located within the 100-year floodplain.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DALLAS COUNTY
CITY OF WILMER
CITY OF WILMER
480190
DALLAS COUNTY
UNINCORPORATED AREAS
480165
CITY OF FERRIS
481076
APPROVED BY CITY OF FERRIS FEB. 28, 2012.
LIMIT OF STUDY
Tenmile Creek
Tenmile Creek
Tenmile Creek
Tenmile Creek
LAVENDER ROAD
LAVENDER ROAD
FERRIS ROAD
LAKE TRAIL DRIVE
SLEEPY HOLLOW LANE
NOLAN ROAD
DALLAS COUNTY
FERRIS ROAD
HORNET STREET
EWING
ASH STREET
OAK STR
PECAN ST
A AV
N CENTRAL STREET
RAILROAD
OLD BRICKYARD GOLF COURSE STREET
Bridge
Bridge
Bridge
45
45B
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ZONE AE
ZONE AE

City of Ferris



"A Texas Main Street City"

February 28, 2012

Kenneth J. Welch, P.E.
Principal Engineer
Biggs & Mathews Environmental, Inc.
1700 Robert Road, Suite 100
Mansfield, Texas 76063

Re: Waste Management of Texas, Inc.
Skyline Landfill
Coordination of 100-Year Floodplain
City of Ferris, Texas

Dear Mr. Welch:

The City of Ferris Floodplain Administrator is responsible for floodplain management within the City of Ferris. The responsibilities of the City of Ferris Floodplain Administrator are part of the duties of the City Manager's Office. The City Manager's Office has reviewed the 100-year Floodplain Analysis of Ten Mile Creek related to the expansion of the Skyline Landfill. The Skyline Landfill is located entirely within the city limits of Ferris.

The 100-year Floodplain Analysis states that the proposed expansion of the Skyline Landfill requires placement of approximately 2,500 cubic yards of fill within the limits of the Federal Emergency Management Agency (FEMA) 100-year floodplain resulting in a loss of temporary floodplain storage volume of about 1.55 acre-feet. The analysis also states that the proposed expansion includes approximately 2,600 cubic yards of excavation within the limits of the FEMA 100-year floodplain providing about 1.61 acre-feet of temporary floodplain storage volume. These improvements within the 100-year floodplain are not within the 100-year floodway of Ten Mile Creek.

Our review of this analysis finds that the Skyline Landfill, if expanded as proposed, will not restrict the flow of the 100-year flood, will not reduce the temporary water storage capacity of the floodplain, and that the proposed encroachment in the 100-year floodplain by placement of fill is authorized. Waste Management of Texas, Inc. at the time of development within the 100-year floodplain will submit certified as-built information to the FEMA through the City of Ferris for a LOMR-F to be issued.

Sincerely,

Eric Strong
City Manager
City of Ferris, Texas

WASTE MANAGEMENT SKYLINE LANDFILL
DALLAS AND ELLIS COUNTIES, TEXAS
TCEQ PERMIT APPLICATION NO. MSW 42E

PERMIT AMENDMENT APPLICATION

PART III – FACILITY INVESTIGATION AND DESIGN
ATTACHMENT C3
DRAINAGE SYSTEM PLANS AND DETAILS

Prepared for

WASTE MANAGEMENT

Waste Management of Texas, Inc.

March 2026

STATE OF TEXAS
FELIPE ANTONIO WESCOUP
103826
LICENSED
PROFESSIONAL ENGINEER
3/31/2026

Biggs & Mathews Environmental, Inc.
Firm Registration No. F-256

Prepared by

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

TEXAS BOARD OF PROFESSIONAL ENGINEERS
FIRM REGISTRATION NO. F-256 AND NO. 10194895

TEXAS BOARD OF PROFESSIONAL GEOSCIENTISTS
FIRM REGISTRATION NO. 50222

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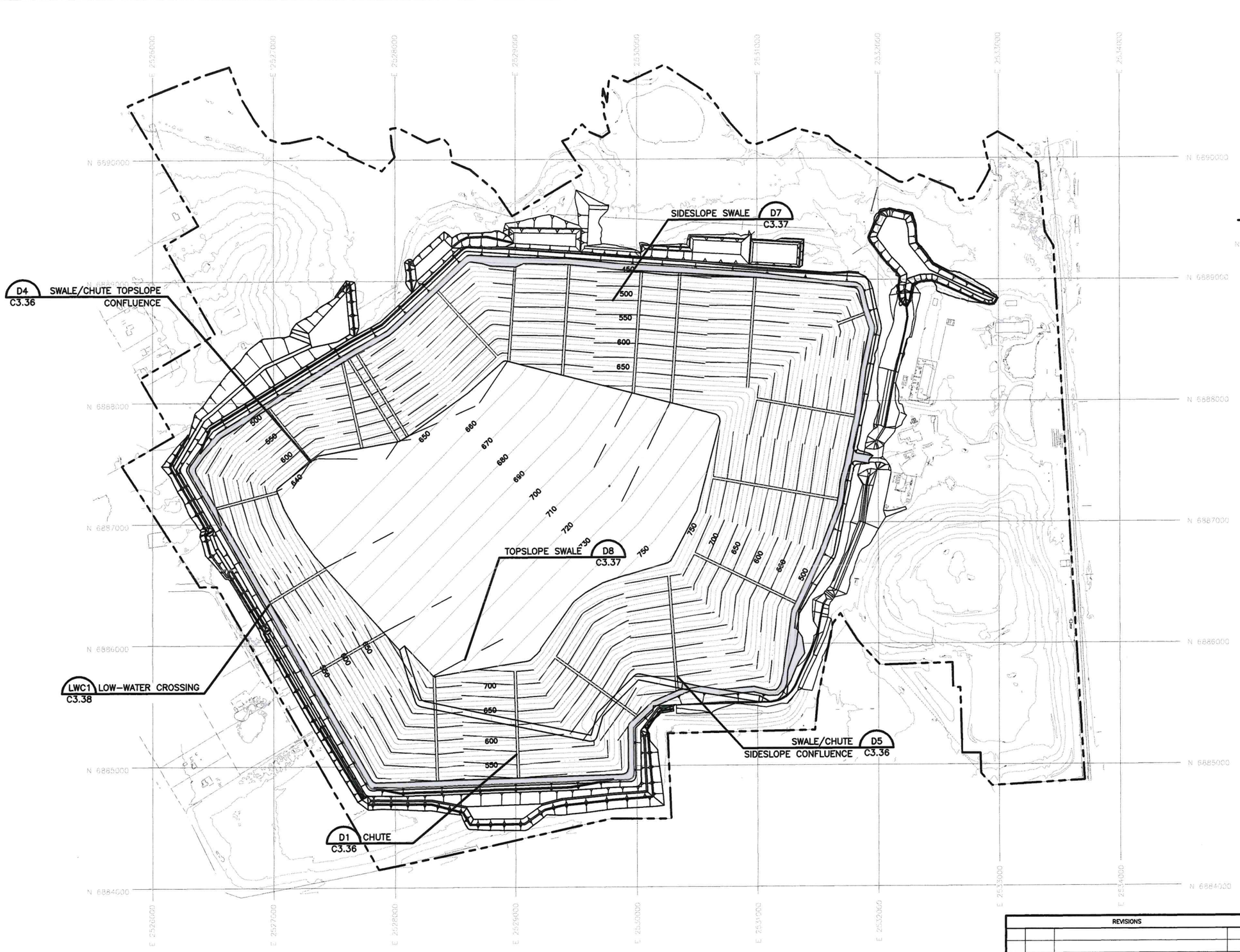
C3.46 - CP-25 through CP-27
C3.47 - CP-28



3/31/2026

Biggs & Mathews Environmental, Inc.
Firm Registration No. F-256



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SCALE IN FEET

LEGEND

PERMIT BOUNDARY

STATE PLANE GRID NAD 83

NOTE:

1. EXISTING CONTOURS COMPILED BY HYDREX DRONE DIVISION, FROM AERIAL SURVEY FLOWN MARCH 5, 2025.
2. CONTOURS WITHIN WASTE DISPOSAL FOOTPRINT DEPICT PROPOSED FINAL CONTOURS.
3. REFER TO FINAL COVER DRAINAGE STRUCTURE CALLOUTS FOR TYPICAL DETAILS FOR CHUTES, SWALES, AND LOW-WATER CROSSING.

STATE OF TEXAS
FELIPE ANTONIO WESCOUP
103826
LICENSED
PROFESSIONAL ENGINEER

3/31/2026

DRAINAGE STRUCTURE PLAN (FINAL COVER LAYOUT)

WASTE MANAGEMENT OF TEXAS, INC. SKYLINE LANDFILL

REVISIONS			
REV	DATE	DESCRIPTION	DWN BY

BIGGS & MATHEWS ENVIRONMENTAL
1700 ROBERT ROAD, STE. 100
MANSFIELD, TEXAS 76063
817-563-1144

TBPELS FIRM NO. F-256 AND NO. 10194895
TBPG FIRM NO. 50222

DRAWING C3.1

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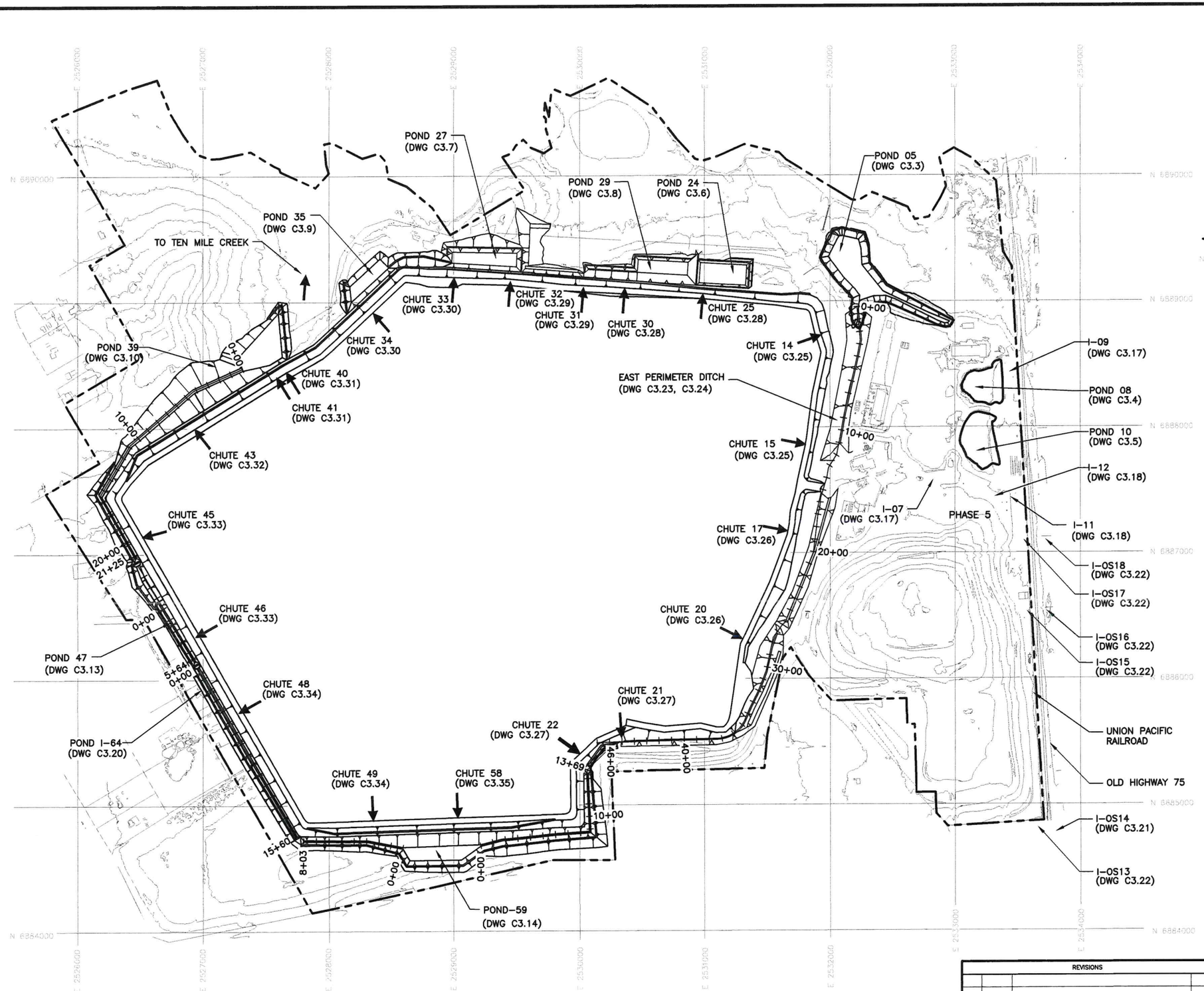

0 400 800
SCALE IN FEET

LEGEND

PERMIT BOUNDARY

STATE PLANE GRID NAD 83

NOTE:

1. EXISTING CONTOURS COMPILED BY HYDREX DRONE DIVISION, FROM AERIAL SURVEY FLOWN MARCH 5, 2025.
2. REFER TO DRAINAGE SYSTEM CALLOUTS FOR PONDS, CHANNELS, CHUTES, AND CULVERT DETAILS.

STATE OF TEXAS
FELIPE ANTONIO WESCOUP
103826
LICENSED
PROFESSIONAL ENGINEER

3/31/2026

DRAINAGE STRUCTURE PLAN (DRAINAGE SYSTEM LAYOUT)

WASTE MANAGEMENT OF TEXAS, INC. SKYLINE LANDFILL

REV	DATE	DESCRIPTION	DWN BY

BIGGS & MATHEWS ENVIRONMENTAL
1700 ROBERT ROAD, STE. 100
MANSFIELD, TEXAS 76063
817-563-1144

TBPELS FIRM NO. F-256 AND NO. 10194895

TBPG FIRM NO. 50222

DRAWING C3.2

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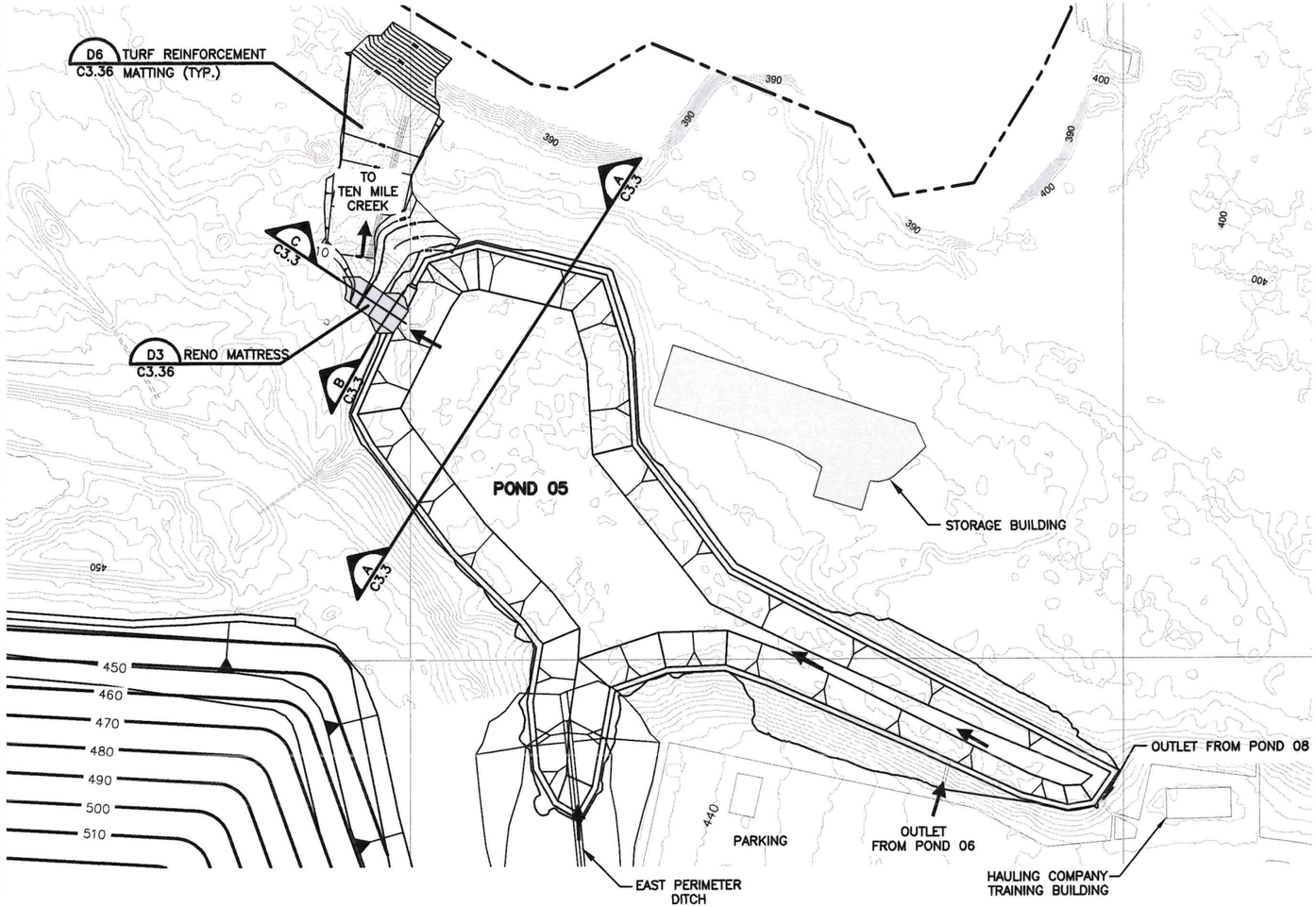



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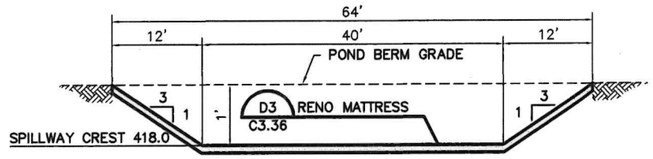
SCALE IN FEET



SPILLWAY SECTION B C3.3

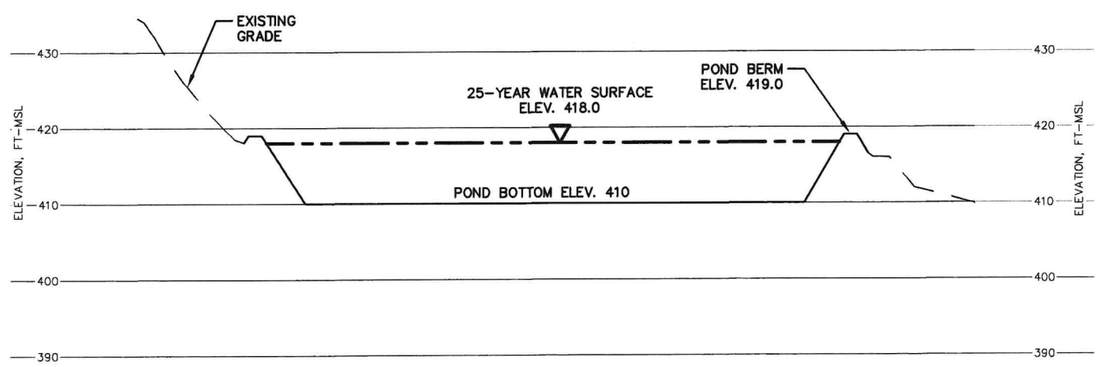
0 10 20 HORIZONTAL SCALE IN FEET
0 5 10 VERTICAL SCALE IN FEET

LEGEND

- PERMIT BOUNDARY
- N 6888000 STATE PLANE GRID NAD 83
- DRAINAGE FLOW DIRECTION

NOTE:

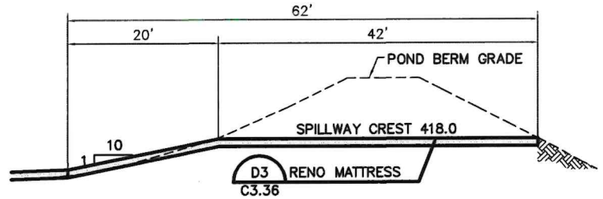
1. EXISTING CONTOURS COMPILED BY HYDREX DRONE DIVISION, FROM AERIAL SURVEY FLOWN MARCH 5, 2025.
2. EXISTING POND 05 AND THE EXISTING SPILLWAY AND OUTLET STRUCTURE ARE CONSTRUCTED CONSISTENT WITH MSW PERMIT NO. 42C AND SUBSEQUENT MODIFICATIONS AND AUTHORIZATIONS.
3. EXISTING POND 05 AND THE EXISTING SPILLWAY AND OUTLET STRUCTURE ARE INCORPORATED AS PART OF THE DRAINAGE SYSTEM FOR MSW PERMIT NO. 42D.



POND 05 – SECTION A A C3.3

0 50 100 HORIZONTAL SCALE IN FEET
0 10 20 VERTICAL SCALE IN FEET

POND 05 ELEVATION–STORAGE RELATIONSHIP	
ELEVATION (FT)	VOLUME AT ELEVATION (AC-FT)
410	7.906
412	16.766
414	26.462
416	37.005
418	48.557
420	60.951
422	74.272



SPILLWAY SECTION C C3.3

0 10 20 HORIZONTAL SCALE IN FEET
0 5 10 VERTICAL SCALE IN FEET



3/31/2026

REVISIONS			
REV	DATE	DESCRIPTION	DWN BY

POND 05 (EXISTING POND)

WASTE MANAGEMENT OF TEXAS, INC. SKYLINE LANDFILL

BME
BIGGS & MATHEWS ENVIRONMENTAL
1700 ROBERT ROAD, STE. 100
MANSFIELD, TEXAS 76063
817-563-1144
TBPELS FIRM NO. F-256 AND NO. 10194895
TBPG FIRM NO. 50222

DRAWING C3.3

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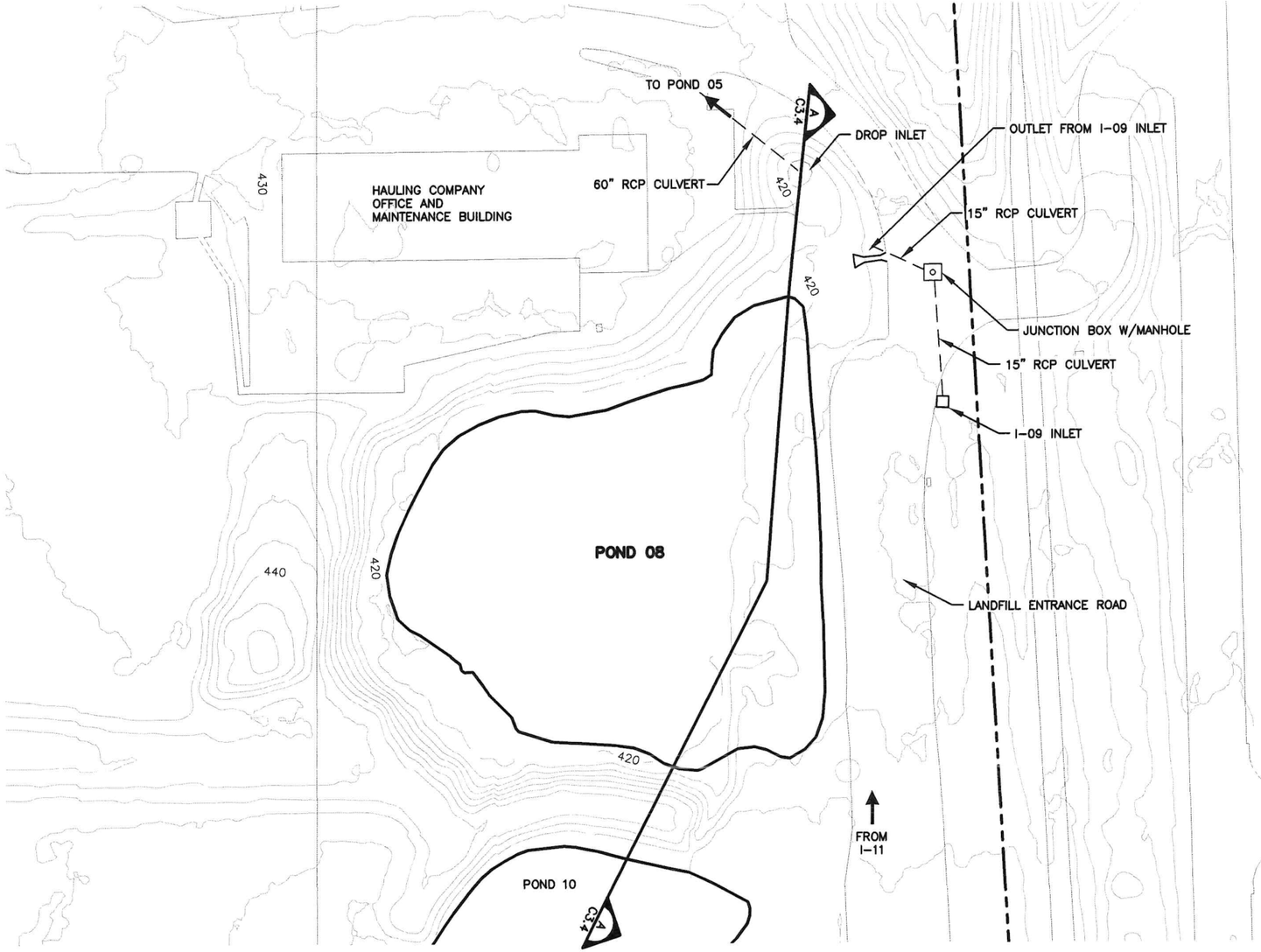

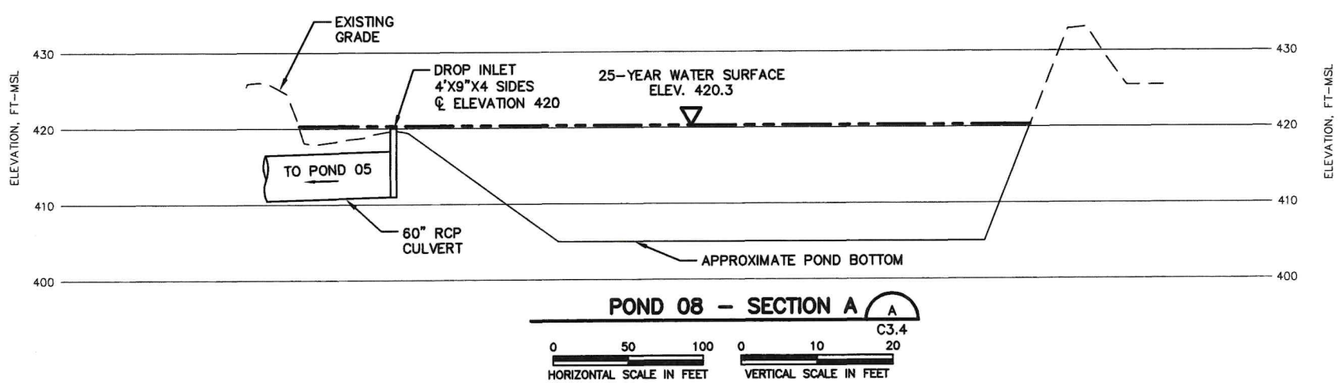

POND 08 – SECTION A (A C3.4)

0 50 100 HORIZONTAL SCALE IN FEET

0 10 20 VERTICAL SCALE IN FEET

0 50 100 SCALE IN FEET

LEGEND

PERMIT BOUNDARY

N 6888000 STATE PLANE GRID NAD 83

DRAINAGE FLOW DIRECTION

NOTE:

1. EXISTING CONTOURS COMPILED BY HYDREX DRONE DIVISION, FROM AERIAL SURVEY FLOWN MARCH 5, 2025.
2. EXISTING POND 08 AND THE EXISTING SPILLWAY AND OUTLET STRUCTURE ARE CONSTRUCTED CONSISTENT WITH MSW PERMIT NO. 42C AND SUBSEQUENT MODIFICATIONS AND AUTHORIZATIONS.
3. EXISTING POND 08 AND THE EXISTING SPILLWAY AND OUTLET STRUCTURE ARE INCORPORATED AS PART OF THE DRAINAGE SYSTEM FOR MSW PERMIT NO. 42D.

POND 08 ELEVATION–STORAGE RELATIONSHIP	
ELEVATION (FT)	VOLUME AT ELEVATION (AC–FT)
405	0
406	1
408	2
410	3
412	4
414	7
416	10
418	12
420	15.29
422	20.45
424	25.90

STATE OF TEXAS
FELIPE ANTONIO WESCOUP
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POND 08 (EXISTING POND)

WASTE MANAGEMENT OF TEXAS, INC. SKYLINE LANDFILL

BIGGS & MATHEWS ENVIRONMENTAL
1700 ROBERT ROAD, STE. 100
MANSFIELD, TEXAS 76063
817-563-1144

TBPELS FIRM NO. F-256 AND NO. 10194895
TBPG FIRM NO. 50222

DRAWING C3.4

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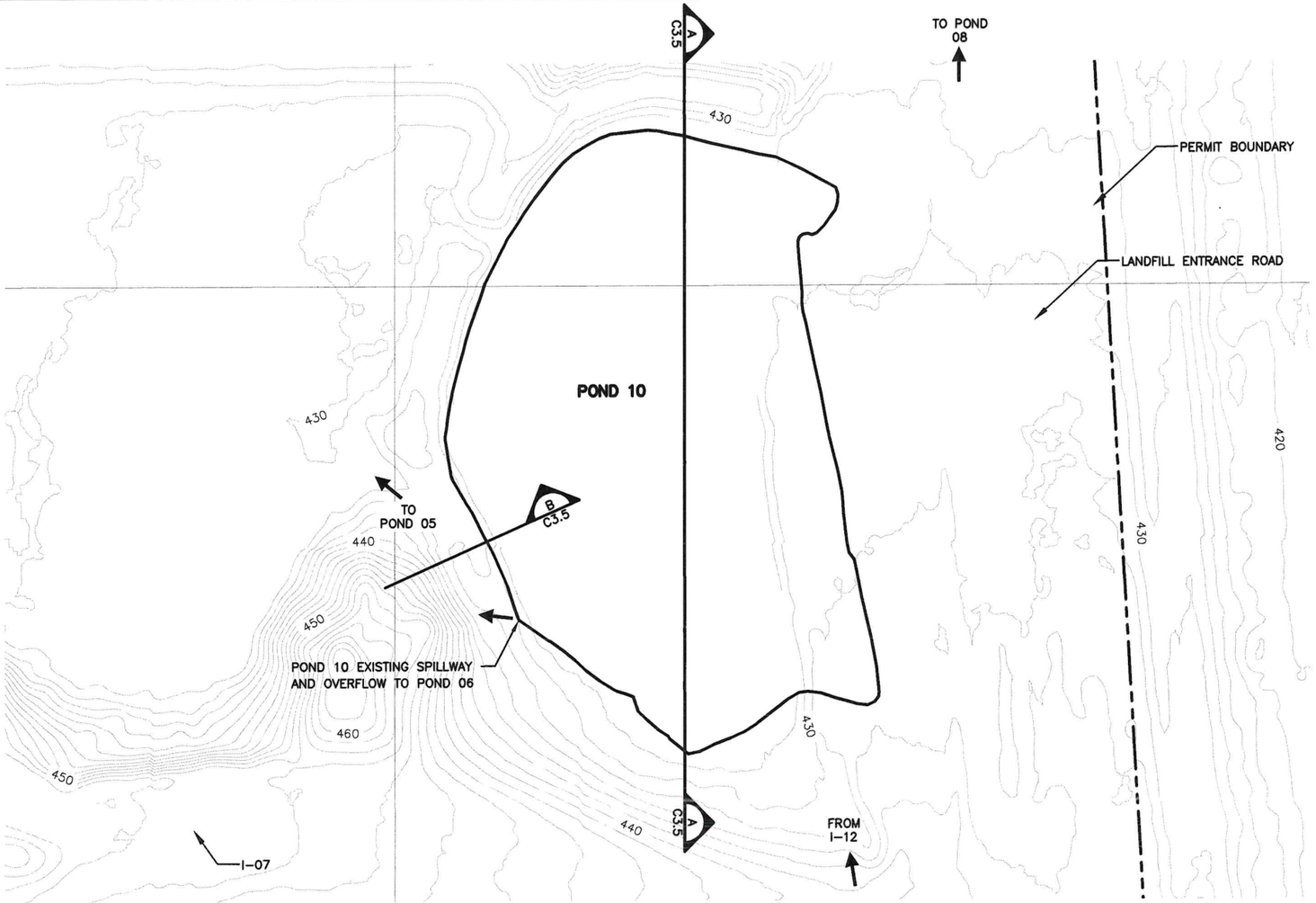




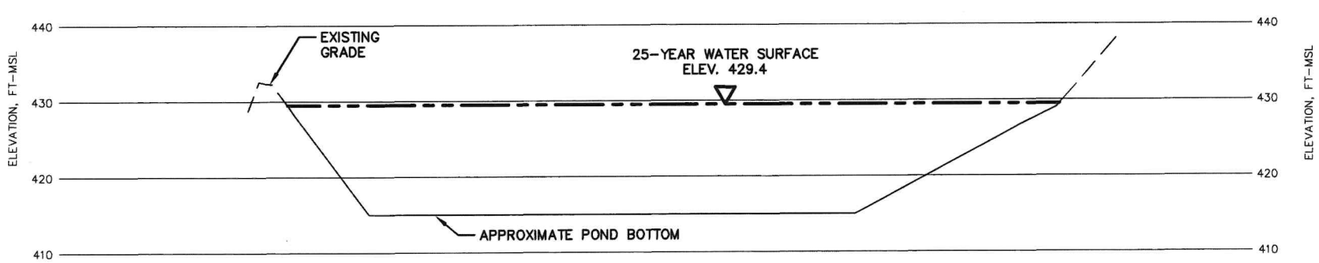
LEGEND

- PERMIT BOUNDARY
- N 6885000 STATE PLANE GRID NAD 83
- DRAINAGE FLOW DIRECTION

NOTE:

1. EXISTING CONTOURS COMPILED BY HYDREX DRONE DIVISION, FROM AERIAL SURVEY FLOWN MARCH 5, 2025.
2. EXISTING POND 10 AND THE EXISTING SPILLWAY AND OUTLET STRUCTURE ARE CONSTRUCTED CONSISTENT WITH MSW PERMIT NO. 42C AND SUBSEQUENT MODIFICATIONS AND AUTHORIZATIONS.
3. EXISTING POND 08 AND THE EXISTING SPILLWAY AND OUTLET STRUCTURE ARE INCORPORATED AS PART OF THE DRAINAGE SYSTEM FOR MSW PERMIT NO. 42D.

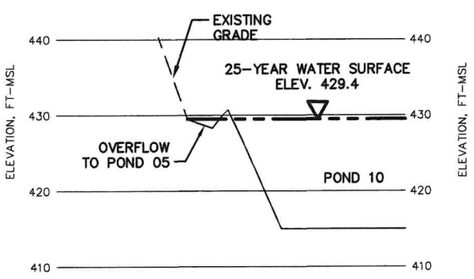
POND 10 ELEVATION–STORAGE RELATIONSHIP	
ELEVATION (FT)	VOLUME AT ELEVATION (AC–FT)
415	0
416	1.06
418	3.44
420	6.17
422	9.29
424	12.83
426	16.81
428	21.99
430	27.81
432	33.93



POND 10 – SECTION A (A C3.5)

0 50 100 HORIZONTAL SCALE IN FEET

0 10 20 VERTICAL SCALE IN FEET



POND 10 – SECTION B (B C3.5)

0 50 100 HORIZONTAL SCALE IN FEET

0 10 20 VERTICAL SCALE IN FEET

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FELIPE ANTONIO WESCOUP
103826
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POND 10 (EXISTING POND)

WASTE MANAGEMENT OF TEXAS, INC. SKYLINE LANDFILL

BIGGS & MATHEWS ENVIRONMENTAL
1700 ROBERT ROAD, STE. 100
MANSFIELD, TEXAS 76063
817–563–1144

TBPELS FIRM NO. F–256 AND NO. 10194895
TBPG FIRM NO. 50222

DRAWING C3.5

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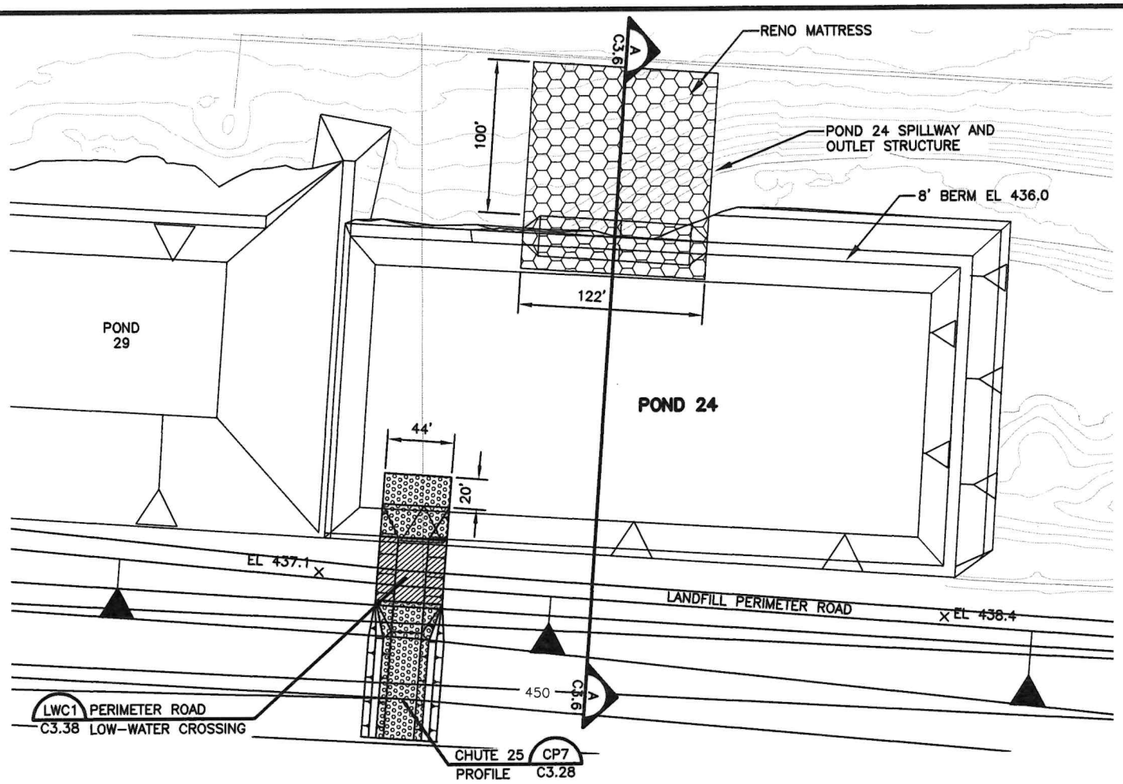


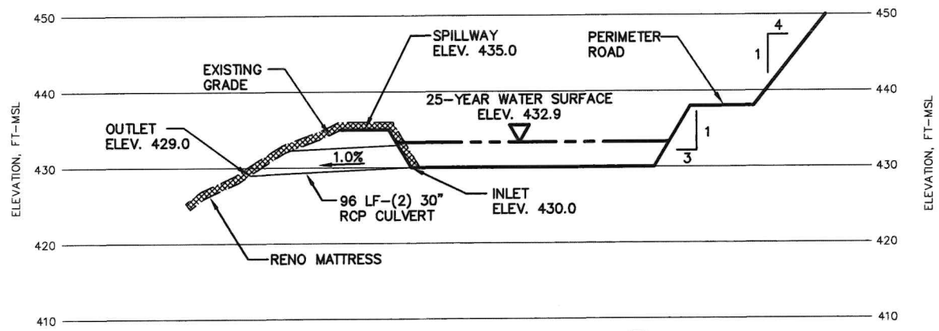


LEGEND

- PERMIT BOUNDARY
- N 6885000 — STATE PLANE GRID NAD 83
- DRAINAGE FLOW DIRECTION

NOTE:

1. EXISTING CONTOURS COMPILED BY HYDREX DRONE DIVISION, FROM AERIAL SURVEY FLOWN MARCH 5, 2025.
2. DETENTION POND 24 AND ITS SPILLWAY AND OUTLET STRUCTURE TO BE CONSTRUCTED AS PART OF THE DRAINAGE IMPROVEMENTS FOR MSW PERMIT NO. 42D.



POND 24 – SECTION A (A C3.6)

0 50 100 HORIZONTAL SCALE IN FEET

0 10 20 VERTICAL SCALE IN FEET

POND 24 ELEVATION–STORAGE RELATIONSHIP	
ELEVATION (FT)	VOLUME AT ELEVATION (AC-FT)
430	0
432	2.88
434	6.06
436	9.56

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POND 24 (DETENTION POND)

WASTE MANAGEMENT OF TEXAS, INC. SKYLINE LANDFILL

BME
BIGGS & MATHEWS ENVIRONMENTAL
1700 ROBERT ROAD, STE. 100
MANSFIELD, TEXAS 76063
817-563-1144
TBPELS FIRM NO. F-256 AND NO. 10194895
TBPG FIRM NO. 50222

DRAWING C3.6

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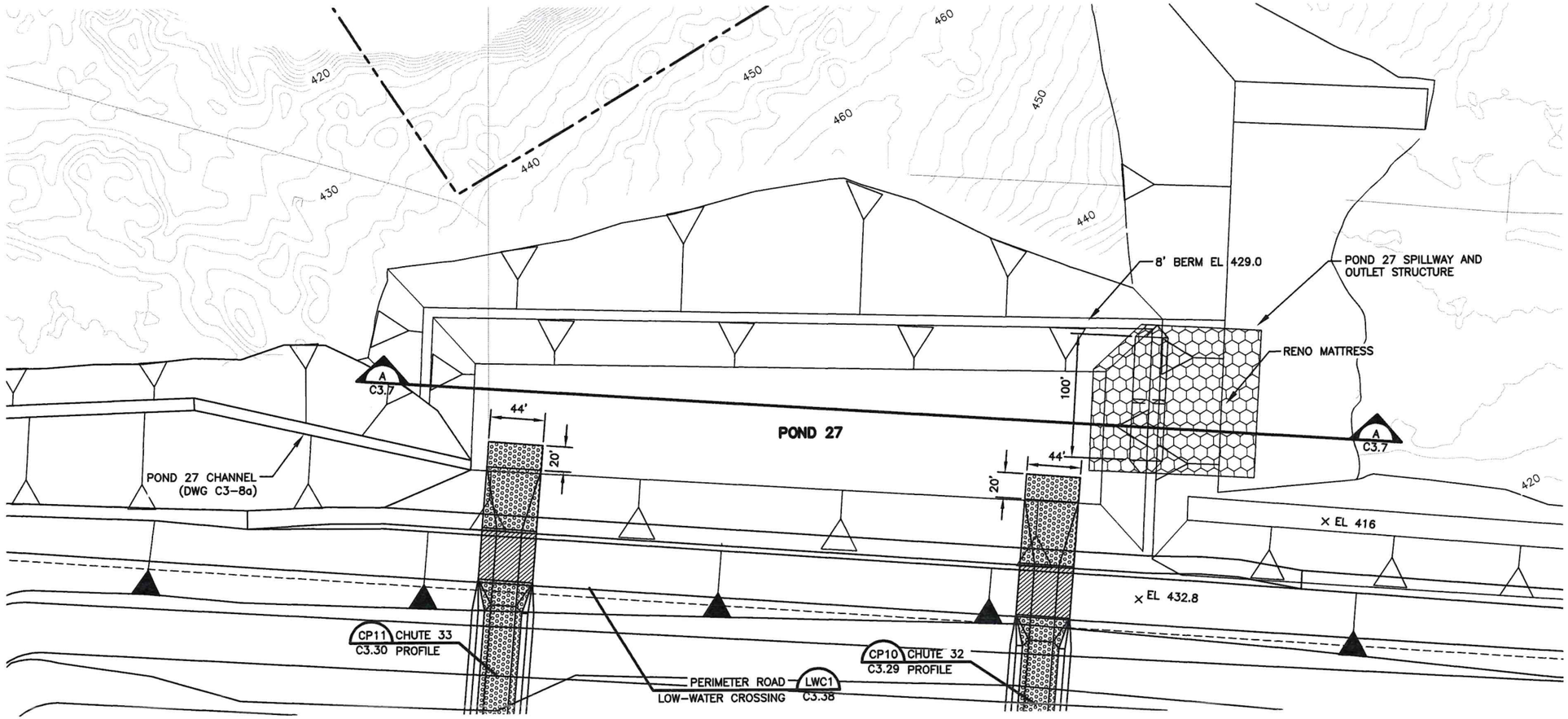

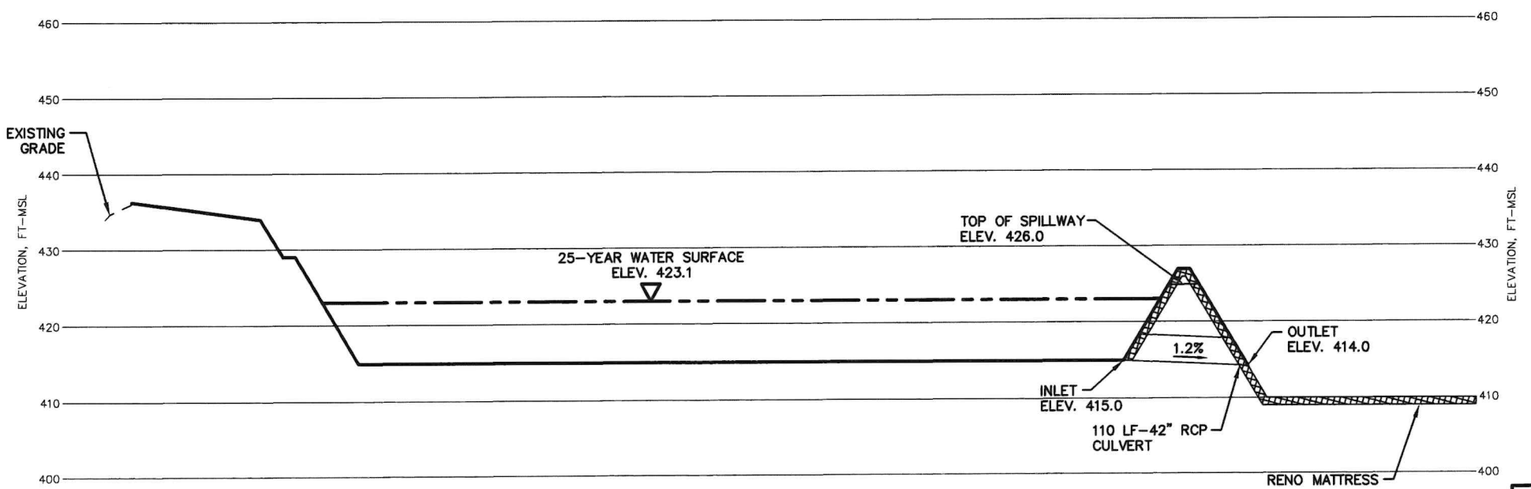

POND 27 - SECTION A

A
C3.7

0 50 100
HORIZONTAL SCALE IN FEET

0 10 20
VERTICAL SCALE IN FEET

0 50 100
SCALE IN FEET

LEGEND

- PERMIT BOUNDARY
- N 6888000 — STATE PLANE GRID NAD 83
- DRAINAGE FLOW DIRECTION

NOTE:

1. EXISTING CONTOURS COMPILED BY HYDREX DRONE DIVISION, FROM AERIAL SURVEY FLOWN MARCH 5, 2025.
2. DETENTION POND 27 AND ITS SPILLWAY AND OUTLET STRUCTURE TO BE CONSTRUCTED AS PART OF THE DRAINAGE IMPROVEMENTS FOR MSW PERMIT NO. 42D.

POND59 ELEVATION-STORAGE RELATIONSHIP	
ELEVATION (FT)	VOLUME AT ELEVATION (AC-FT)
415	0
416	0.05
418	0.48
420	1.38
422	2.78
424	4.69
426	7.01
428	30.80

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REVISIONS			
REV	DATE	DESCRIPTION	DWN BY

POND 27
(DETENTION POND)

WASTE MANAGEMENT OF TEXAS, INC.
SKYLINE LANDFILL

BIGGS & MATHEWS ENVIRONMENTAL
1700 ROBERT ROAD, STE. 100
MANSFIELD, TEXAS 76063
817-563-1144

TBPELS FIRM NO. F-256 AND NO. 10194895
TBPG FIRM NO. 50222

DRAWING
C3.7

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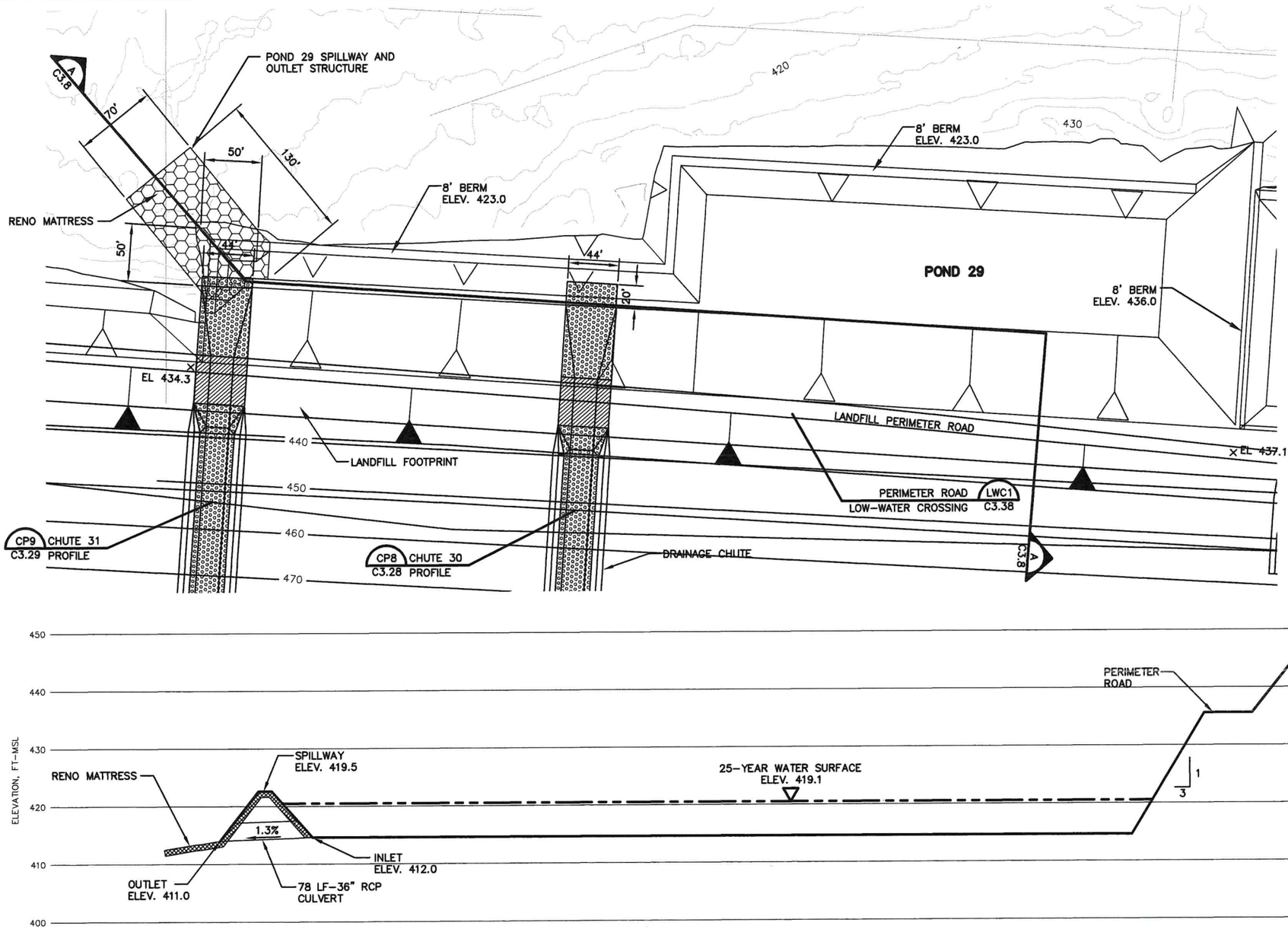

POND 29 – SECTION A (A C3.8)

0 50 100 HORIZONTAL SCALE IN FEET

0 10 20 VERTICAL SCALE IN FEET

0 50 100 SCALE IN FEET

LEGEND

- PERMIT BOUNDARY
- N 6888000 STATE PLANE GRID NAD 83
- DRAINAGE FLOW DIRECTION

NOTE:

1. EXISTING CONTOURS COMPILED BY HYDREX DRONE DIVISION, FROM AERIAL SURVEY FLOWN MARCH 5, 2025.
2. DETENTION POND 29 AND ITS SPILLWAY AND OUTLET STRUCTURE TO BE CONSTRUCTED AS PART OF THE DRAINAGE IMPROVEMENTS FOR MSW PERMIT NO. 42D.

POND 29 ELEVATION–STORAGE RELATIONSHIP

ELEVATION (FT)	VOLUME AT ELEVATION (AC-FT)
412	0
414	2.299
416	5.140
418	8.580
420	12.704

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POND 29 (DETENTION POND)

WASTE MANAGEMENT OF TEXAS, INC. SKYLINE LANDFILL

BIGGS & MATHEWS ENVIRONMENTAL
1700 ROBERT ROAD, STE. 100
MANSFIELD, TEXAS 76063
817-563-1144

TBPELS FIRM NO. F-256 AND NO. 10194895

TBPG FIRM NO. 50222

DRAWING C3.8

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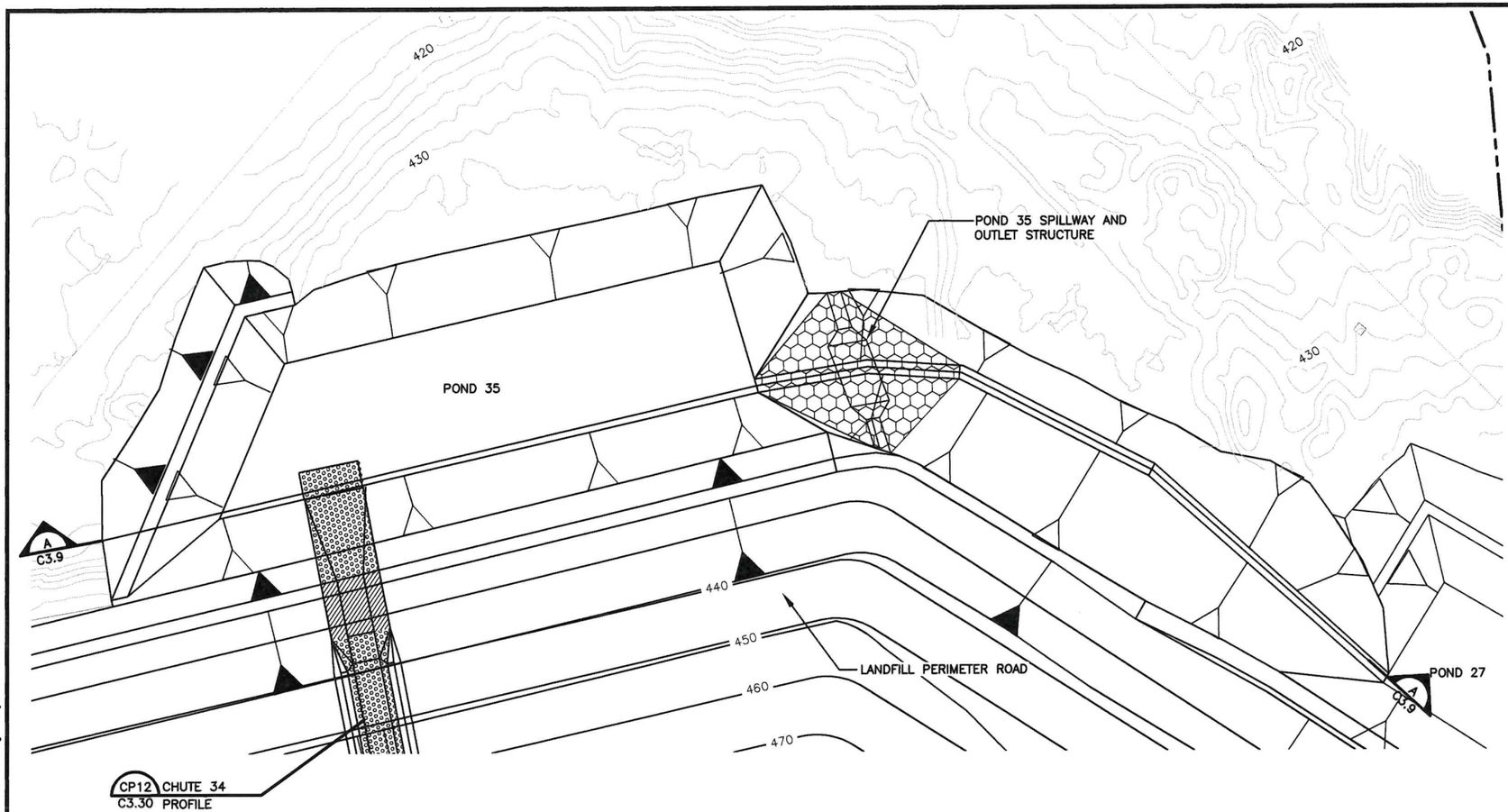

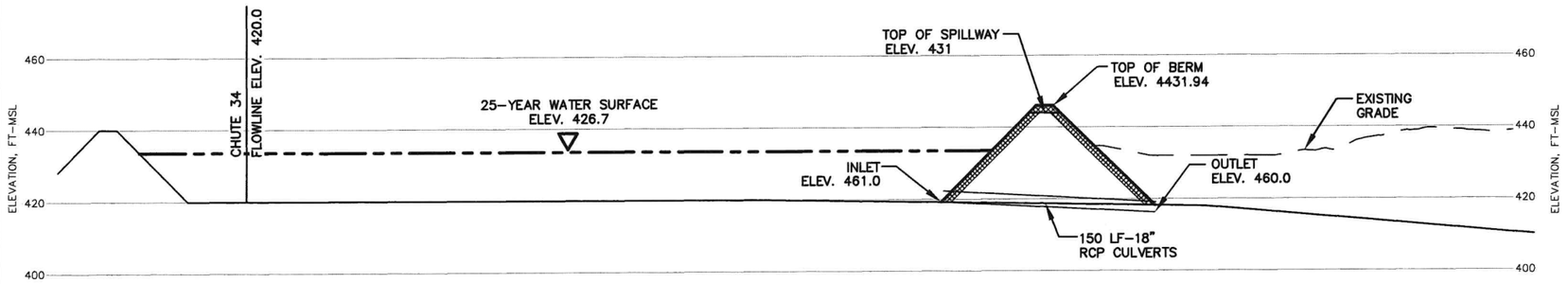

POND 35 – SECTION A (A C3.9)

0 50 100 HORIZONTAL SCALE IN FEET

0 10 20 VERTICAL SCALE IN FEET



0 50 100
SCALE IN FEET

LEGEND

PERMIT BOUNDARY

N 6585000 STATE PLANE GRID NAD 83

DRAINAGE FLOW DIRECTION

NOTE:

1. EXISTING CONTOURS COMPILED BY HYDREX DRONE DIVISION, FROM AERIAL SURVEY FLOWN MARCH 5, 2025.
2. EXISTING POND 35 AND THE EXISTING SPILLWAY AND OUTLET STRUCTURE ARE CONSTRUCTED CONSISTENT WITH MSW PERMIT NO. 42C AND SUBSEQUENT MODIFICATIONS AND AUTHORIZATIONS.
3. EXISTING POND 35 AND THE EXISTING SPILLWAY AND OUTLET STRUCTURE ARE INCORPORATED AS PART OF THE DRAINAGE SYSTEM FOR MSW PERMIT NO. 42D.
4. REFER TO DRAWING C3-10A FOR POND 35 OUTLET STRUCTURE.

POND35 ELEVATION–STORAGE RELATIONSHIP	
ELEVATION (FT)	VOLUME AT ELEVATION (AC-FT)
420	0
422	1.87
424	4.15
426	6.92
428	10.21
430	10.07
432	16.60

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3/31/2026

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POND 35 (DETENTION POND)

WASTE MANAGEMENT OF TEXAS, INC. SKYLINE LANDFILL

BIGGS & MATHEWS ENVIRONMENTAL
1700 ROBERT ROAD, STE. 100
MANSFIELD, TEXAS 76063
817-563-1144

TBPELS FIRM NO. F-256 AND NO. 10194895
TBPG FIRM NO. 50222

DRAWING C3.9

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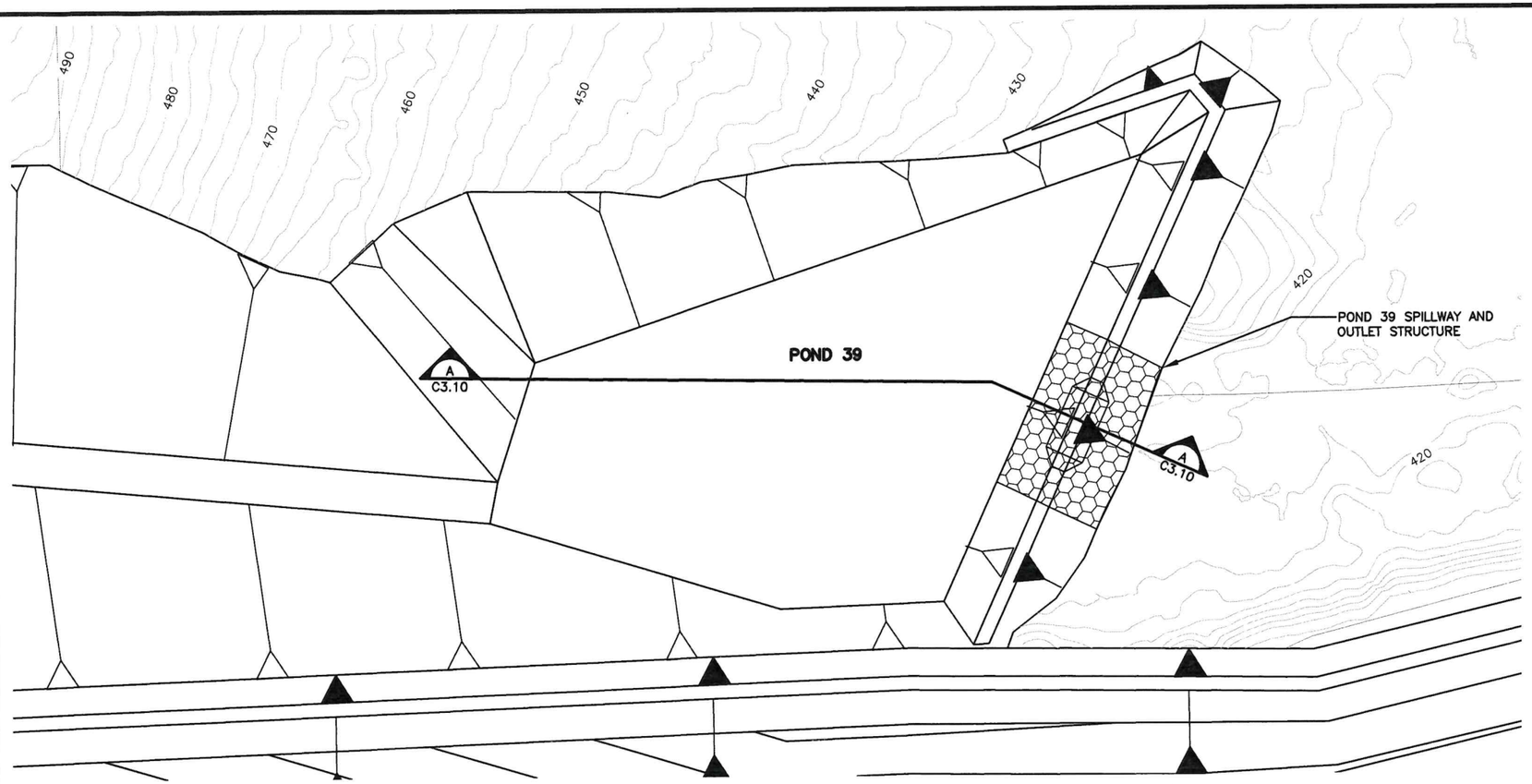




0 50 100
SCALE IN FEET

LEGEND

PERMIT BOUNDARY

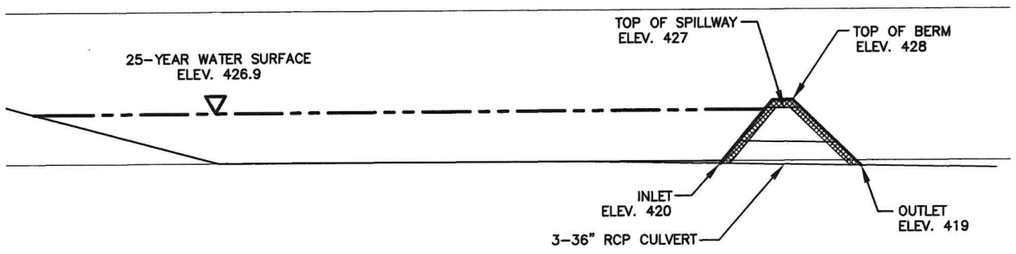
N 6588000 STATE PLANE GRID NAD 83

DRAINAGE FLOW DIRECTION

NOTE:

1. EXISTING CONTOURS COMPILED BY HYDREX DRONE DIVISION, FROM AERIAL SURVEY FLOWN MARCH 5, 2025.
2. EXISTING POND 39 AND THE EXISTING SPILLWAY AND OUTLET STRUCTURE ARE CONSTRUCTED CONSISTENT WITH MSW PERMIT NO. 42C AND SUBSEQUENT MODIFICATIONS AND AUTHORIZATIONS.
3. EXISTING POND 39 AND THE EXISTING SPILLWAY AND OUTLET STRUCTURE ARE INCORPORATED AS PART OF THE DRAINAGE SYSTEM FOR MSW PERMIT NO. 42D.
4. REFER TO DRAWING C3-10A FOR POND 39 OUTLET STRUCTURE.

POND39 ELEVATION–STORAGE RELATIONSHIP	
ELEVATION (FT)	VOLUME AT ELEVATION (AC-FT)
420	0.02
422	4.25
424	9.20
426	14.95
428	21.54
430	25.39



POND 39 – SECTION A (A, C3.10)

0 100 200 HORIZONTAL SCALE IN FEET

0 10 20 VERTICAL SCALE IN FEET

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FELIPE ANTONIO WESCOUP
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POND 39
(DETENTION POND)

WASTE MANAGEMENT OF TEXAS, INC.
SKYLINE LANDFILL

BIGGS & MATHEWS ENVIRONMENTAL
1700 ROBERT ROAD, STE. 100
MANSFIELD, TEXAS 76063
817-563-1144

TBPELS FIRM NO. F-256 AND NO. 10194895
TBPG FIRM NO. 50222

DRAWING
C3.10

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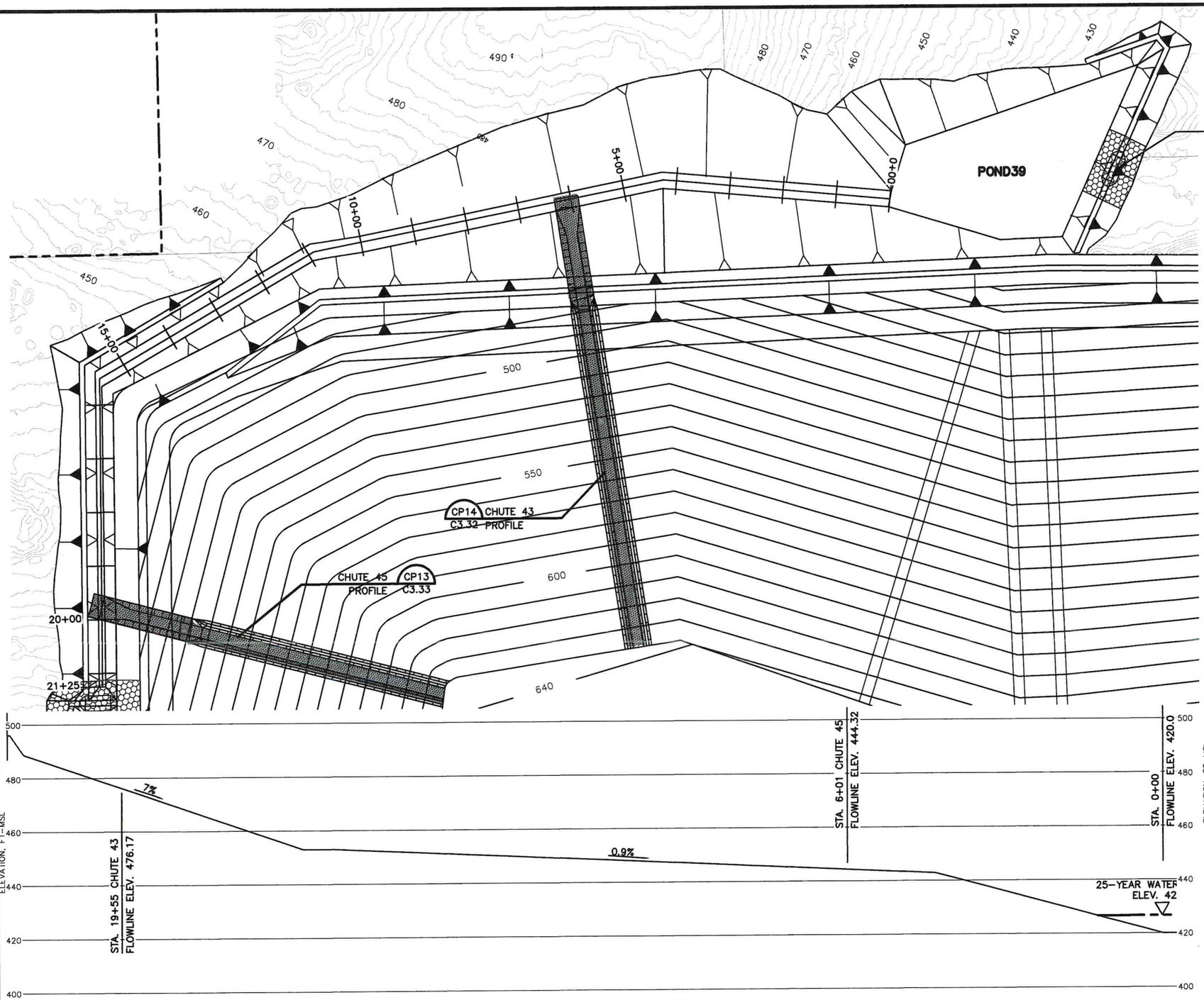



0 100 200
SCALE IN FEET

LEGEND

- PERMIT BOUNDARY
- N 5686300 STATE PLANE GRID NAD 83
- DRAINAGE FLOW DIRECTION

NOTE:

1. EXISTING CONTOURS COMPILED BY HYDREX DRONE DIVISION, FROM AERIAL SURVEY FLOWN MARCH 5, 2025.
2. EXISTING POND 39 AND THE EXISTING SPILLWAY AND OUTLET STRUCTURE ARE CONSTRUCTED CONSISTENT WITH MSW PERMIT NO. 42C AND SUBSEQUENT MODIFICATIONS AND AUTHORIZATIONS.
3. EXISTING POND 39 AND THE EXISTING SPILLWAY AND OUTLET STRUCTURE ARE INCORPORATED AS PART OF THE DRAINAGE SYSTEM FOR MSW PERMIT NO. 42D.
4. REFER TO DRAWING C3.10A FOR POND 39 OUTLET STRUCTURE.

STATE OF TEXAS
FELIPE ANTONIO WESCOUP
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25 YEAR HYDRAULIC ANALYSIS

DITCH	STATION		BOTTOM SLOPE (%)	BOTTOM WIDTH (ft)	CHANNEL DEPTH (ft)	FLOW DEPTH (ft)	FREE-BOARD (ft)	FLOW RATE (cfs)	FLOW VELOCITY (fps)	EROSION PROTECTION
POND 39 CHANNEL	0+00	6+01	0.04	30	35.00	0.85	34.15	238.1	8.19	TURF MAT
POND 39 CHANNEL	6+01	21+25	0.029	30	5.00	0.47	4.53	73	4.83	EST. VEGETATION

POND 39 – CHANNEL PROFILE (A C3.11)

0 100 200
HORIZONTAL SCALE IN FEET

0 10 20
VERTICAL SCALE IN FEET

REVISIONS			
REV	DATE	DESCRIPTION	DWN BY

POND 39 CHANNEL PROFILE

WASTE MANAGEMENT OF TEXAS, INC. SKYLINE LANDFILL

BIGGS & MATHEWS ENVIRONMENTAL
1700 ROBERT ROAD, STE. 100
MANSFIELD, TEXAS 76063
817-563-1144

TBPELS FIRM NO. F-256 AND NO. 10194895
TBPG FIRM NO. 50222

DRAWING C3.11

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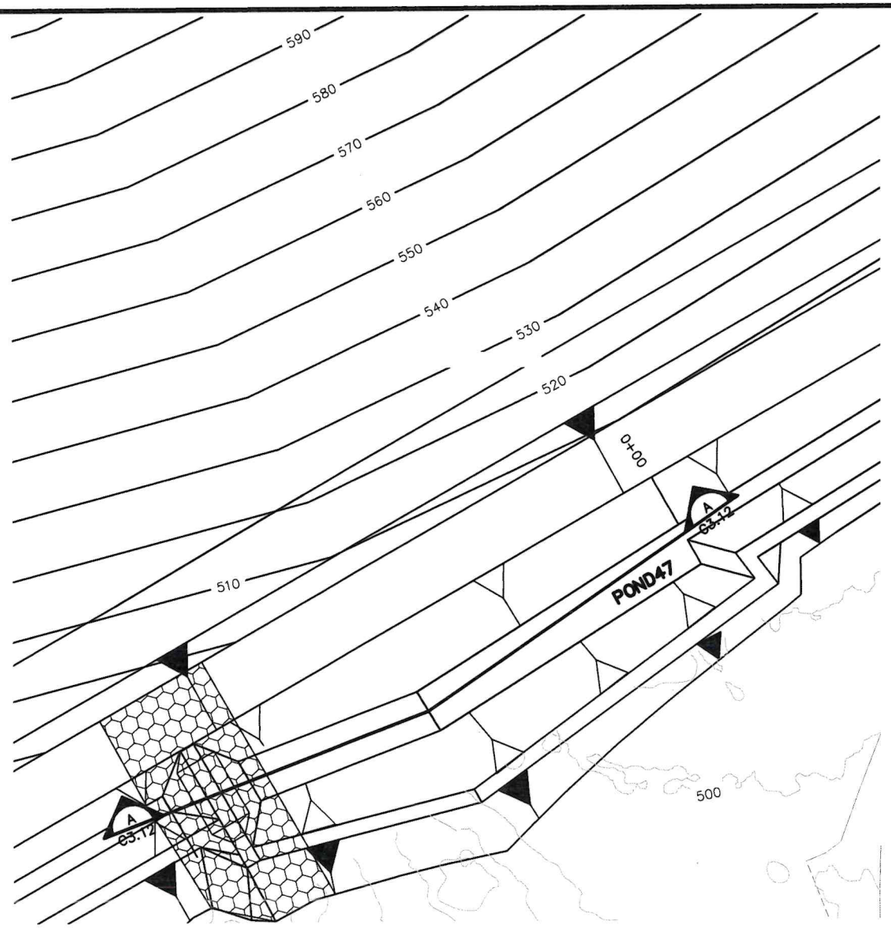

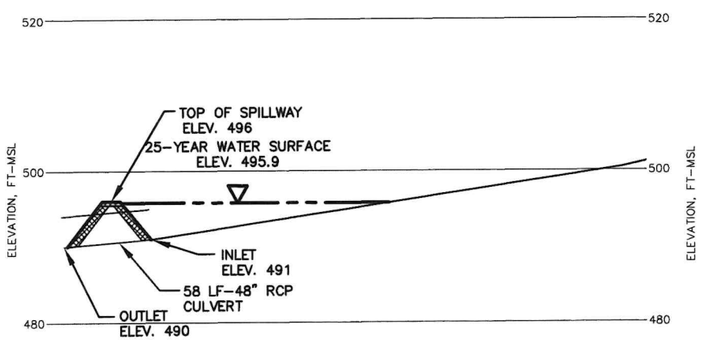

POND 47 – SECTION A (A C3.12)

0 50 100 HORIZONTAL SCALE IN FEET

0 10 20 VERTICAL SCALE IN FEET

0 50 100 SCALE IN FEET

LEGEND

PERMIT BOUNDARY

N 6868000 STATE PLANE GRID NAD 83

DRAINAGE FLOW DIRECTION

NOTE:

1. EXISTING CONTOURS COMPILED BY HYDREX DRONE DIVISION, FROM AERIAL SURVEY FLOWN MARCH 5, 2025.
2. EXISTING POND 47 AND THE EXISTING SPILLWAY AND OUTLET STRUCTURE ARE CONSTRUCTED CONSISTENT WITH MSW PERMIT NO. 42C AND SUBSEQUENT MODIFICATIONS AND AUTHORIZATIONS.
3. EXISTING POND 47 AND THE EXISTING SPILLWAY AND OUTLET STRUCTURE ARE INCORPORATED AS PART OF THE DRAINAGE SYSTEM FOR MSW PERMIT NO. 42D.
4. REFER TO DRAWING C3.10A FOR POND 47 OUTLET STRUCTURE.

POND47 ELEVATION–STORAGE RELATIONSHIP	
ELEVATION (FT)	VOLUME AT ELEVATION (AC-FT)
491	0
492	.014
494	.142
496	.447
498	.679

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FELIPE ANTONIO WESCOUP
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3/31/2026

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POND 47 (DETENTION POND)

WASTE MANAGEMENT OF TEXAS, INC. SKYLINE LANDFILL

BIGGS & MATHEWS ENVIRONMENTAL
1700 ROBERT ROAD, STE. 100
MANSFIELD, TEXAS 76063
817-563-1144

TBPELS FIRM NO. F-256 AND NO. 10194895
TBPG FIRM NO. 50222

DRAWING C3.12

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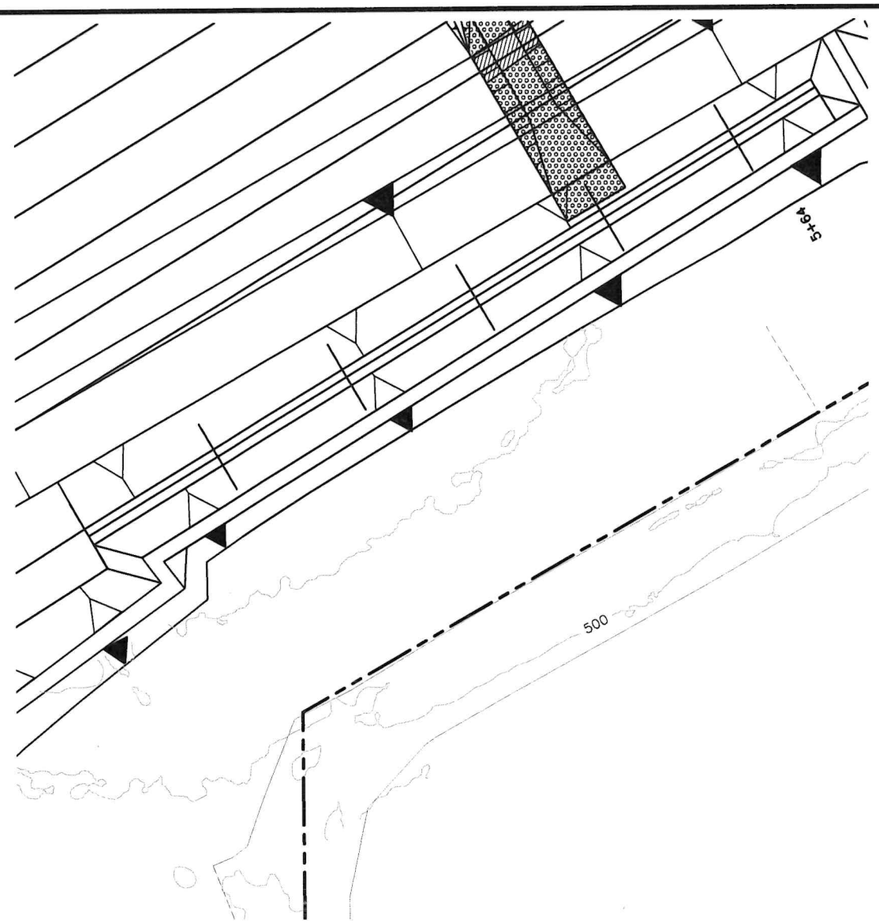

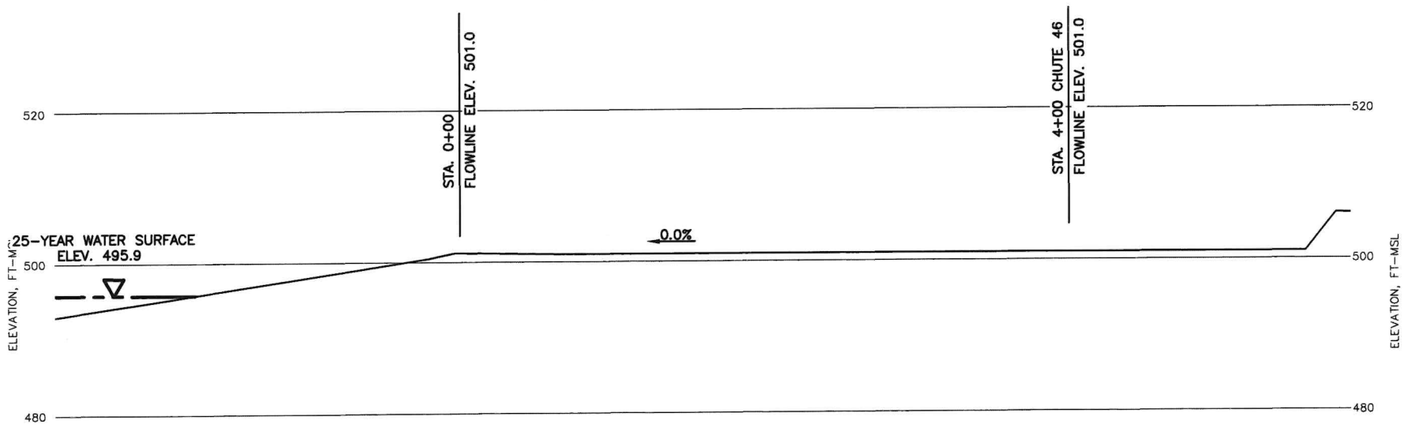

POND 47 – SECTION A (A, C3.13)

0 50 100 HORIZONTAL SCALE IN FEET

0 10 20 VERTICAL SCALE IN FEET

0 50 100 SCALE IN FEET

LEGEND

PERMIT BOUNDARY

N 6525000 STATE PLANE GRID NAD 83

DRAINAGE FLOW DIRECTION

NOTE:

1. EXISTING CONTOURS COMPILED BY HYDREX DRONE DIVISION, FROM AERIAL SURVEY FLOWN MARCH 5, 2025.
2. EXISTING POND 47 AND THE EXISTING SPILLWAY AND OUTLET STRUCTURE ARE CONSTRUCTED CONSISTENT WITH MSW PERMIT NO. 42C AND SUBSEQUENT MODIFICATIONS AND AUTHORIZATIONS.
3. EXISTING POND 47 AND THE EXISTING SPILLWAY AND OUTLET STRUCTURE ARE INCORPORATED AS PART OF THE DRAINAGE SYSTEM FOR MSW PERMIT NO. 42D.
4. REFER TO DRAWING C3.10A FOR POND 47 OUTLET STRUCTURE.

25 YEAR HYDRAULIC ANALYSIS

DITCH	STATION		BOTTOM SLOPE (%)	BOTTOM WIDTH (ft)	CHANNEL DEPTH (ft)	FLOW DEPTH (ft)	FREE-BOARD (ft)	FLOW RATE (cfs)	FLOW VELOCITY (fps)	EROSION PROTECTION
POND 47 CHANNEL	0+00	4+00	0.09	12	8.00	1.16	6.84	88.5	4.38	EST. VEGETATION
POND 47 CHANNEL	4+00	5+64	0.09	12	6.00	0.46	5.54	16.9	2.54	EST. VEGETATION

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FELIPE ANTONIO WESCOUP
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REVISIONS			
REV	DATE	DESCRIPTION	DWN BY

POND 47 CHANNEL PROFILE

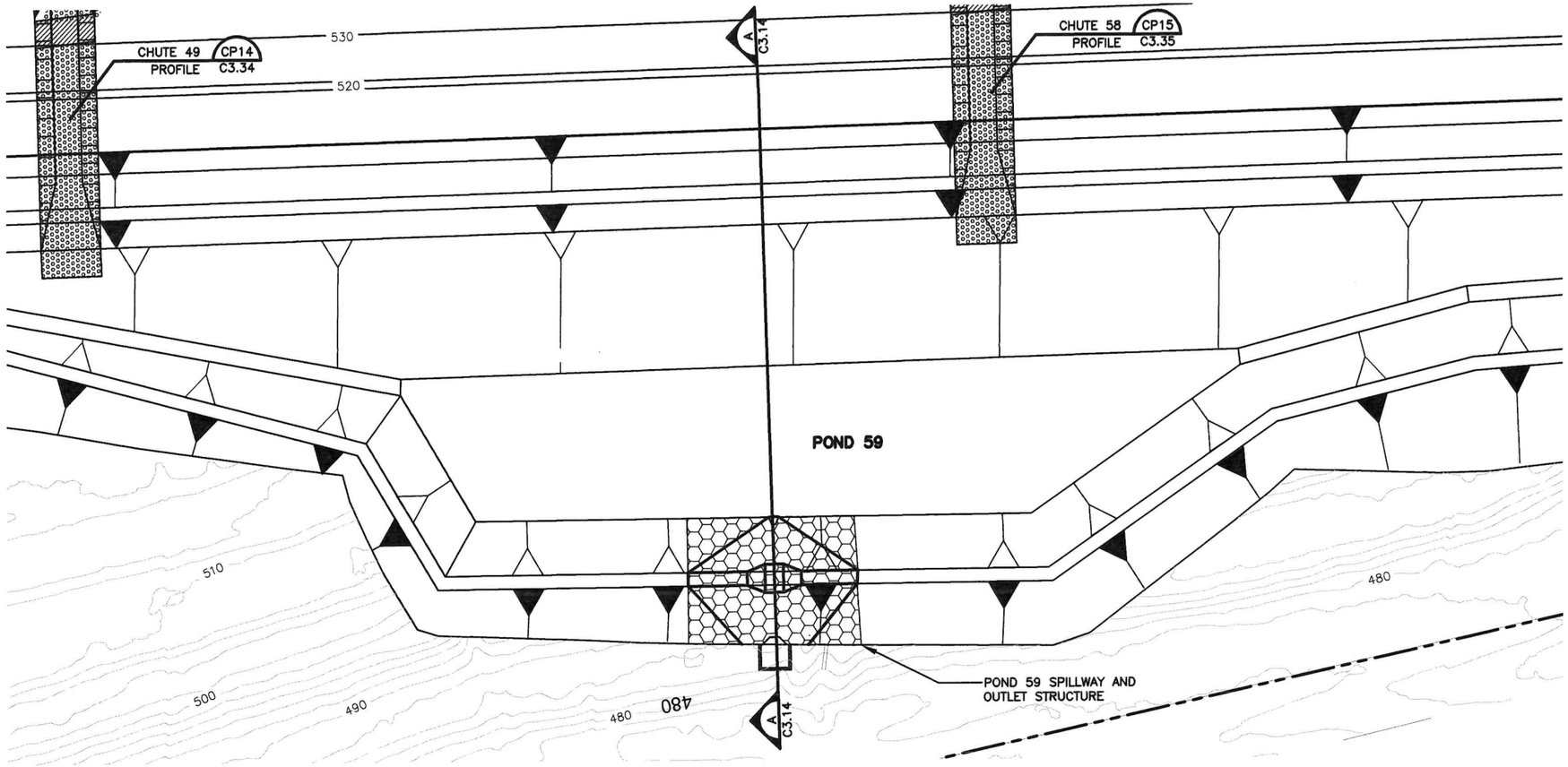
WASTE MANAGEMENT OF TEXAS, INC. SKYLINE LANDFILL

BIGGS & MATHEWS ENVIRONMENTAL
1700 ROBERT ROAD, STE. 100
MANSFIELD, TEXAS 76063
817-563-1144

TBPELS FIRM NO. F-256 AND NO. 10194895
TBPG FIRM NO. 50222

DRAWING C3.13

O:\Waste Management\Skyline\Solid Waste\P\Drawings\Part III\Att. C\C3.9 to 13.dwg Layout: C3.13 User: awhite





0 50 100
SCALE IN FEET

LEGEND

PERMIT BOUNDARY

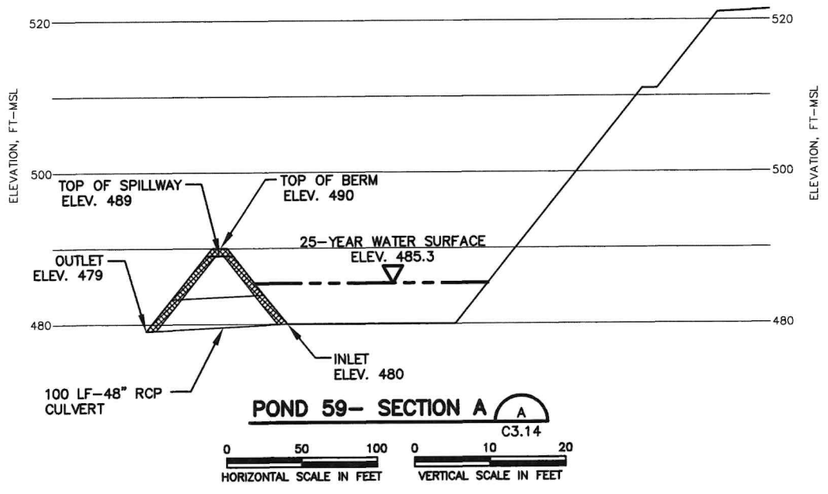
N 6886000 STATE PLANE GRID NAD 83

DRAINAGE FLOW DIRECTION

NOTE:

1. EXISTING CONTOURS COMPILED BY HYDREX DRONE DIVISION, FROM AERIAL SURVEY FLOWN MARCH 5, 2025.
2. EXISTING POND 59 AND THE EXISTING SPILLWAY AND OUTLET STRUCTURE ARE CONSTRUCTED CONSISTENT WITH MSW PERMIT NO. 42C AND SUBSEQUENT MODIFICATIONS AND AUTHORIZATIONS.
3. EXISTING POND 59 AND THE EXISTING SPILLWAY AND OUTLET STRUCTURE ARE INCORPORATED AS PART OF THE DRAINAGE SYSTEM FOR MSW PERMIT NO. 42D.
4. REFER TO DRAWING C3.10A FOR POND 59 OUTLET STRUCTURE.

POND59 ELEVATION–STORAGE RELATIONSHIP	
ELEVATION (FT)	VOLUME AT ELEVATION (AC–FT)
480	0.05
482	3.36
484	7.97
486	13.42
488	20.89
490	30.19
492	35.56



POND 59– SECTION A (A C3.14)

0 50 100 HORIZONTAL SCALE IN FEET

0 10 20 VERTICAL SCALE IN FEET

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POND 59 (DETENTION POND)

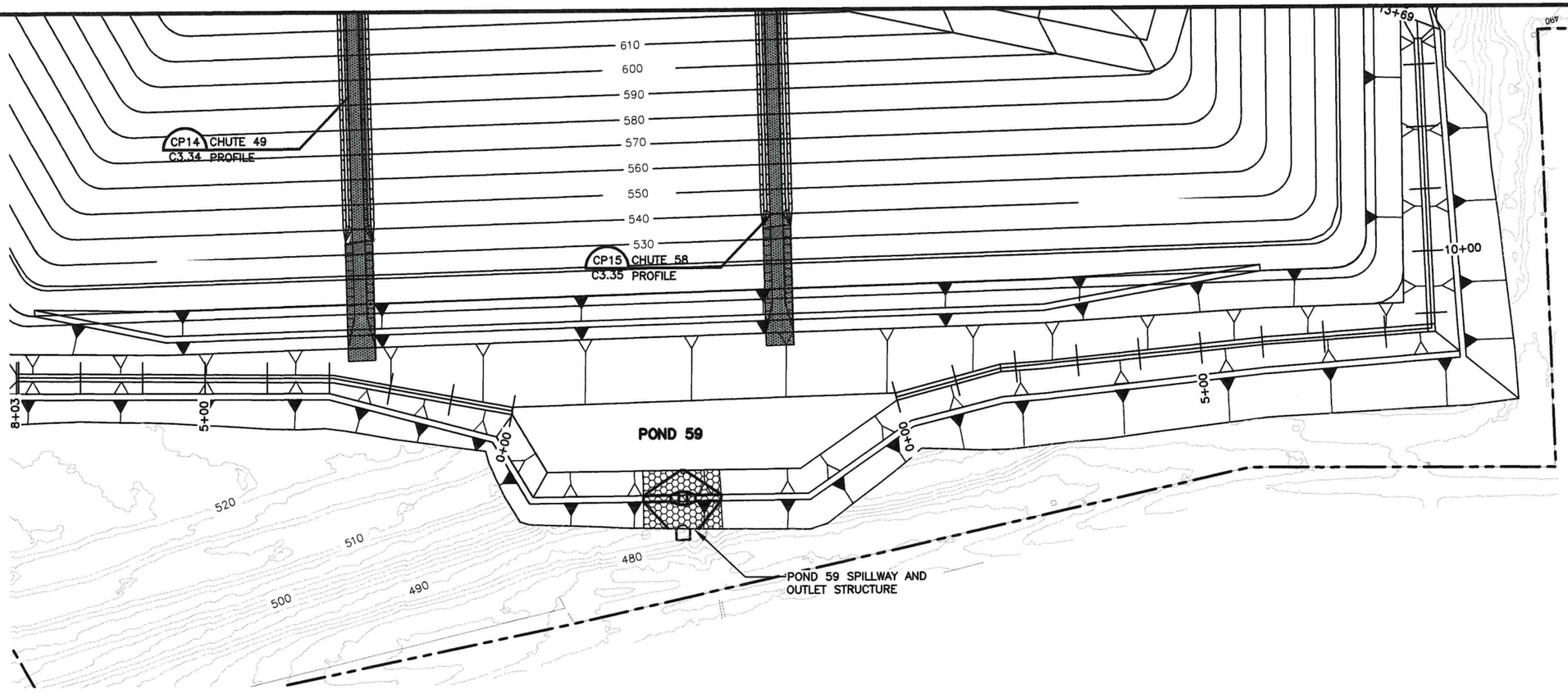
WASTE MANAGEMENT OF TEXAS, INC. SKYLINE LANDFILL

BIGGS & MATHEWS ENVIRONMENTAL
1700 ROBERT ROAD, STE. 100
MANSFIELD, TEXAS 76063
817–563–1144

TBPELS FIRM NO. F–256 AND NO. 10194895
TBPG FIRM NO. 50222

DRAWING C3.14

O:\Waste Management\Skyline\Solid Waste\P\Drawings\Part III\Att. C\C3.9 to 13.dwg Layout: C3.14 User: awhite



0 100 200
SCALE IN FEET

LEGEND

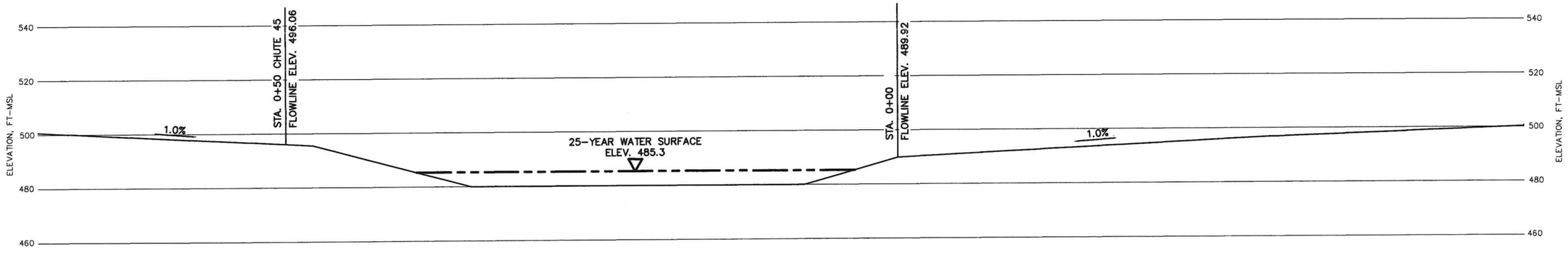
PERMIT BOUNDARY

N 6558000 STATE PLANE GRID NAD 83

DRAINAGE FLOW DIRECTION

NOTE:

1. EXISTING CONTOURS COMPILED BY HYDREX DRONE DIVISION, FROM AERIAL SURVEY FLOWN MARCH 5, 2025.
2. EXISTING POND 59 AND THE EXISTING SPILLWAY AND OUTLET STRUCTURE ARE CONSTRUCTED CONSISTENT WITH MSW PERMIT NO. 42C AND SUBSEQUENT MODIFICATIONS AND AUTHORIZATIONS.
3. EXISTING POND 59 AND THE EXISTING SPILLWAY AND OUTLET STRUCTURE ARE INCORPORATED AS PART OF THE DRAINAGE SYSTEM FOR MSW PERMIT NO. 42D.
4. REFER TO DRAWING C3.10A FOR POND 59 OUTLET STRUCTURE.



POND 59– CHANNEL PROFILE (A) C3.15

0 100 200
HORIZONTAL SCALE IN FEET

0 10 20
VERTICAL SCALE IN FEET

25 YEAR HYDRAULIC ANALYSIS

DITCH	STATION		BOTTOM SLOPE (%)	BOTTOM WIDTH (ft)	CHANNEL DEPTH (ft)	FLOW DEPTH (ft)	FREE-BOARD (ft)	FLOW RATE (cfs)	FLOW VELOCITY (fps)	EROSION PROTECTION
POND 59 CHANNEL	0+00	0+05	0.01	12	16.00	0.96	15.04	64.9	4.04	EST. VEGETATION
POND 59 CHANNEL	0+05	8+03	0.01	12	6.00	0.42	5.58	15	2.53	EST. VEGETATION

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PROFESSIONAL ENGINEER
3/31/2026

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POND 59
CHANNEL PROFILE

WASTE MANAGEMENT OF TEXAS, INC.
SKYLINE LANDFILL

BIGGS & MATHEWS ENVIRONMENTAL
1700 ROBERT ROAD, STE. 100
MANSFIELD, TEXAS 76063
817-563-1144

TBPELS FIRM NO. F-256 AND NO. 10194895
TBPG FIRM NO. 50222

DRAWING C3.15

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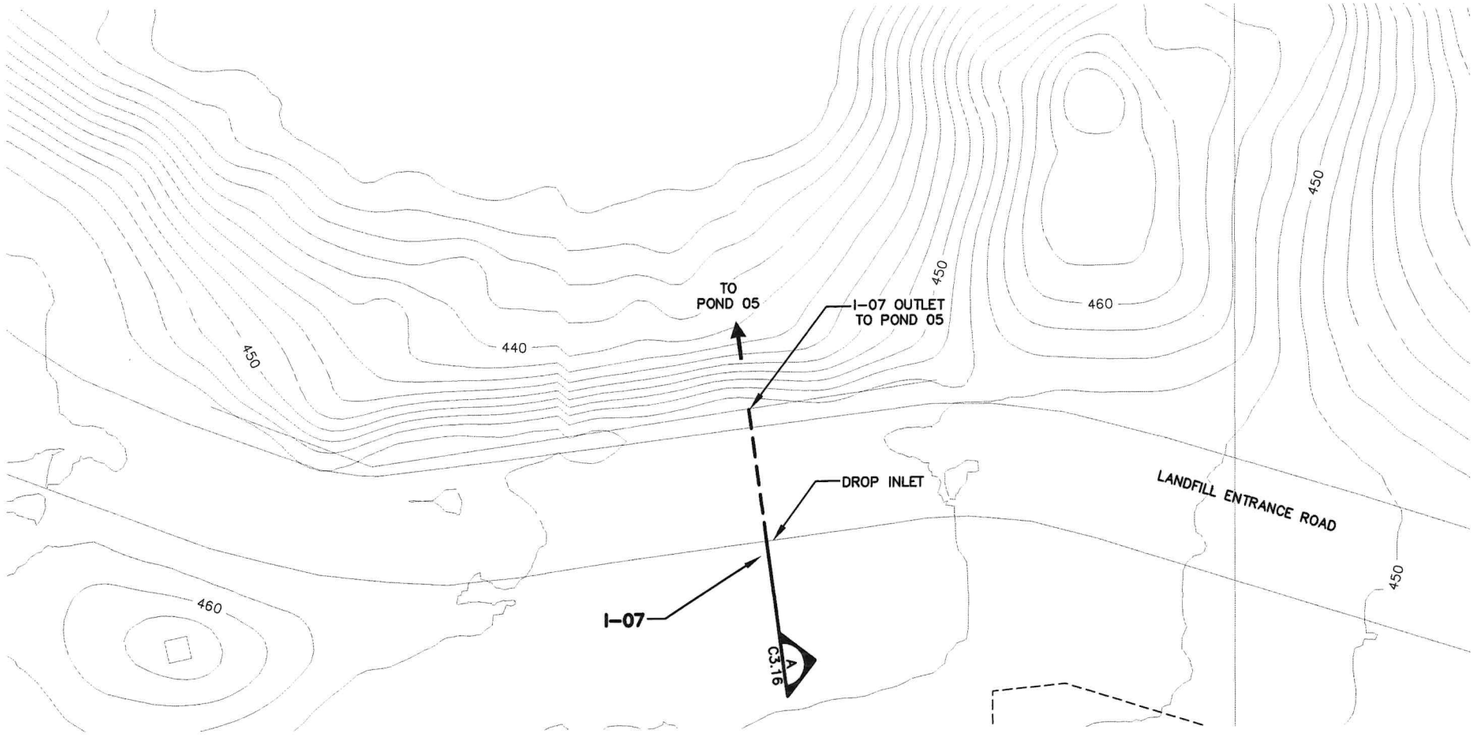


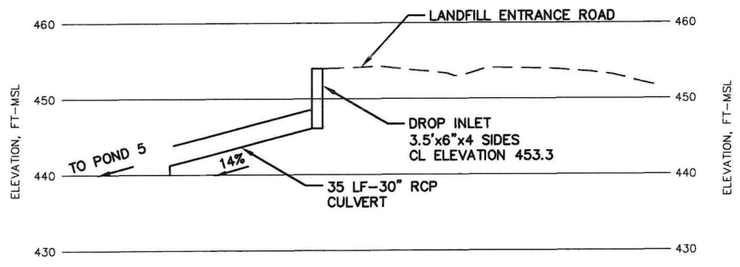


LEGEND

- PERMIT BOUNDARY
- N 6885000 — STATE PLANE GRID NAD 83
- DRAINAGE FLOW DIRECTION

NOTE:

1. EXISTING CONTOURS COMPILED BY HYDREX DRONE DIVISION, FROM AERIAL SURVEY FLOWN MARCH 5, 2025.
2. EXISTING DROP INLET I-07, CULVERT AND CULVERT OUTLET ARE CONSTRUCTED CONSISTENT WITH MSW PERMIT NO. 42C AND SUBSEQUENT MODIFICATIONS AND AUTHORIZATIONS.
3. EXISTING DROP INLET I-07, CULVERT AND CULVERT OUTLET ARE INCORPORATED AS PART OF THE DRAINAGE SYSTEM FOR MSW PERMIT NO. 42D.



I-07- SECTION A (A C3-16)

0 20 40 HORIZONTAL SCALE IN FEET

0 10 20 VERTICAL SCALE IN FEET

I-07 ELEVATION-STORAGE RELATIONSHIP	
ELEVATION (FT)	VOLUME AT ELEVATION (AC-FT)
453	0
455	.006

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I-07 (EXISTING STRUCTURE)

WASTE MANAGEMENT OF TEXAS, INC. SKYLINE LANDFILL

BIGGS & MATHEWS ENVIRONMENTAL
1700 ROBERT ROAD, STE. 100
MANSFIELD, TEXAS 76063
817-563-1144

TBPELS FIRM NO. F-256 AND NO. 10194895

TBPG FIRM NO. 50222

DRAWING C3.16

REVISIONS			
REV	DATE	DESCRIPTION	DWN BY

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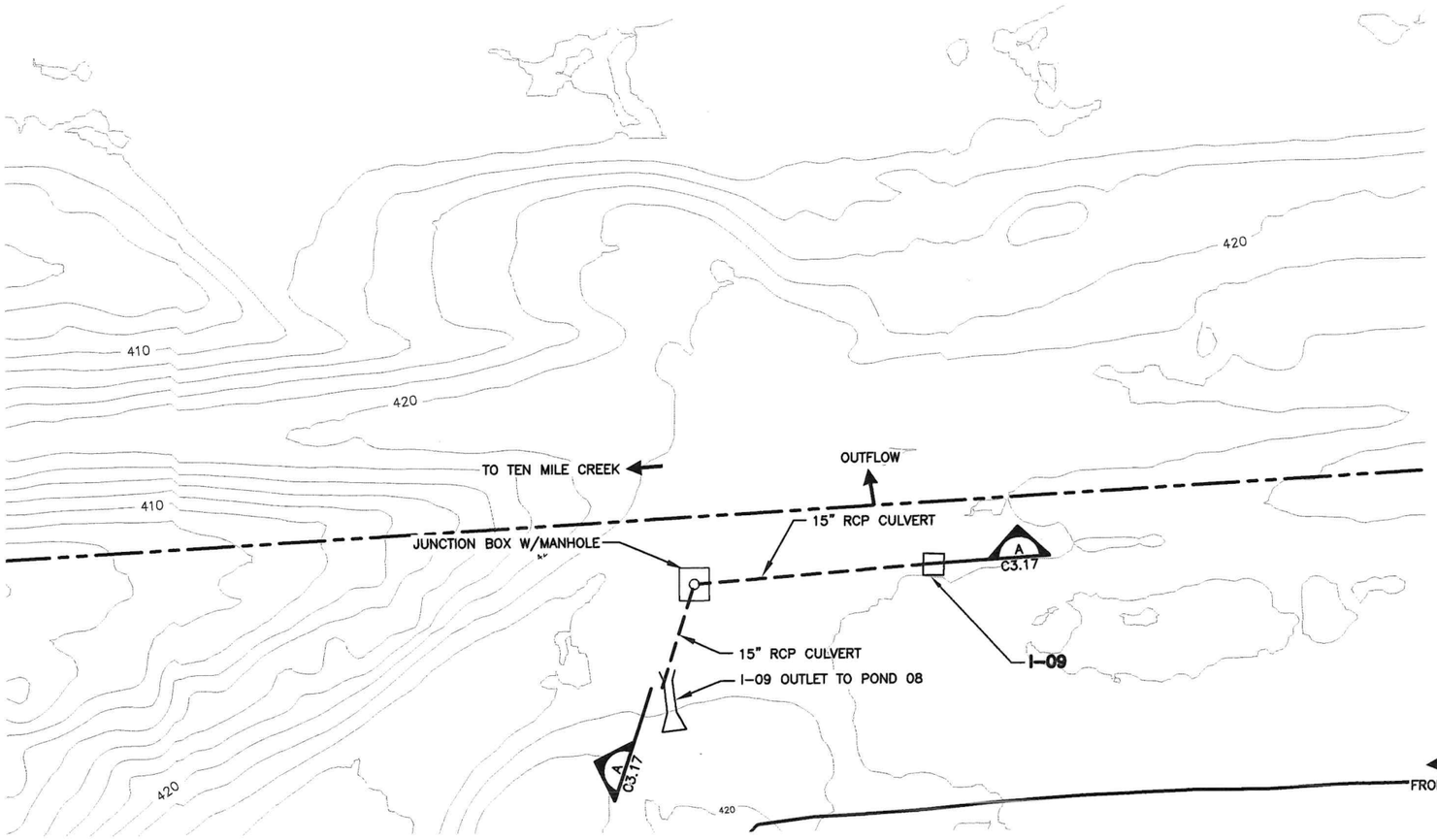

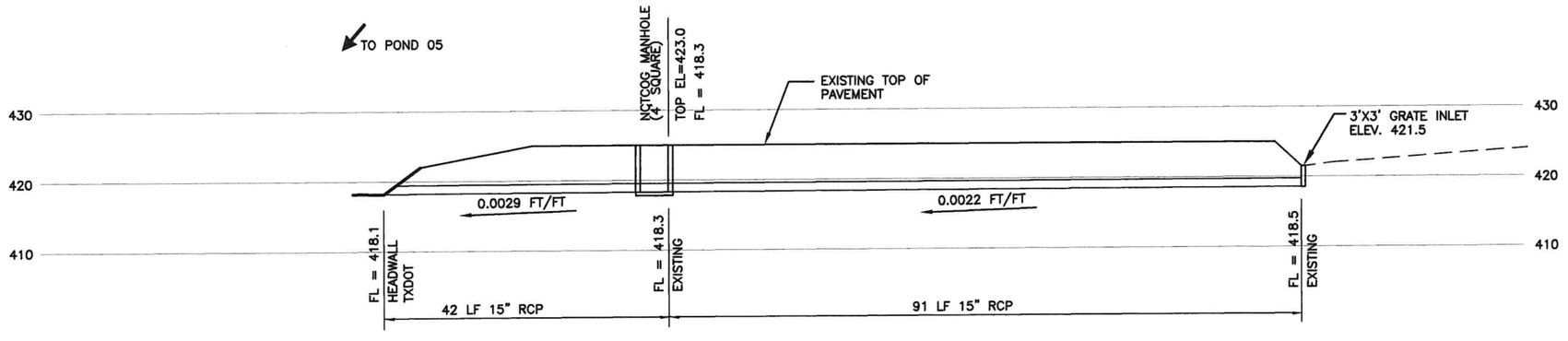

I-09 – SECTION A (A C3.17)

0 10 20
HORIZONTAL SCALE IN FEET

0 10 20
VERTICAL SCALE IN FEET

I-09 ELEVATION-STORAGE RELATIONSHIP	
ELEVATION (FT)	VOLUME AT ELEVATION (AC-FT)
421	0
423	0.01

0 30 60
SCALE IN FEET

LEGEND

- PERMIT BOUNDARY
- N 6885000 STATE PLANE GRID NAD 83
- DRAINAGE FLOW DIRECTION

NOTE:

1. EXISTING CONTOURS COMPILED BY HYDREX DRONE DIVISION, FROM AERIAL SURVEY FLOWN MARCH 5, 2025.
2. EXISTING DROP INLET I-09, CULVERT AND CULVERT OUTLET ARE CONSTRUCTED CONSISTENT WITH MSW PERMIT NO. 42C AND SUBSEQUENT MODIFICATIONS AND AUTHORIZATIONS.
3. EXISTING DROP INLET I-09, CULVERT AND CULVERT OUTLET ARE INCORPORATED AS PART OF THE DRAINAGE SYSTEM FOR MSW PERMIT NO. 42D.

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I-09 (EXISTING STRUCTURE)

WASTE MANAGEMENT OF TEXAS, INC. SKYLINE LANDFILL

BIGGS & MATHEWS ENVIRONMENTAL
1700 ROBERT ROAD, STE. 100
MANSFIELD, TEXAS 76063
817-563-1144

TBPELS FIRM NO. F-256 AND NO. 10194895
TBPG FIRM NO. 50222

DRAWING C3.17

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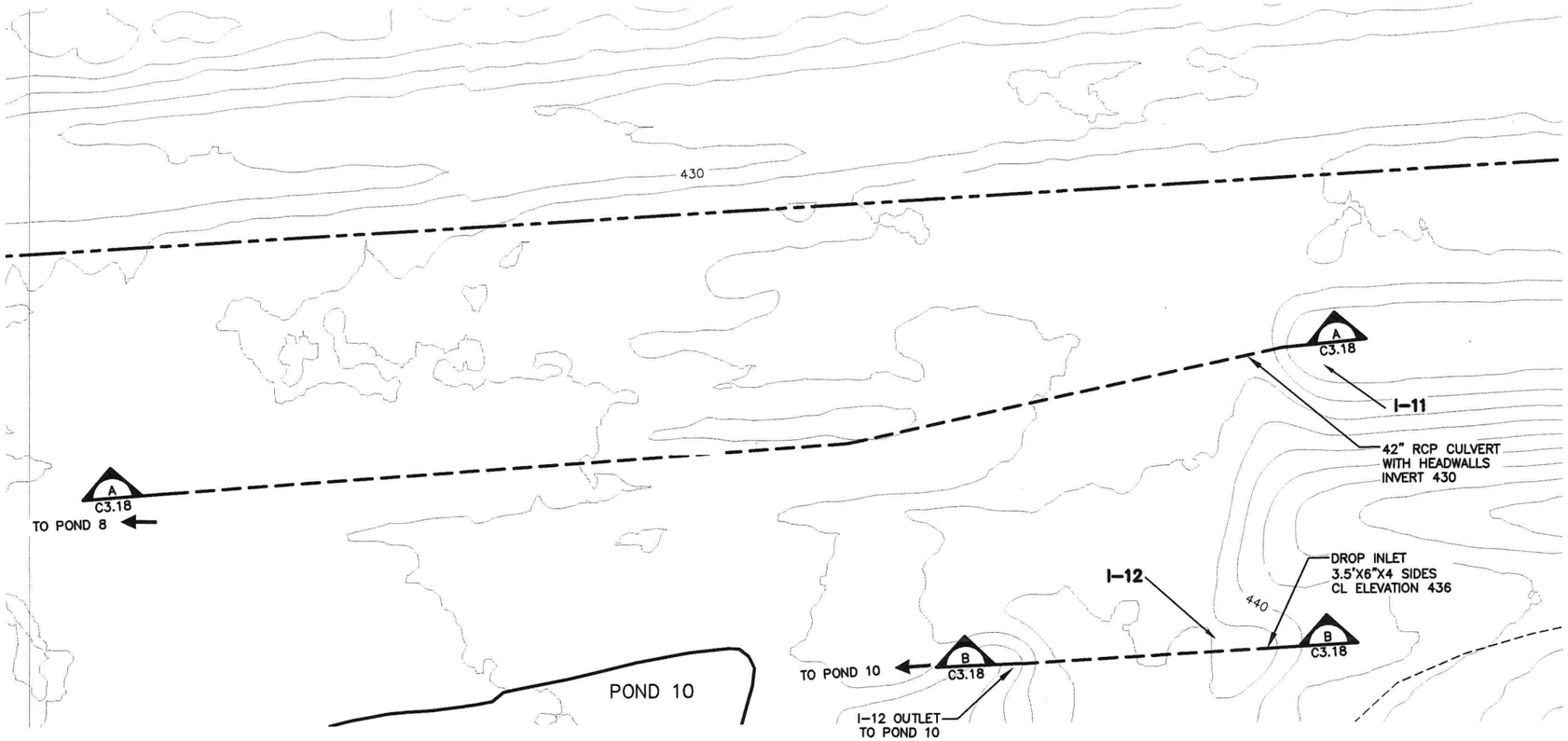


0 30 60
SCALE IN FEET

LEGEND

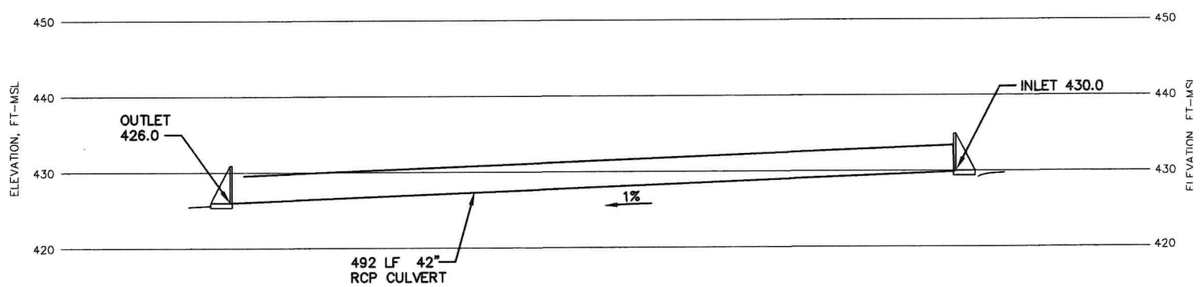
PERMIT BOUNDARY

N 5486000 STATE PLANE GRID NAD 83

DRAINAGE FLOW DIRECTION

NOTE:

1. EXISTING CONTOURS COMPILED BY HYDREX DRONE DIVISION, FROM AERIAL SURVEY FLOWN MARCH 5, 2025.
2. EXISTING CULVERT I-11 AND ITS OUTLET STRUCTURE AND DROP INLET I-12 AND ITS OUTLET STRUCTURE ARE CONSTRUCTED CONSISTENT WITH MSW PERMIT NO. 42C AND SUBSEQUENT MODIFICATIONS AND AUTHORIZATIONS.
3. EXISTING CULVERT I-11 AND ITS OUTLET STRUCTURE AND DROP INLET I-12 AND ITS OUTLET STRUCTURE ARE INCORPORATED AS PART OF THE DRAINAGE SYSTEM FOR MSW PERMIT NO. 42D.

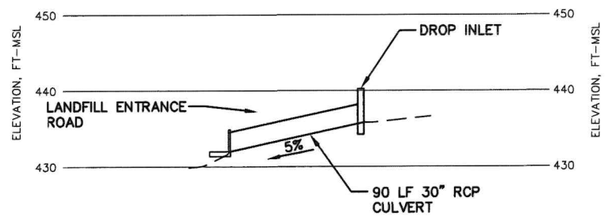


I-11 – SECTION A (A C3.18)

0 50 100 HORIZONTAL SCALE IN FEET

0 10 20 VERTICAL SCALE IN FEET

I-11 ELEVATION–STORAGE RELATIONSHIP	
ELEVATION (FT)	VOLUME AT ELEVATION (AC-FT)
428	0
430	0.003
432	0.15
434	0.69
436	1.49
438	2.29



I-12 – SECTION B (B C3.18)

0 50 100 HORIZONTAL SCALE IN FEET

0 10 20 VERTICAL SCALE IN FEET

I-12 ELEVATION–STORAGE RELATIONSHIP	
ELEVATION (FT)	VOLUME AT ELEVATION (AC-FT)
434	0
436	0.001
438	0.037

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FELIPE ANTONIO WESCOUP
103826
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I-11 AND I-12 (EXISTING STRUCTURE)

WASTE MANAGEMENT OF TEXAS, INC. SKYLINE LANDFILL

BIGGS & MATHEWS ENVIRONMENTAL
1700 ROBERT ROAD, STE. 100
MANSFIELD, TEXAS 76063
817-563-1144

TBPELS FIRM NO. F-256 AND NO. 10194895
TBPG FIRM NO. 50222

DRAWING C3.18

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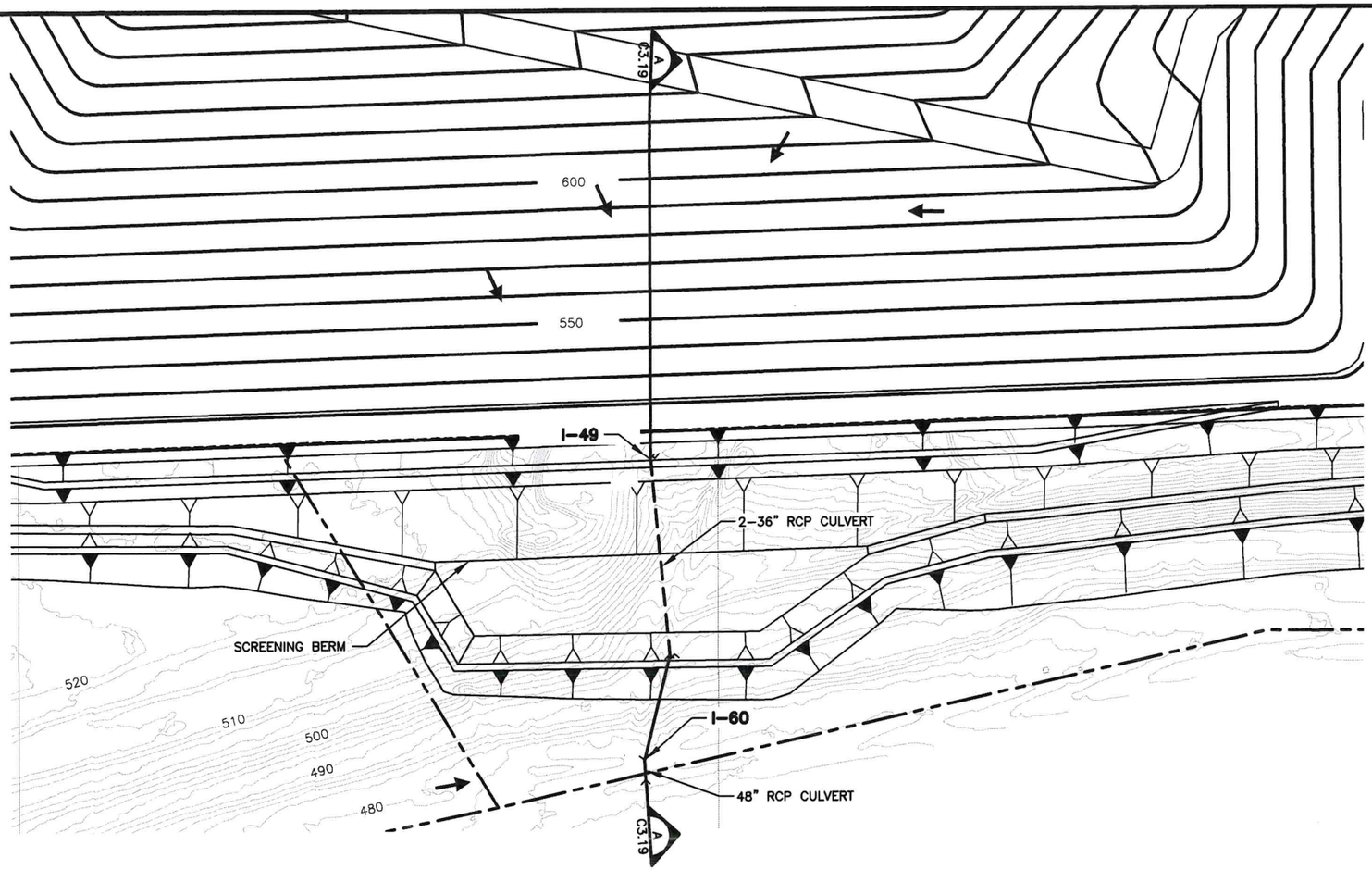

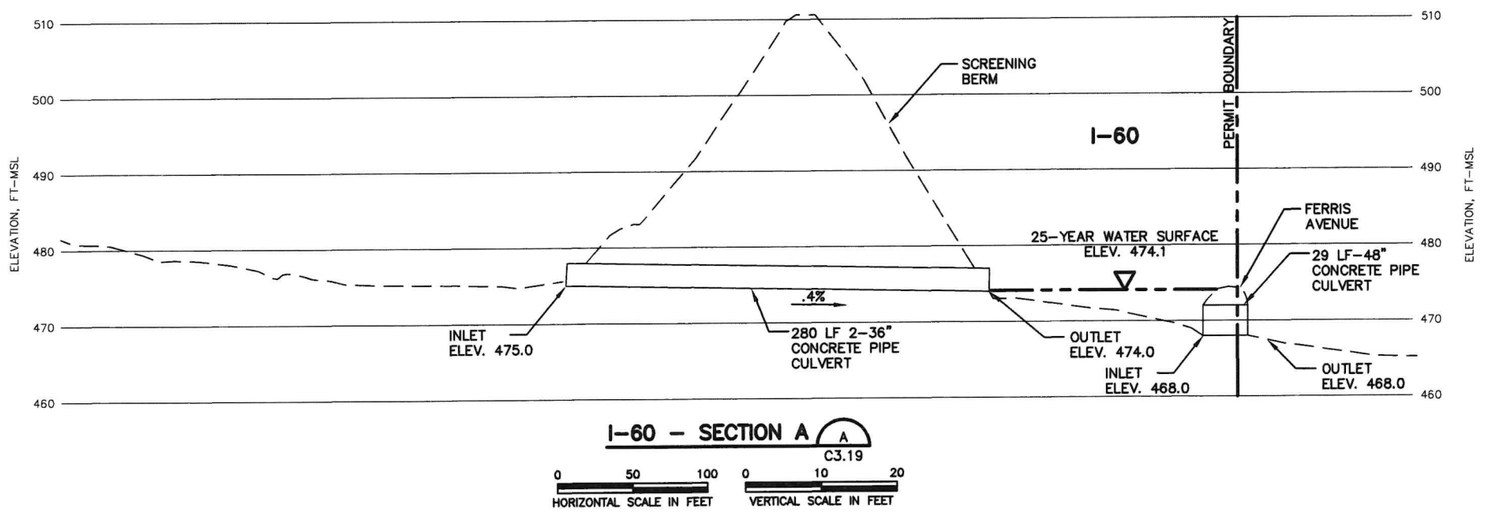

I-60 – SECTION A (A, C3.19)

0 50 100 HORIZONTAL SCALE IN FEET

0 10 20 VERTICAL SCALE IN FEET

0 100 200 SCALE IN FEET

LEGEND

- PERMIT BOUNDARY
- N 5888000 STATE PLANE GRID NAD 83
- DRAINAGE FLOW DIRECTION

NOTE:

1. EXISTING CONTOURS COMPILED BY HYDREX DRONE DIVISION, FROM AERIAL SURVEY FLOWN MARCH 5, 2025.
2. EXISTING CULVERT I-60 IS CONSTRUCTED AS PART OF FERRIS AVE. BY OTHERS. CULVERT I-60 IS NOT LOCATED WITHIN THE MSW PERMIT NO. 42C OR MSW PERMIT NO. 42D PERMIT BOUNDARY.
3. EXISTING CULVERT I-60 IS INCLUDED IN THE DRAINAGE ANALYSIS FOR MSW PERMIT NO. 42C AND MSW PERMIT NO. 42D.

POND I-60 ELEVATION-STORAGE RELATIONSHIP	
ELEVATION (FT)	VOLUME AT ELEVATION (AC-FT)
468	0
472	0.001
474	0.660
476	4.341

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I-60 (EXISTING STRUCTURE)

WASTE MANAGEMENT OF TEXAS, INC. SKYLINE LANDFILL

BIGGS & MATHEWS ENVIRONMENTAL
1700 ROBERT ROAD, STE. 100
MANSFIELD, TEXAS 76063
817-563-1144

TBPELS FIRM NO. F-256 AND NO. 10194895

TBPG FIRM NO. 50222

DRAWING C3.19

REVISIONS			
REV	DATE	DESCRIPTION	DWN BY

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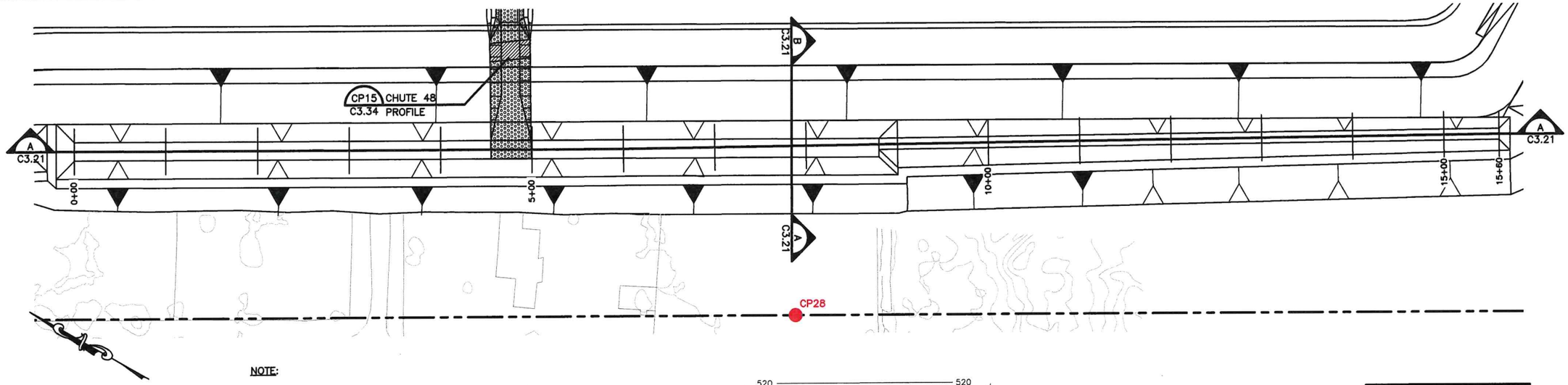


0 60 120
SCALE IN FEET

LEGEND

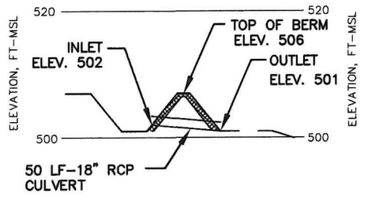
PERMIT BOUNDARY

N 5888000 STATE PLANE GRID NAD 83

DRAINAGE FLOW DIRECTION

NOTE:

1. EXISTING CONTOURS COMPILED BY HYDREX DRONE DIVISION, FROM AERIAL SURVEY FLOWN MARCH 5, 2025.
2. EXISTING POND 64 AND THE EXISTING SPILLWAY AND OUTLET STRUCTURE ARE CONSTRUCTED CONSISTENT WITH MSW PERMIT NO. 42C AND SUBSEQUENT MODIFICATIONS AND AUTHORIZATIONS.
3. EXISTING POND 64 AND THE EXISTING SPILLWAY AND OUTLET STRUCTURE ARE INCORPORATED AS PART OF THE DRAINAGE SYSTEM FOR MSW PERMIT NO. 42D.
4. REFER TO DRAWING C3.10A FOR POND 64 OUTLET STRUCTURE.

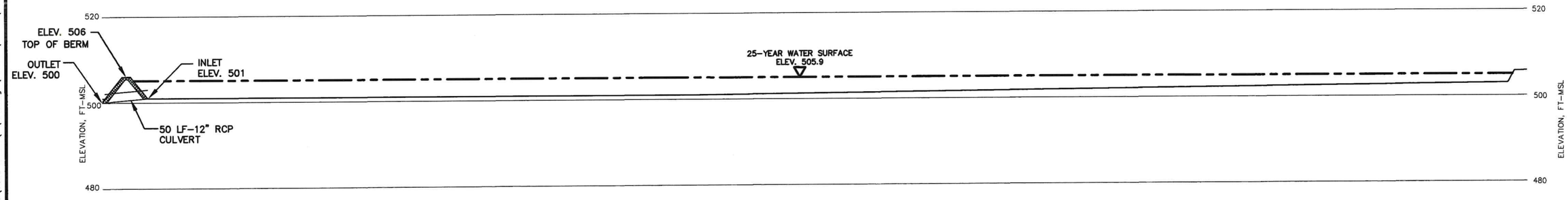


I-64 – SECTION B (B C3.21)

0 60 120
HORIZONTAL SCALE IN FEET

0 10 20
VERTICAL SCALE IN FEET

I-64 ELEVATION-STORAGE RELATIONSHIP	
ELEVATION (FT)	VOLUME AT ELEVATION (AC-FT)
501	0
502	0.325
504	1.321
506	2.795
507	3.655



I-64 – SECTION A (A C3.21)

0 60 120
HORIZONTAL SCALE IN FEET

0 10 20
VERTICAL SCALE IN FEET

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FELIPE ANTONIO WESCOUP
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3/31/2026

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REV	DATE	DESCRIPTION	DWN BY

I-64 (DETENTION POND)

WASTE MANAGEMENT OF TEXAS, INC. SKYLINE LANDFILL

BIGGS & MATHEWS ENVIRONMENTAL
1700 ROBERT ROAD, STE. 100
MANSFIELD, TEXAS 76063
817-563-1144

TBPE FIRM NO. F-256
TBPG FIRM NO. 50222

DRAWING
C3.20

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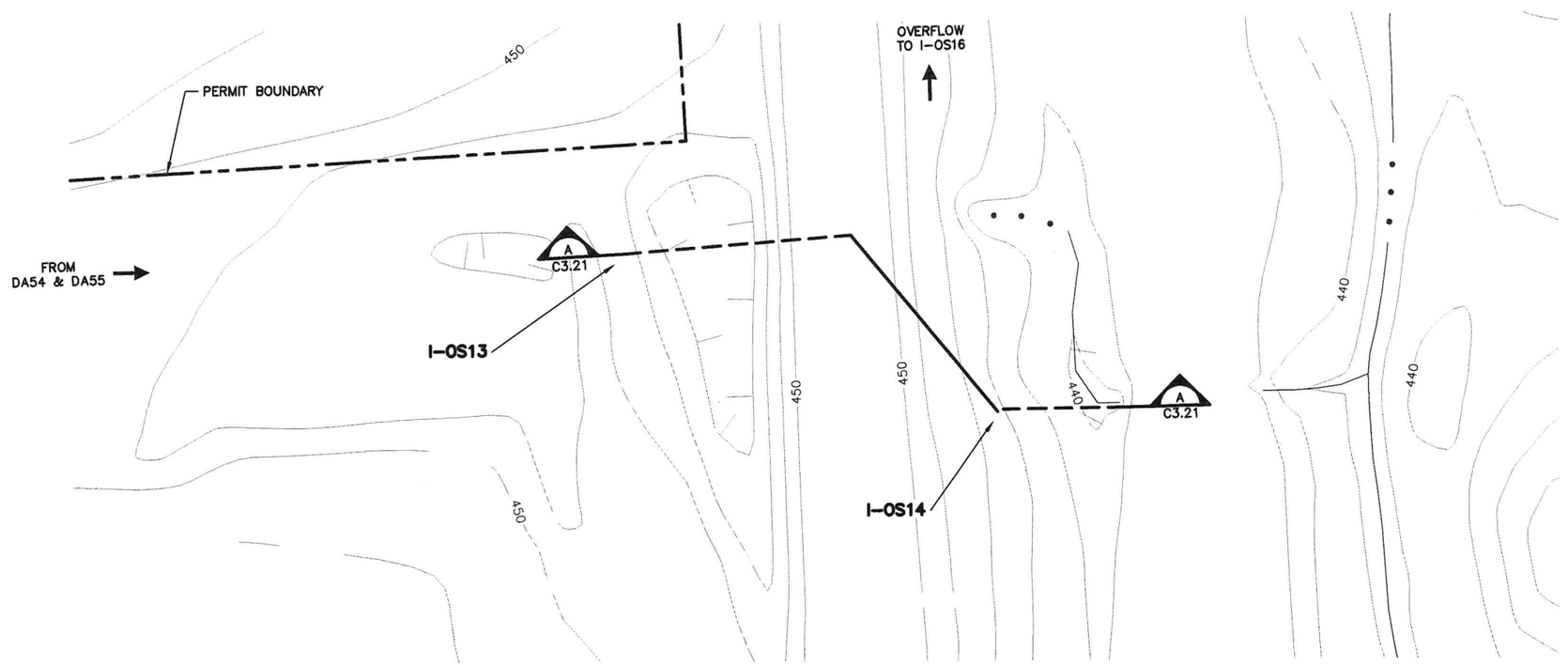


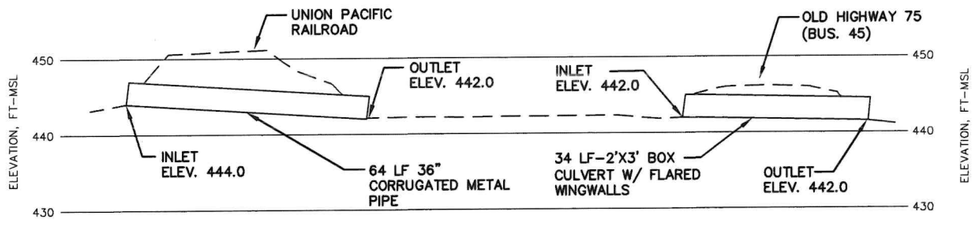


LEGEND

- PERMIT BOUNDARY
- N 6836000 — STATE PLANE GRID NAD 83
- DRAINAGE FLOW DIRECTION

NOTE:

1. EXISTING CONTOURS COMPILED BY HYDREX DRONE DIVISION, FROM AERIAL SURVEY FLOWN MARCH 5, 2025.
2. EXISTING CULVERT I-OS13 IS CONSTRUCTED AS PART OF THE UNION PACIFIC RAILROAD BY OTHERS. EXISTING CULVERT I-OS14 IS CONSTRUCTED AS PART OF OLD HIGHWAY 75 (BUS. 45) BY OTHERS. EXISTING CULVERTS I-OS13 AND I-OS14 ARE NOT LOCATED WITHIN THE MSW PERMIT NO. 42C OR MSW PERMIT NO. 42D PERMIT BOUNDARY.
3. EXISTING CULVERTS I-OS13 AND I-OS14 ARE INCLUDED IN THE DRAINAGE ANALYSIS FOR MSW PERMIT NO. 42C AND MSW PERMIT NO. 42D.



I-OS13 & I-OS14 SECTION (A C3.21)

0 20 40 HORIZONTAL SCALE IN FEET

0 10 20 VERTICAL SCALE IN FEET

I-OS13 ELEVATION-STORAGE RELATIONSHIP	
ELEVATION (FT)	VOLUME AT ELEVATION (AC-FT)
444	0.018
446	0.085
448	0.463
450	1.665
452	3.353

I-OS14 ELEVATION-STORAGE RELATIONSHIP	
ELEVATION (FT)	VOLUME AT ELEVATION (AC-FT)
440	0.002
442	0.051
444	0.180

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3/31/2026

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I-OS13 AND I-OS14 (EXISTING OFFSITE STRUCTURE)

WASTE MANAGEMENT OF TEXAS, INC. SKYLINE LANDFILL

BIGGS & MATHEWS ENVIRONMENTAL
1700 ROBERT ROAD, STE. 100
MANSFIELD, TEXAS 76063
817-563-1144

TBPELS FIRM NO. F-256 AND NO. 10194895
TBPG FIRM NO. 50222

DRAWING C3.21

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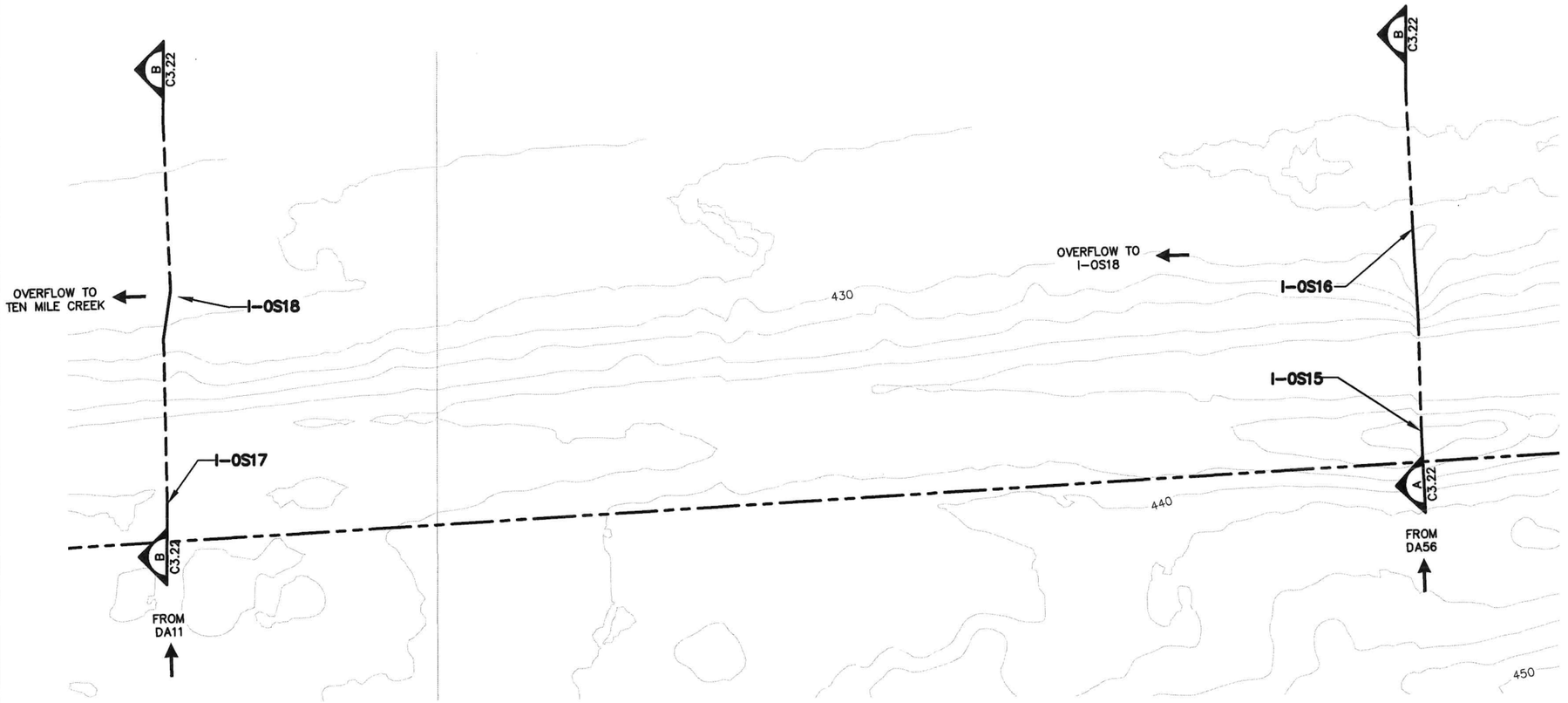


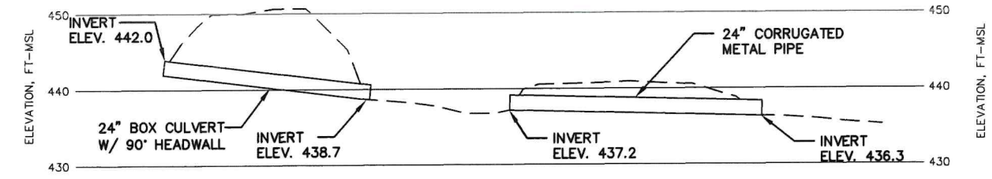


LEGEND

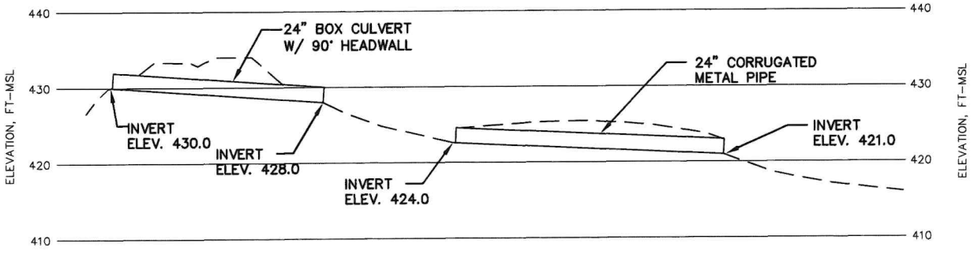
- PERMIT BOUNDARY
- N 6828000 STATE PLANE GRID NAD 83
- DRAINAGE FLOW DIRECTION

NOTE:

1. EXISTING CONTOURS COMPILED BY HYDREX DRONE DIVISION, FROM AERIAL SURVEY FLOWN MARCH 5, 2025.
2. EXISTING CULVERTS I-OS15 AND I-OS17 ARE CONSTRUCTED AS PART OF THE UNION PACIFIC RAILROAD BY OTHERS. I-OS16 AND I-OS18 ARE CONSTRUCTED AS PART OF OLD HIGHWAY 75 (BUS. 45) BY OTHERS. EXISTING CULVERTS I-OS15, I-OS16, I-OS17, AND I-OS18 ARE NOT LOCATED WITHIN MSW PERMIT NO. 42C OR MSW PERMIT NO. 42D.
3. EXISTING CULVERTS I-OS15, I-OS16, I-OS17, AND I-OS18 ARE INCLUDED IN THE DRAINAGE ANALYSIS FOR MSW PERMIT NO. 42C AND MSW PERMIT NO. 42D.



I-OS15 & I-OS16 SECTION A C3.22



I-OS17 & I-OS18 SECTION B C3.22

I-OS15 ELEVATION-STORAGE RELATIONSHIP	
ELEVATION (FT)	VOLUME AT ELEVATION (AC-FT)
432	0.001
434	0.025
436	0.118
438	0.339
440	0.660

I-OS16 ELEVATION-STORAGE RELATIONSHIP	
ELEVATION (FT)	VOLUME AT ELEVATION (AC-FT)
426	0.000
428	0.009
430	0.037
432	0.065

I-OS17 ELEVATION-STORAGE RELATIONSHIP	
ELEVATION (FT)	VOLUME AT ELEVATION (AC-FT)
428	0.000
430	0.004
432	0.030
434	0.203

I-OS18 ELEVATION-STORAGE RELATIONSHIP	
ELEVATION (FT)	VOLUME AT ELEVATION (AC-FT)
424	0.004
426	0.127



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I-OS15, I-OS16, I-OS17 AND I-OS18 (EXISTING OFFSITE STRUCTURE)

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1700 ROBERT ROAD, STE. 100
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TBPELS FIRM NO. F-256 AND NO. 10194895
TBPG FIRM NO. 50222

DRAWING C3.22

REVISIONS			
REV	DATE	DESCRIPTION	DWN BY

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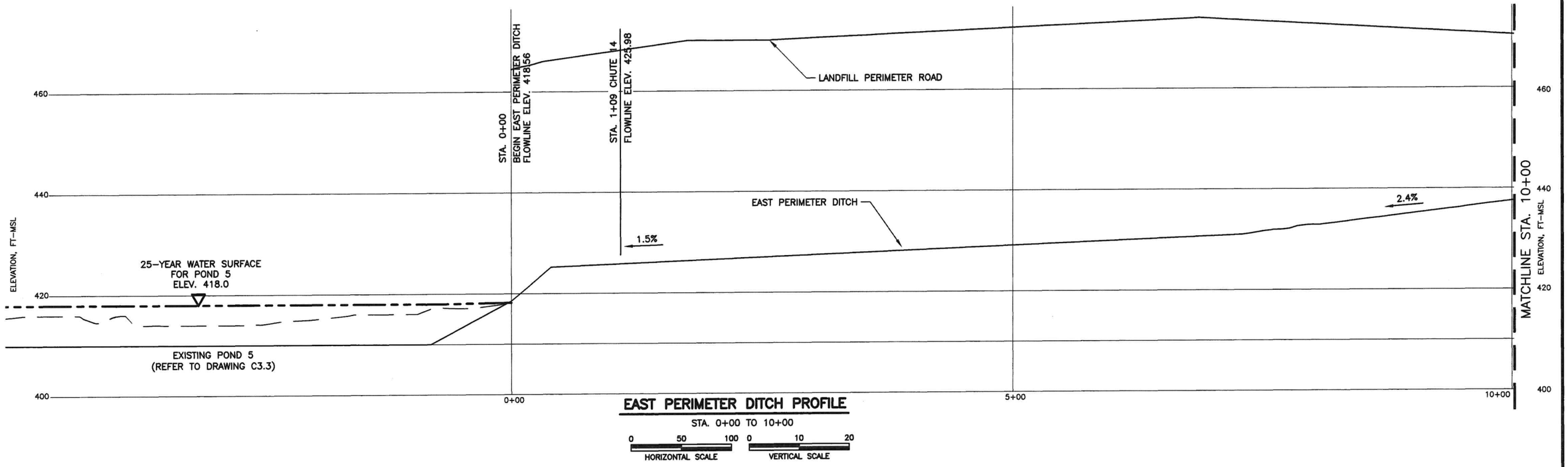
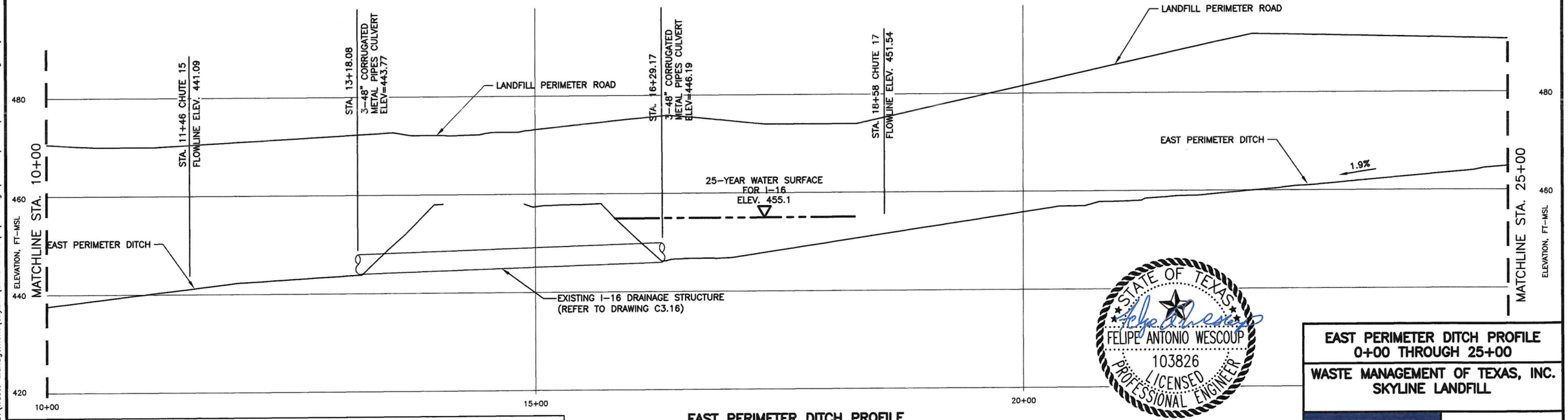


EAST PERIMETER DITCH PROFILE

STA. 0+00 TO 10+00

0 50 100 HORIZONTAL SCALE

0 10 20 VERTICAL SCALE



EAST PERIMETER DITCH PROFILE

STA. 10+00 TO 25+00

0 50 100 HORIZONTAL SCALE

0 10 20 VERTICAL SCALE

25 YEAR HYDRAULIC ANALYSIS

DITCH	STATION		BOTTOM SLOPE (%)	BOTTOM WIDTH (ft)	CHANNEL DEPTH (ft)	FLOW DEPTH (ft)	FREE-BOARD (ft)	FLOW RATE (cfs)	FLOW VELOCITY (fps)	EROSION PROTECTION
EAST	0+00	1+09	0.015	10	9.36	2.39	6.97	422.5	8.04	TURF MAT
EAST	1+09	11+46	0.016	14	6.00	2.12	3.88	419.6	8.05	TURF MAT
EAST	11+46	16+29	0.042	14	9.00	1.57	7.43	378.8	11.08	TURF MAT
EAST	16+29	18+58	0.023	19	9.00	1.57	7.43	359.6	8.54	TURF MAT

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EAST PERIMETER DITCH PROFILE 0+00 THROUGH 25+00

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TBPG FIRM NO. 50222

DRAWING C3.23

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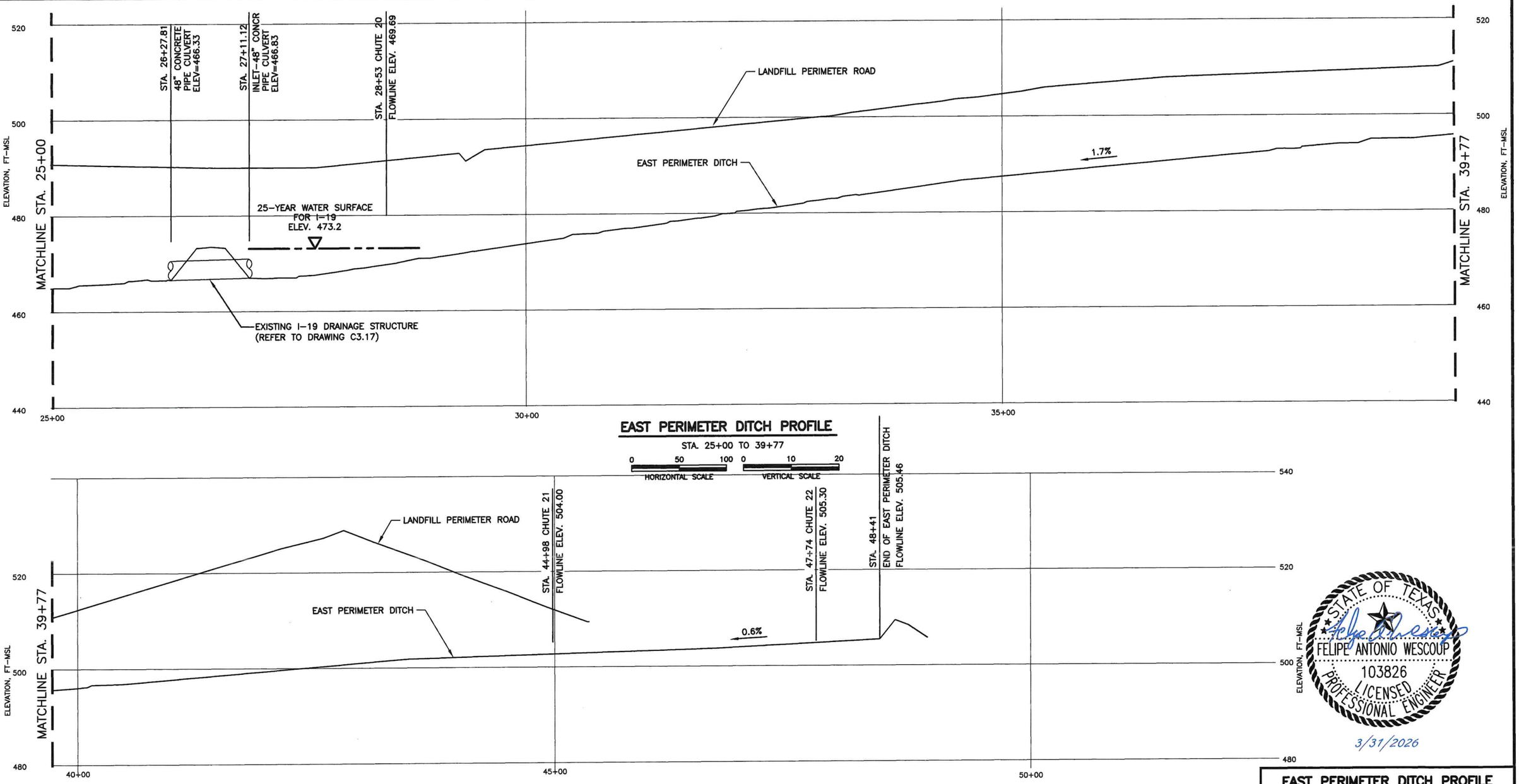

EAST PERIMETER DITCH PROFILE

STA. 25+00 TO 39+77

HORIZONTAL SCALE 0 50 100 — VERTICAL SCALE 0 10 20

EAST PERIMETER DITCH PROFILE

STA 39+77 TO 48+91

HORIZONTAL SCALE 0 50 100 — VERTICAL SCALE 0 10 20

25 YEAR HYDRAULIC ANALYSIS

DITCH	STATION		BOTTOM SLOPE (%)	BOTTOM WIDTH (ft)	CHANNEL DEPTH (ft)	FLOW DEPTH (ft)	FREE-BOARD (ft)	FLOW RATE (cfs)	FLOW VELOCITY (fps)	EROSION PROTECTION
EAST	18+58	27+11	0.026	25	5.50	1.16	4.34	280.2	7.83	TURF MAT
EAST	27+11	28+53	0.021	10	7.00	1.81	5.19	280.2	7.83	TURF MAT
EAST	28+53	44+98	0.021	10	6.00	1.47	4.53	186.3	7.28	TURF MAT
EAST	44+98	48+41	0.019	10	6.00	0.99	5.01	81.3	5.23	TURF MAT

NOTE:

1. EXISTING EAST PERIMETER DITCH IS CONSTRUCTED CONSISTENT WITH MSW PERMIT NO. 42C AND SUBSEQUENT MODIFICATIONS AND AUTHORIZATIONS.
2. EXISTING EAST PERIMETER DITCH IS INCORPORATED AS PART OF THE DRAINAGE SYSTEM FOR MSW PERMIT NO. 42D.

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EAST PERIMETER DITCH PROFILE 25+00 THROUGH 48+41

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DRAWING C3.24

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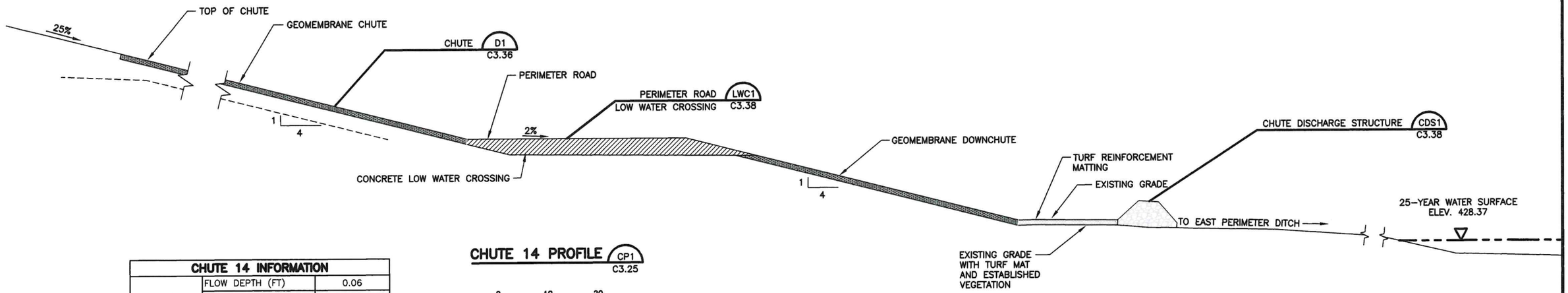
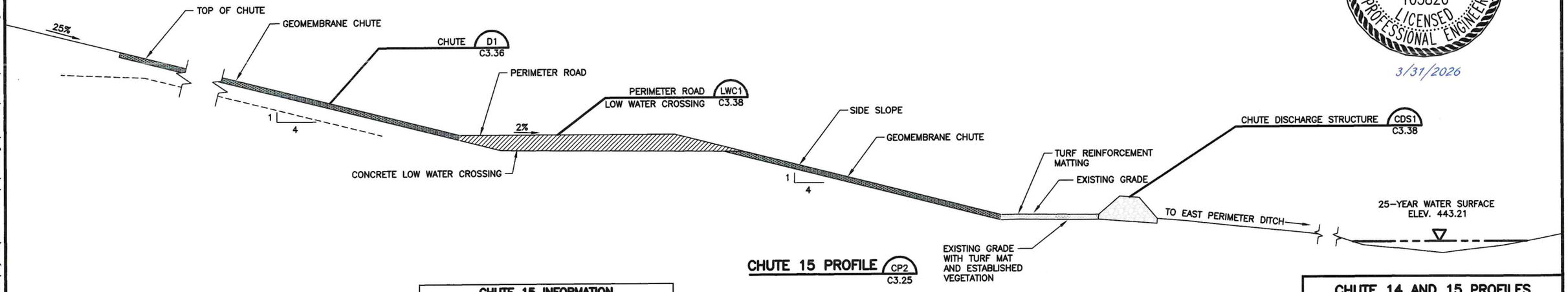


CHUTE 14 PROFILE CP1 C3.25

0 10 20
SCALE IN FEET

CHUTE 14 INFORMATION		
CHUTE	FLOW DEPTH (FT)	0.06
	FLOW VELOCITY (FPS)	8.55
	BERM HEIGHT (FT)	3.00
LOW-WATER CROSSING	FLOW DEPTH (FT)	0.16
	FLOW VELOCITY (FPS)	2.91
AFTER LOW-WATER CROSSING	FLOW DEPTH (FT)	0.06
	FLOW VELOCITY (FPS)	7.84

NOTE: SEE ATTACHMENT C1, APPENDIX C1.E, PAGE C1.E.20 FOR CHUTE CALCULATIONS.



CHUTE 15 PROFILE CP2 C3.25

0 10 20
SCALE IN FEET

CHUTE 15 INFORMATION		
CHUTE	FLOW DEPTH (FT)	0.22
	FLOW VELOCITY (FPS)	20.04
	BERM HEIGHT (FT)	3.00
LOW-WATER CROSSING	FLOW DEPTH (FT)	0.56
	FLOW VELOCITY (FPS)	6.11
AFTER LOW-WATER CROSSING	FLOW DEPTH (FT)	0.23
	FLOW VELOCITY (FPS)	17.61

NOTE: SEE ATTACHMENT C1, APPENDIX C1.E, PAGE C1.E.20 FOR CHUTE CALCULATIONS.

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CHUTE 14 AND 15 PROFILES

WASTE MANAGEMENT OF TEXAS, INC. SKYLINE LANDFILL

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TBPG FIRM NO. 50222

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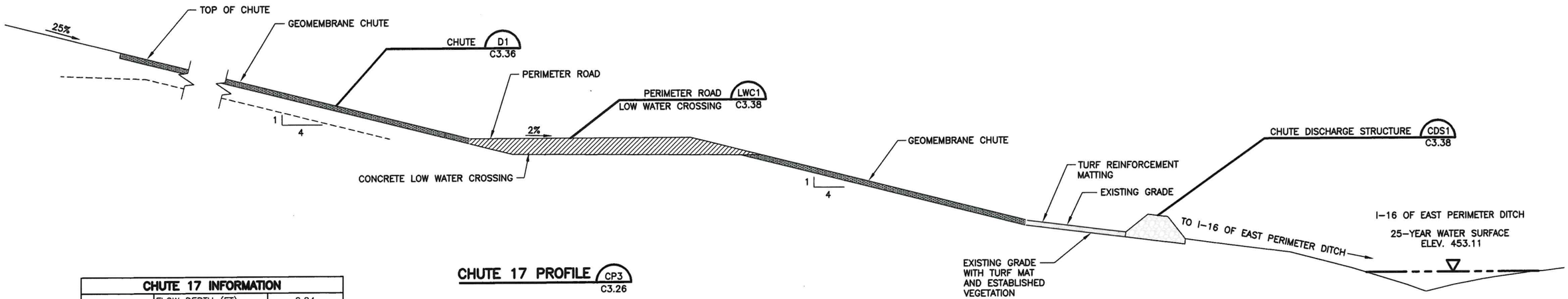
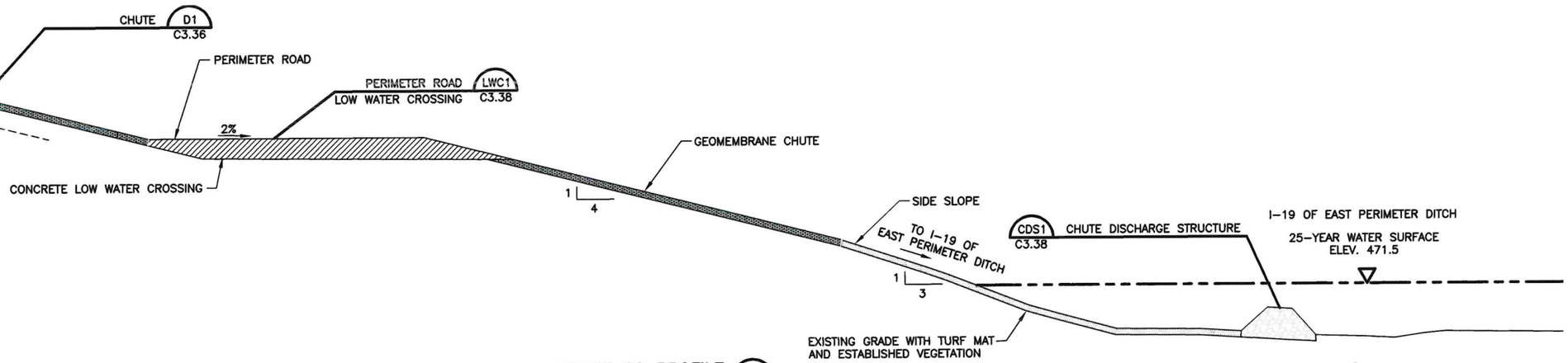


CHUTE 17 PROFILE CP3 C3.26

0 10 20
SCALE IN FEET

CHUTE 17 INFORMATION		
CHUTE	FLOW DEPTH (FT)	0.24
	FLOW VELOCITY (FPS)	21.46
	BERM HEIGHT (FT)	3.00
LOW-WATER CROSSING	FLOW DEPTH (FT)	0.61
	FLOW VELOCITY (FPS)	6.47
AFTER LOW-WATER CROSSING	FLOW DEPTH (FT)	0.25
	FLOW VELOCITY (FPS)	18.76

NOTE: SEE ATTACHMENT C1, APPENDIX C1.E, PAGE C1.E.20 FOR CHUTE CALCULATIONS.



CHUTE 20 PROFILE CP4 C3.26

0 10 20
SCALE IN FEET

CHUTE 20 INFORMATION		
CHUTE	FLOW DEPTH (FT)	0.25
	FLOW VELOCITY (FPS)	22.04
	BERM HEIGHT (FT)	3.00
LOW-WATER CROSSING	FLOW DEPTH (FT)	0.64
	FLOW VELOCITY (FPS)	6.61
AFTER LOW-WATER CROSSING	FLOW DEPTH (FT)	0.26
	FLOW VELOCITY (FPS)	19.22

NOTE: SEE ATTACHMENT C1, APPENDIX C1.E, PAGE C1.E.20 FOR CHUTE CALCULATIONS.

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CHUTE 17 AND 20 PROFILES

WASTE MANAGEMENT OF TEXAS, INC.
SKYLINE LANDFILL

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817-563-1144

TBPELS FIRM NO. F-256 AND NO. 10194895
TBPG FIRM NO. 50222

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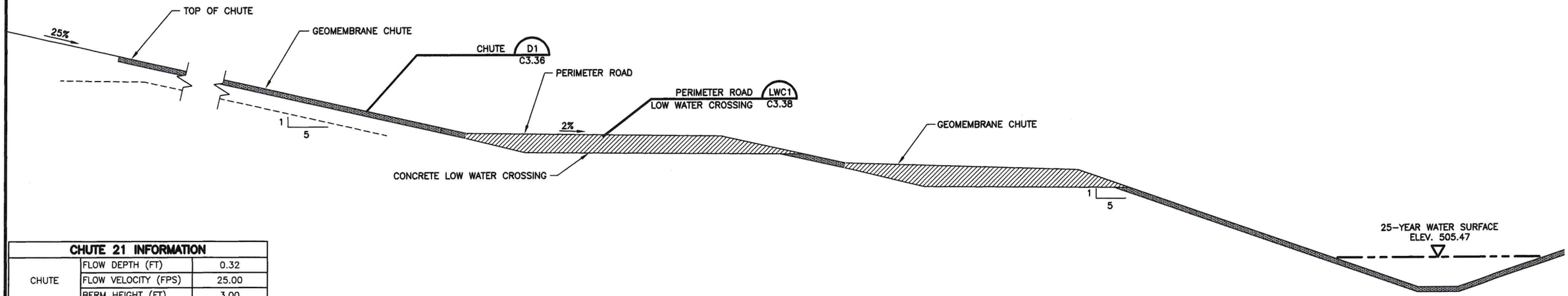


CHUTE 21 INFORMATION		
CHUTE	FLOW DEPTH (FT)	0.32
	FLOW VELOCITY (FPS)	25.00
	BERM HEIGHT (FT)	3.00
LOW-WATER CORSSING	FLOW DEPTH (FT)	0.61
	FLOW VELOCITY (FPS)	6.42
AFTER LOW-WATER CORSSING	FLOW DEPTH (FT)	0.22
	FLOW VELOCITY (FPS)	17.69

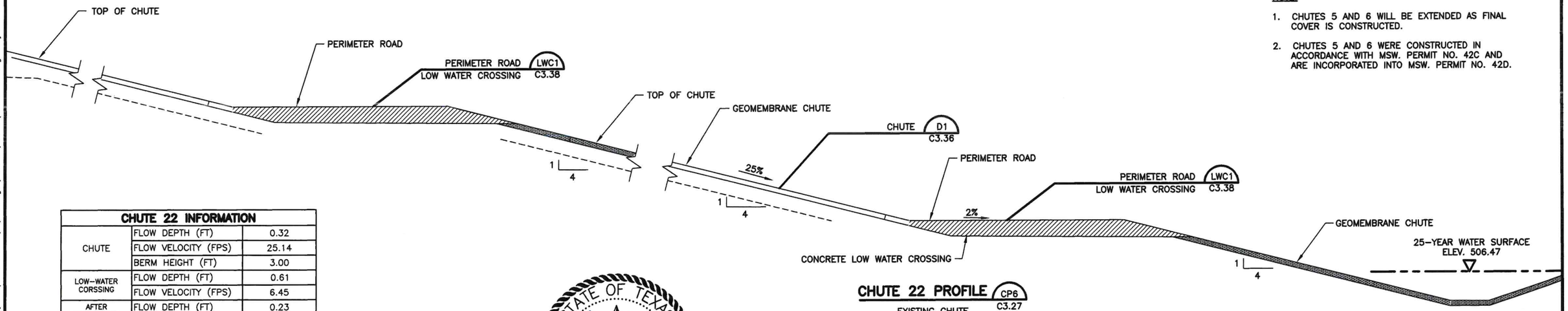
NOTE: SEE ATTACHMENT C1, APPENDIX C1.E, PAGE C1.E.20 FOR CHUTE CALCULATIONS.

CHUTE 21 PROFILE CP5 C3.27

EXISTING CHUTE

0 10 20

SCALE IN FEET



CHUTE 22 INFORMATION		
CHUTE	FLOW DEPTH (FT)	0.32
	FLOW VELOCITY (FPS)	25.14
	BERM HEIGHT (FT)	3.00
LOW-WATER CORSSING	FLOW DEPTH (FT)	0.61
	FLOW VELOCITY (FPS)	6.45
AFTER LOW-WATER CORSSING	FLOW DEPTH (FT)	0.23
	FLOW VELOCITY (FPS)	17.79

NOTE: SEE ATTACHMENT C1, APPENDIX C1.E, PAGE C1.E.20 FOR CHUTE CALCULATIONS.

CHUTE 22 PROFILE CP6 C3.27

EXISTING CHUTE

0 10 20

SCALE IN FEET

STATE OF TEXAS
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NOTE:

1. CHUTES 5 AND 6 WILL BE EXTENDED AS FINAL COVER IS CONSTRUCTED.
2. CHUTES 5 AND 6 WERE CONSTRUCTED IN ACCORDANCE WITH MSW. PERMIT NO. 42C AND ARE INCORPORATED INTO MSW. PERMIT NO. 42D.

REVISIONS			
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CHUTE 21 AND 22 PROFILES

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TBPG FIRM NO. 50222

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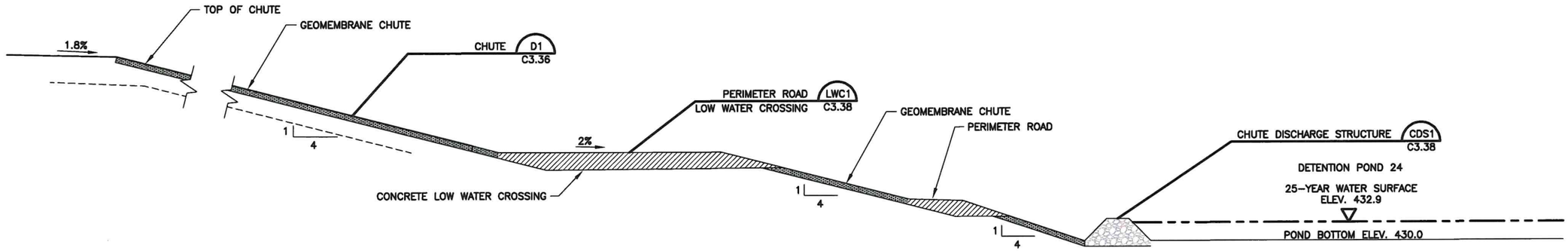
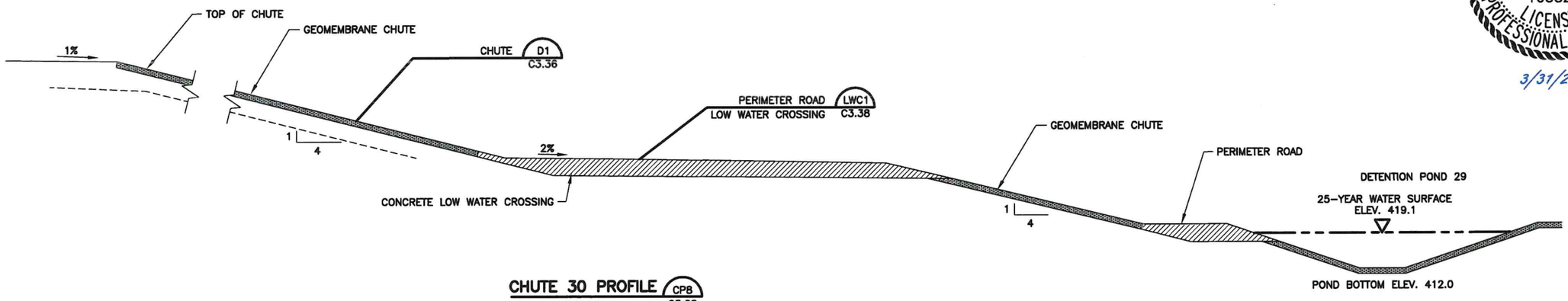


CHUTE 25 PROFILE CP7 C3.28

0 10 20
SCALE IN FEET

CHUTE 25 INFORMATION		
CHUTE	FLOW DEPTH (FT)	0.25
	FLOW VELOCITY (FPS)	21.80
	BERM HEIGHT (FT)	3.00
LOW-WATER CROSSING	FLOW DEPTH (FT)	0.63
	FLOW VELOCITY (FPS)	6.55
AFTER LOW-WATER CROSSING	FLOW DEPTH (FT)	0.26
	FLOW VELOCITY (FPS)	19.02

NOTE: SEE ATTACHMENT C1, APPENDIX C1.E, PAGE C1.E.20 FOR CHUTE CALCULATIONS.



CHUTE 30 PROFILE CP8 C3.28

0 10 20
SCALE IN FEET

CHUTE 30 INFORMATION		
CHUTE	FLOW DEPTH (FT)	0.25
	FLOW VELOCITY (FPS)	21.80
	BERM HEIGHT (FT)	3.00
LOW-WATER CROSSING	FLOW DEPTH (FT)	0.63
	FLOW VELOCITY (FPS)	6.55
AFTER LOW-WATER CROSSING	FLOW DEPTH (FT)	0.26
	FLOW VELOCITY (FPS)	19.02

NOTE: SEE ATTACHMENT C1, APPENDIX C1.E, PAGE C1.E.20 FOR CHUTE CALCULATIONS.

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CHUTE 25 AND 30 PROFILES

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817-563-1144

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TBPELS FIRM NO. F-256 AND NO. 10194895
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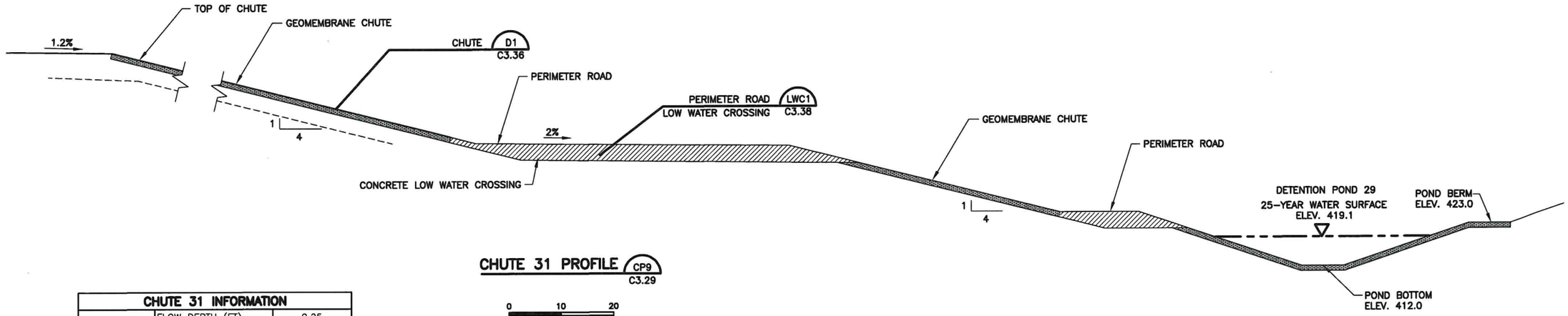
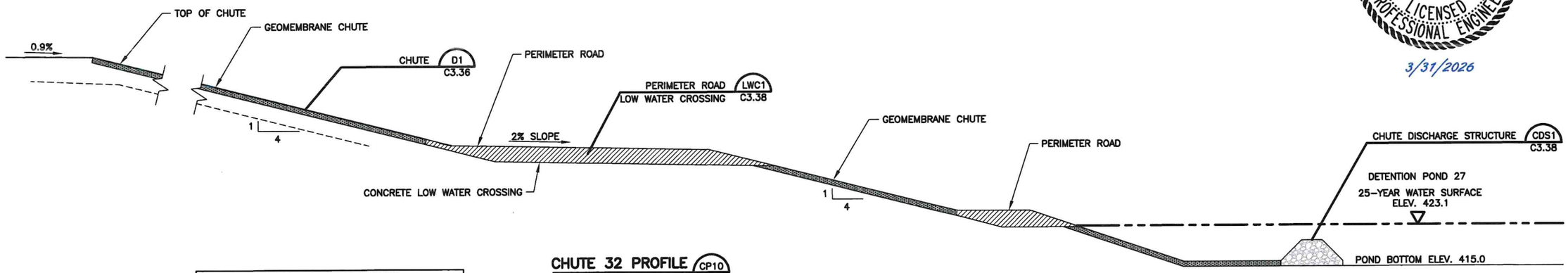


CHUTE 31 PROFILE CP9 C3.29

0 10 20
SCALE IN FEET

CHUTE 31 INFORMATION		
CHUTE	FLOW DEPTH (FT)	0.25
	FLOW VELOCITY (FPS)	22.16
	BERM HEIGHT (FT)	3.00
LOW-WATER CROSSING	FLOW DEPTH (FT)	0.64
	FLOW VELOCITY (FPS)	6.64
AFTER LOW-WATER CROSSING	FLOW DEPTH (FT)	0.26
	FLOW VELOCITY (FPS)	19.31

NOTE: SEE ATTACHMENT C1, APPENDIX C1.E, PAGE C1.E.20 FOR CHUTE CALCULATIONS.



CHUTE 32 PROFILE CP10 C3.29

0 10 20
SCALE IN FEET

CHUTE 32 INFORMATION		
CHUTE	FLOW DEPTH (FT)	0.25
	FLOW VELOCITY (FPS)	21.96
	BERM HEIGHT (FT)	3.00
LOW-WATER CROSSING	FLOW DEPTH (FT)	0.63
	FLOW VELOCITY (FPS)	6.59
AFTER LOW-WATER CROSSING	FLOW DEPTH (FT)	0.26
	FLOW VELOCITY (FPS)	19.15

NOTE: SEE ATTACHMENT C1, APPENDIX C1.E, PAGE C1.E.20 FOR CHUTE CALCULATIONS.

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CHUTE 31 AND 32 PROFILES

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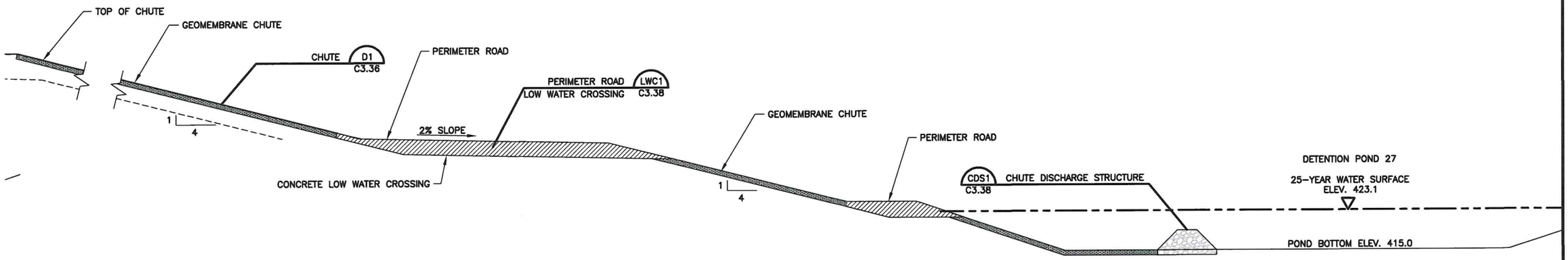
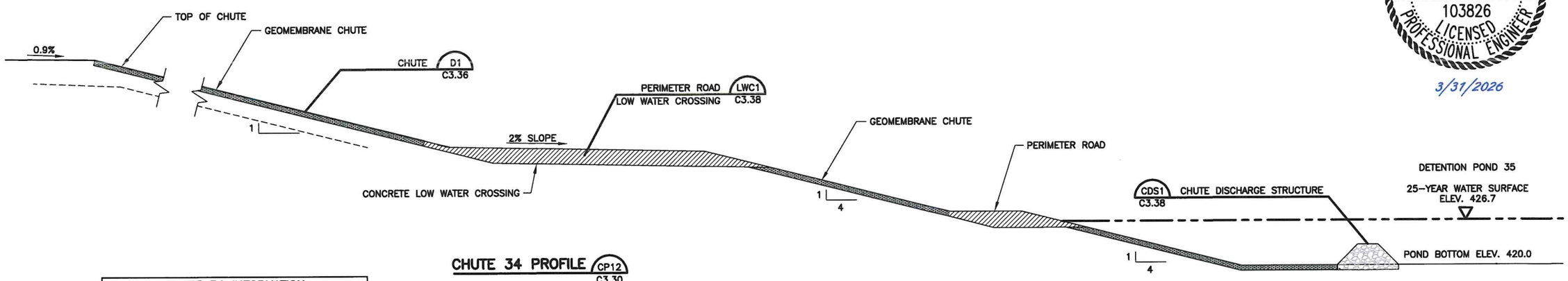


CHUTE 33 PROFILE CP11 C3.30

0 10 20
SCALE IN FEET

CHUTE 33 INFORMATION		
CHUTE	FLOW DEPTH (FT)	0.25
	FLOW VELOCITY (FPS)	22.12
	BERM HEIGHT (FT)	3.00
LOW-WATER CROSSING	FLOW DEPTH (FT)	0.64
	FLOW VELOCITY (FPS)	6.63
AFTER LOW-WATER CROSSING	FLOW DEPTH (FT)	0.26
	FLOW VELOCITY (FPS)	19.28

NOTE: SEE ATTACHMENT C1, APPENDIX C1.E, PAGE C1.E.20 FOR CHUTE CALCULATIONS.



CHUTE 34 PROFILE CP12 C3.30

0 10 20
SCALE IN FEET

CHUTE 34 INFORMATION		
CHUTE	FLOW DEPTH (FT)	0.26
	FLOW VELOCITY (FPS)	22.55
	BERM HEIGHT (FT)	3.00
LOW-WATER CROSSING	FLOW DEPTH (FT)	0.66
	FLOW VELOCITY (FPS)	6.73
AFTER LOW-WATER CROSSING	FLOW DEPTH (FT)	0.27
	FLOW VELOCITY (FPS)	19.62

NOTE: SEE ATTACHMENT C1, APPENDIX C1.E, PAGE C1.E.20 FOR CHUTE CALCULATIONS.

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CHUTE 33 AND 34 PROFILES

WASTE MANAGEMENT OF TEXAS, INC. SKYLINE LANDFILL

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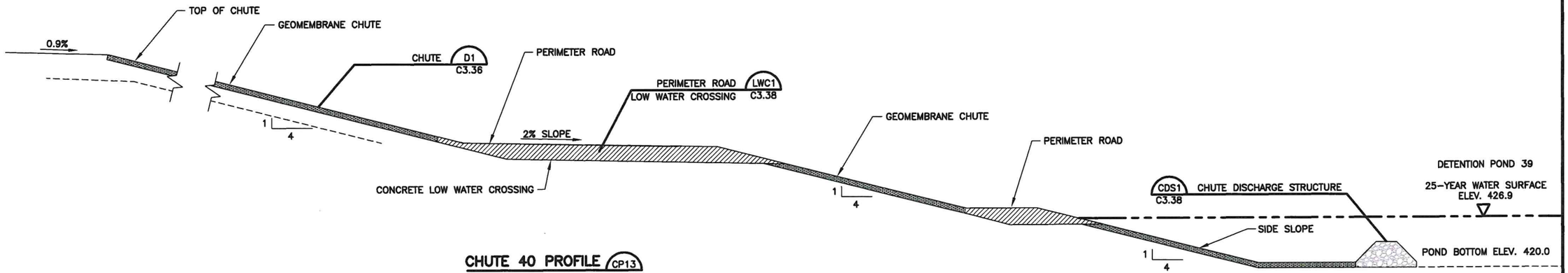

CHUTE 40 PROFILE CP13 C3.31

0 10 20
SCALE IN FEET

CHUTE 40 INFORMATION		
CHUTE	FLOW DEPTH (FT)	0.26
	FLOW VELOCITY (FPS)	22.36
	BERM HEIGHT (FT)	3.00
LOW-WATER CROSSING	FLOW DEPTH (FT)	0.65
	FLOW VELOCITY (FPS)	6.68
AFTER LOW-WATER CROSSING	FLOW DEPTH (FT)	0.27
	FLOW VELOCITY (FPS)	19.47

NOTE: SEE ATTACHMENT C1, APPENDIX C1.E, PAGE C1.E.20



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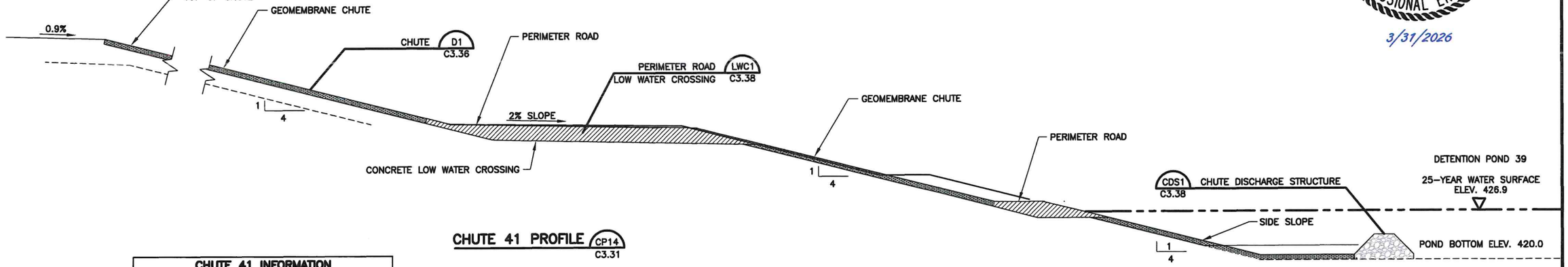

CHUTE 41 PROFILE CP14 C3.31

0 10 20
SCALE IN FEET

CHUTE 41 INFORMATION		
CHUTE	FLOW DEPTH (FT)	0.25
	FLOW VELOCITY (FPS)	21.84
	BERM HEIGHT (FT)	3.00
LOW-WATER CROSSING	FLOW DEPTH (FT)	0.63
	FLOW VELOCITY (FPS)	5.56
AFTER LOW-WATER CROSSING	FLOW DEPTH (FT)	0.26
	FLOW VELOCITY (FPS)	19.05

NOTE: SEE ATTACHMENT C1, APPENDIX C1.E, PAGE C1.E.20 FOR CHUTE CALCULATIONS.

REVISIONS			
REV	DATE	DESCRIPTION	DWN BY

CHUTE 40 AND 41 PROFILES

WASTE MANAGEMENT OF TEXAS, INC. SKYLINE LANDFILL

BIGGS & MATHEWS ENVIRONMENTAL
1700 ROBERT ROAD, STE. 100
MANSFIELD, TEXAS 76063
817-563-1144

TBPELS FIRM NO. F-256 AND NO. 10194895
TBPG FIRM NO. 50222

DRAWING C3.31

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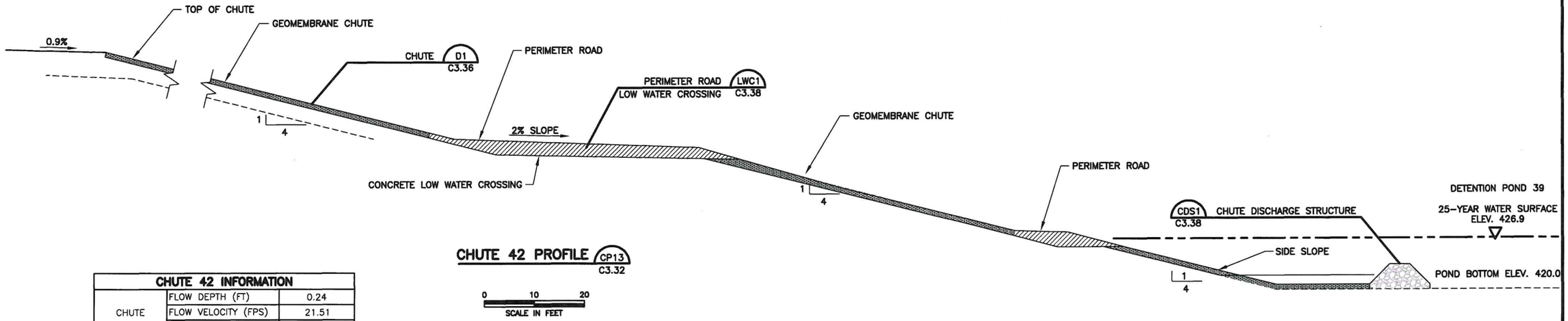
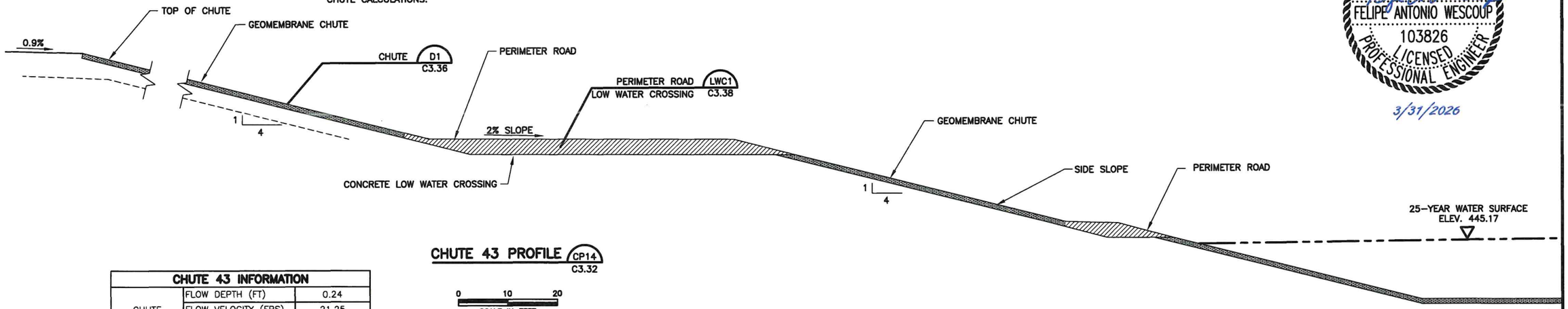


CHUTE 42 PROFILE CP13 C3.32

0 10 20
SCALE IN FEET

CHUTE 42 INFORMATION		
CHUTE	FLOW DEPTH (FT)	0.24
	FLOW VELOCITY (FPS)	21.51
	BERM HEIGHT (FT)	3.00
LOW-WATER CROSSING	FLOW DEPTH (FT)	0.62
	FLOW VELOCITY (FPS)	6.48
AFTER LOW-WATER CROSSING	FLOW DEPTH (FT)	0.25
	FLOW VELOCITY (FPS)	18.79

NOTE: SEE ATTACHMENT C1, APPENDIX C1.E, PAGE C1.E.20 FOR CHUTE CALCULATIONS.



CHUTE 43 PROFILE CP14 C3.32

0 10 20
SCALE IN FEET

CHUTE 43 INFORMATION		
CHUTE	FLOW DEPTH (FT)	0.24
	FLOW VELOCITY (FPS)	21.25
	BERM HEIGHT (FT)	3.00
LOW-WATER CROSSING	FLOW DEPTH (FT)	0.61
	FLOW VELOCITY (FPS)	6.62
AFTER LOW-WATER CROSSING	FLOW DEPTH (FT)	0.25
	FLOW VELOCITY (FPS)	18.59

NOTE: SEE ATTACHMENT C1, APPENDIX C1.E, PAGE C1.E.20 FOR CHUTE CALCULATIONS.

STATE OF TEXAS
FELIPE ANTONIO WESCOUP
103826
LICENSED PROFESSIONAL ENGINEER
3/31/2026

CHUTE 42 AND 43 PROFILES

WASTE MANAGEMENT OF TEXAS, INC. SKYLINE LANDFILL

BIGGS & MATHEWS ENVIRONMENTAL
1700 ROBERT ROAD, STE. 100
MANSFIELD, TEXAS 76063
817-563-1144
TBPELS FIRM NO. F-256 AND NO. 10194895
TBPG FIRM NO. 50222

REVISIONS			
REV	DATE	DESCRIPTION	DWN BY

DRAWING C3.32

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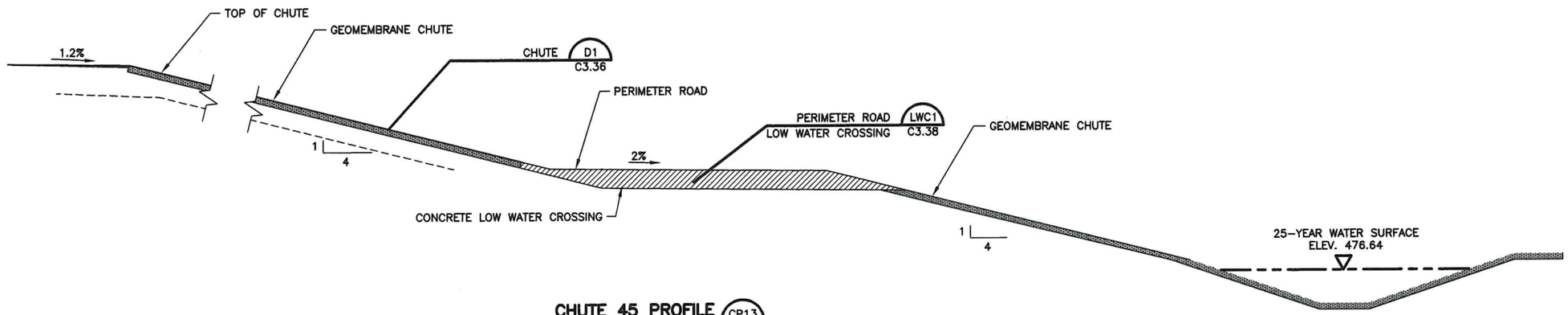
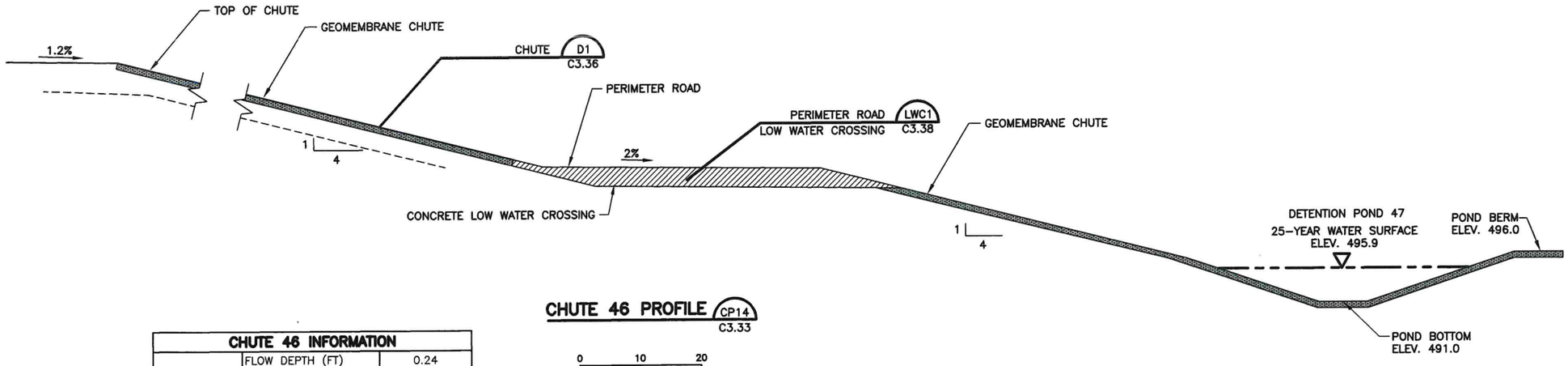


CHUTE 45 PROFILE CP13 C3.33

0 10 20
SCALE IN FEET

CHUTE 45 INFORMATION		
CHUTE	FLOW DEPTH (FT)	0.24
	FLOW VELOCITY (FPS)	21.25
	BERM HEIGHT (FT)	3.00
LOW-WATER CROSSING	FLOW DEPTH (FT)	0.61
	FLOW VELOCITY (FPS)	6.42
AFTER LOW-WATER CROSSING	FLOW DEPTH (FT)	0.25
	FLOW VELOCITY (FPS)	18.59

NOTE: SEE ATTACHMENT C1, APPENDIX C1.E, PAGE C1.E.20 FOR CHUTE CALCULATIONS.



CHUTE 46 PROFILE CP14 C3.33

0 10 20
SCALE IN FEET

CHUTE 46 INFORMATION		
CHUTE	FLOW DEPTH (FT)	0.24
	FLOW VELOCITY (FPS)	21.46
	BERM HEIGHT (FT)	3.00
LOW-WATER CROSSING	FLOW DEPTH (FT)	0.61
	FLOW VELOCITY (FPS)	6.47
AFTER LOW-WATER CROSSING	FLOW DEPTH (FT)	0.25
	FLOW VELOCITY (FPS)	18.76

NOTE: SEE ATTACHMENT C1, APPENDIX C1.E, PAGE C1.E.20 FOR CHUTE CALCULATIONS.

STATE OF TEXAS
FELIPE ANTONIO WESCOUP
103826
LICENSED PROFESSIONAL ENGINEER
3/31/2026

CHUTE 45 AND 46 PROFILES

WASTE MANAGEMENT OF TEXAS, INC.
SKYLINE LANDFILL

BIGGS & MATHEWS ENVIRONMENTAL
1700 ROBERT ROAD, STE. 100
MANSFIELD, TEXAS 76063
817-563-1144

TBPELS FIRM NO. F-256 AND NO. 10194895
TBPG FIRM NO. 50222

DRAWING C3.33

REVISIONS			
REV	DATE	DESCRIPTION	DWN BY

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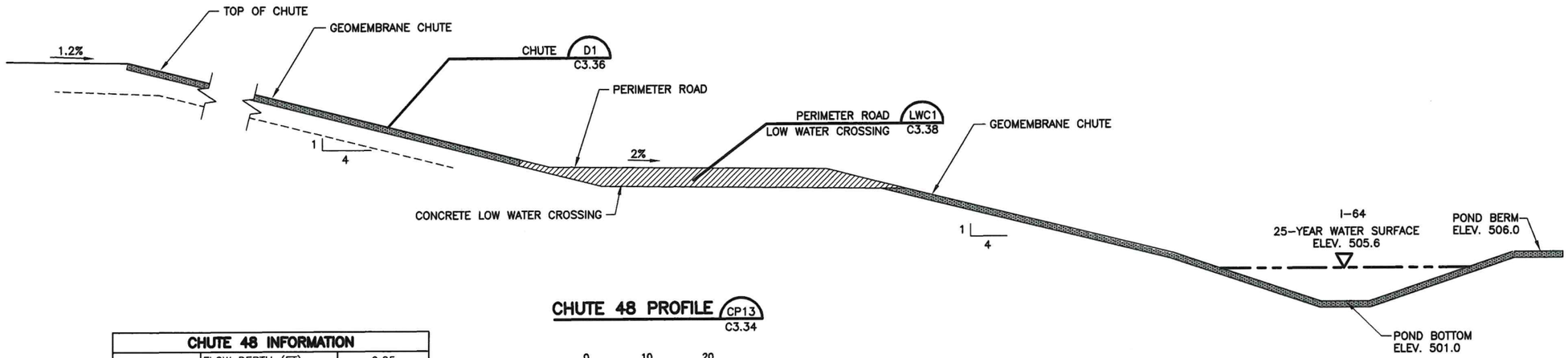
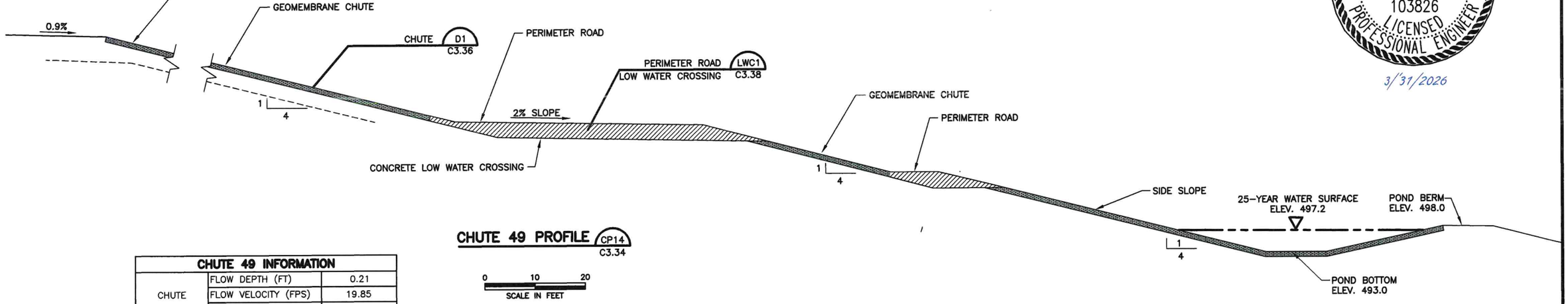


CHUTE 48 PROFILE CP13 C3.34

0 10 20
SCALE IN FEET

CHUTE 48 INFORMATION		
CHUTE	FLOW DEPTH (FT)	0.25
	FLOW VELOCITY (FPS)	21.75
	BERM HEIGHT (FT)	3.00
LOW-WATER CROSSING	FLOW DEPTH (FT)	0.63
	FLOW VELOCITY (FPS)	6.54
AFTER LOW-WATER CROSSING	FLOW DEPTH (FT)	0.26
	FLOW VELOCITY (FPS)	18.99

NOTE: SEE ATTACHMENT C1, APPENDIX C1.E, PAGE C1.E.20 FOR CHUTE CALCULATIONS.



CHUTE 49 PROFILE CP14 C3.34

0 10 20
SCALE IN FEET

CHUTE 49 INFORMATION		
CHUTE	FLOW DEPTH (FT)	0.21
	FLOW VELOCITY (FPS)	19.85
	BERM HEIGHT (FT)	3.00
LOW-WATER CROSSING	FLOW DEPTH (FT)	0.55
	FLOW VELOCITY (FPS)	6.07
AFTER LOW-WATER CROSSING	FLOW DEPTH (FT)	0.22
	FLOW VELOCITY (FPS)	17.45

NOTE: SEE ATTACHMENT C1, APPENDIX C1.E, PAGE C1.E.20 FOR CHUTE CALCULATIONS.

STATE OF TEXAS
FELIPE ANTONIO WESCOUP
103826
LICENSED
PROFESSIONAL ENGINEER
3/31/2026

CHUTE 48 AND 49 PROFILES

WASTE MANAGEMENT OF TEXAS, INC.
SKYLINE LANDFILL

BIGGS & MATHEWS ENVIRONMENTAL
1700 ROBERT ROAD, STE. 100
MANSFIELD, TEXAS 76063
817-563-1144

TBPELS FIRM NO. F-256 AND NO. 10194895
TBPG FIRM NO. 50222

DRAWING C3.34

REVISIONS			
REV	DATE	DESCRIPTION	DWN BY

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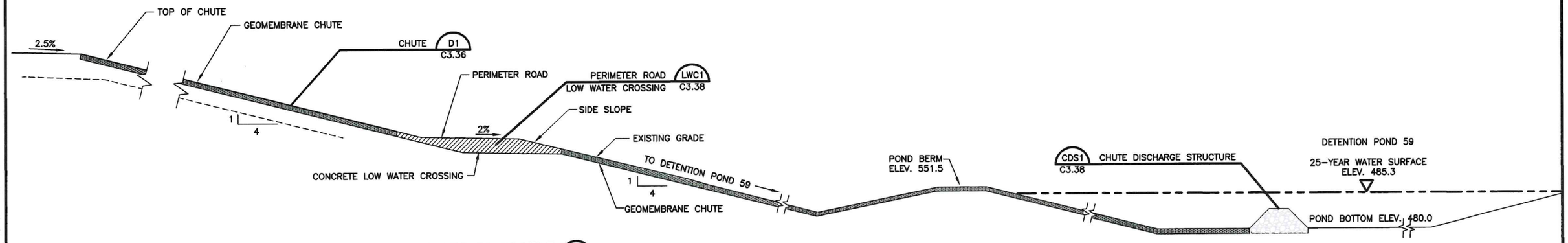

CHUTE 58 PROFILE CP15 C3.35

CHUTE 58 INFORMATION		
CHUTE	FLOW DEPTH (FT)	0.25
	FLOW VELOCITY (FPS)	21.67
	BERM HEIGHT (FT)	3.00
LOW-WATER CROSSING	FLOW DEPTH (FT)	0.62
	FLOW VELOCITY (FPS)	6.52
AFTER LOW-WATER CROSSING	FLOW DEPTH (FT)	0.26
	FLOW VELOCITY (FPS)	18.92

NOTE: SEE ATTACHMENT C1, APPENDIX C1.E, PAGE C1.E.20 FOR CHUTE CALCULATIONS.

0 10 20
SCALE IN FEET

STATE OF TEXAS
FELIPE ANTONIO WESCOUP
103826
LICENSED
PROFESSIONAL ENGINEER
3/31/2026

REVISIONS			
REV	DATE	DESCRIPTION	DWN BY

CHUTE 58 PROFILE

WASTE MANAGEMENT OF TEXAS, INC.
SKYLINE LANDFILL

BIGGS & MATHEWS ENVIRONMENTAL
1700 ROBERT ROAD, STE. 100
MANSFIELD, TEXAS 76063
817-563-1144

TBPELS FIRM NO. F-256 AND NO. 10194895
TBPG FIRM NO. 50222

DRAWING C3.35

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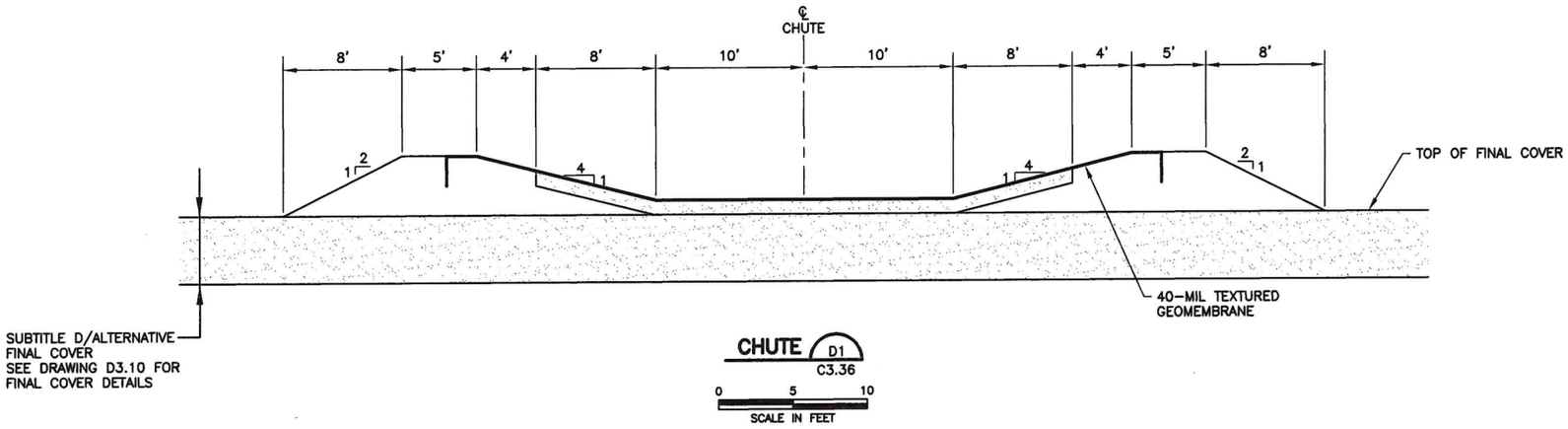
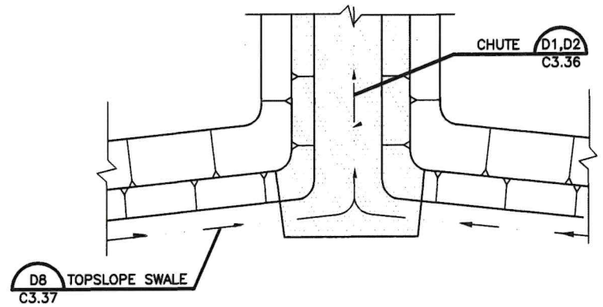


CHUTE D1 C3.36

0 5 10

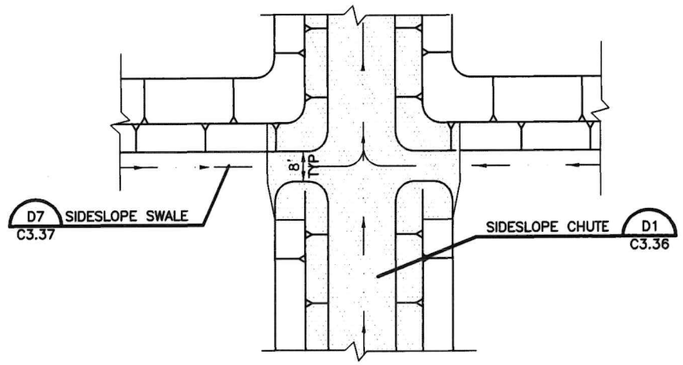
SCALE IN FEET



SWALE/CHUTE TOPSLOPE CONFLUENCE D4 C3.36

0 5 10

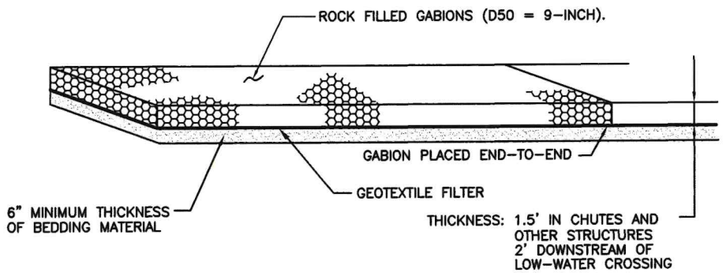
SCALE IN FEET



SWALE/CHUTE SIDESLOPE CONFLUENCE D5 C3.36

0 5 10

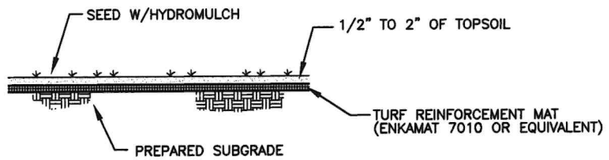
SCALE IN FEET



GABIONS (RENO MATTRESS) D3 C3.36

0 2 4

SCALE IN FEET



TURF REINFORCEMENT MATTING (TYP) D6 C3.36

NTS

STATE OF TEXAS
FELIPE ANTONIO WESCOUP
103826
LICENSED
PROFESSIONAL ENGINEER

3/31/2026

REVISIONS			
REV	DATE	DESCRIPTION	DWN BY

DRAINAGE DETAILS

WASTE MANAGEMENT OF TEXAS, INC.
SKYLINE LANDFILL

BIGGS & MATHEWS ENVIRONMENTAL
1700 ROBERT ROAD, STE. 100
MANSFIELD, TEXAS 76063
817-563-1144

TBPELS FIRM NO. F-256 AND NO. 10194895
TBPG FIRM NO. 50222

DRAWING
C3.36

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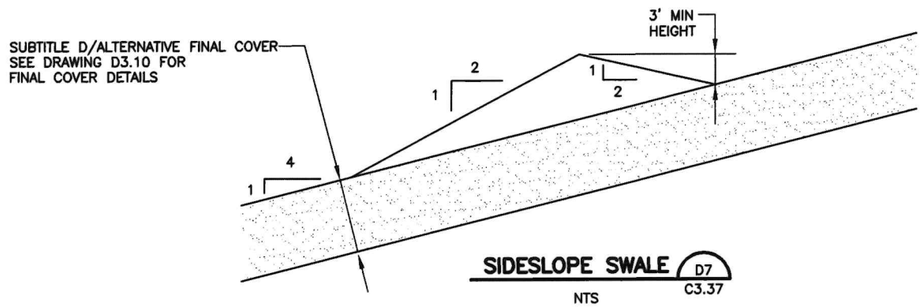
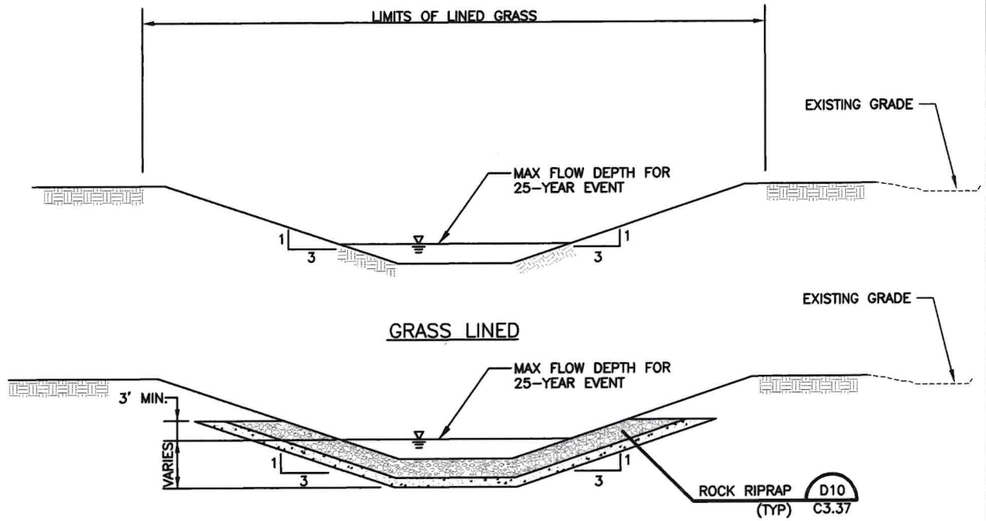


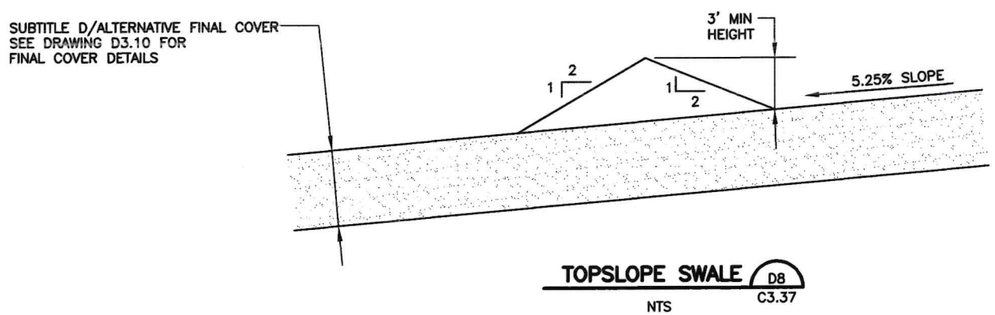
SIDESLOPE SWALE D7 C3.37

NTS



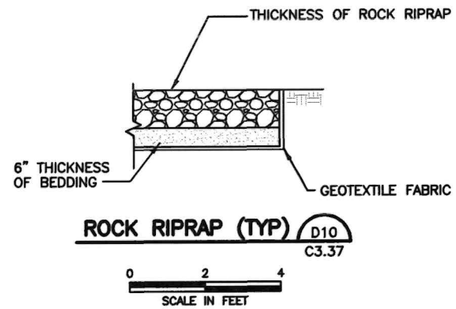
TRAPEZOIDAL DITCH D9 C3.37

NTS



TOPSLOPE SWALE D8 C3.37

NTS



ROCK RIPRAP (TYP) D10 C3.37

0 2 4

SCALE IN FEET

STATE OF TEXAS
FELIPE ANTONIO WESCOUP
103826
LICENSED
PROFESSIONAL ENGINEER

3/31/2026

DRAINAGE DETAILS

WASTE MANAGEMENT OF TEXAS, INC.
SKYLINE LANDFILL

BIGGS & MATHEWS ENVIRONMENTAL
1700 ROBERT ROAD, STE. 100
MANSFIELD, TEXAS 76063
817-563-1144

TBPELS FIRM NO. F-256 AND NO. 10194895

TBPG FIRM NO. 50222

DRAWING C3.37

REVISIONS			
REV	DATE	DESCRIPTION	DWN BY

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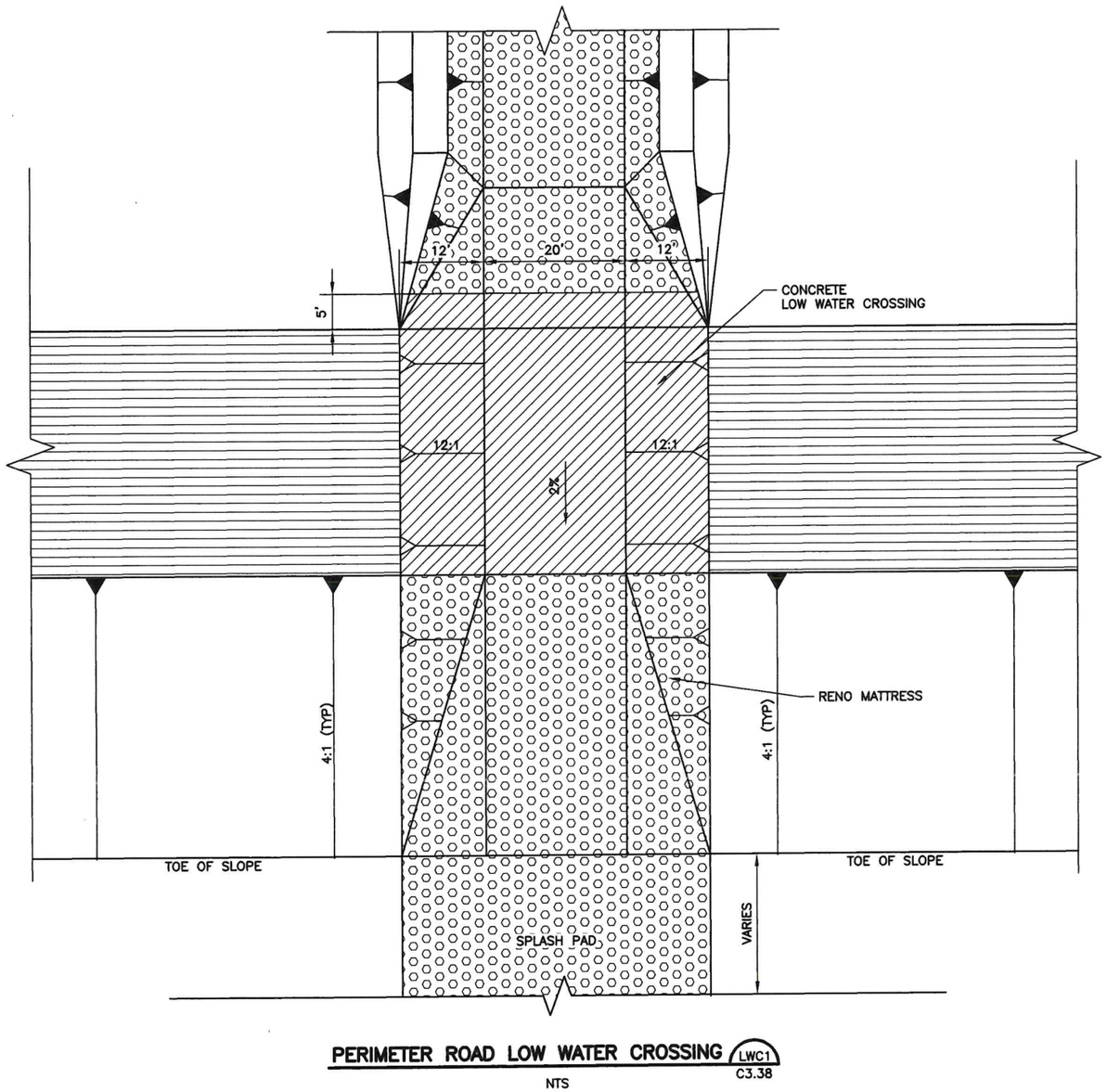
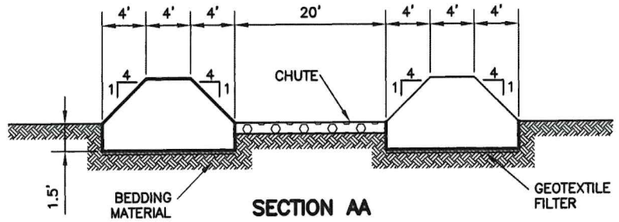
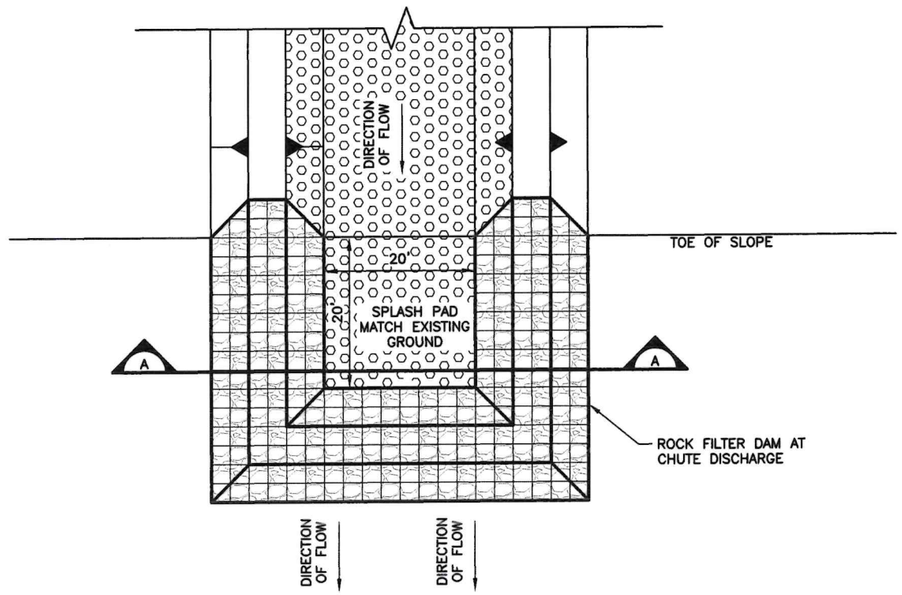


PERIMETER ROAD LOW WATER CROSSING LWC1 C3.38

NTS



SECTION AA



CHUTE DISCHARGE STRUCTURE CDS1 C3.38

NTS

NOTE: CHUTE 13 WILL INCLUDE A LOW WATER CROSSING DISCHARGE.

STATE OF TEXAS
FELIPE ANTONIO WESCOUP
103826
LICENSED
PROFESSIONAL ENGINEER

3/31/2026

REVISIONS			
REV	DATE	DESCRIPTION	DWN BY

PERIMETER ROAD
LOW WATER CROSSING

WASTE MANAGEMENT OF TEXAS, INC.
SKYLINE LANDFILL

BIGGS & MATHEWS ENVIRONMENTAL
1700 ROBERT ROAD, STE. 100
MANSFIELD, TEXAS 76063
817-563-1144

TBPELS FIRM NO. F-256 AND NO. 10194895
TBPG FIRM NO. 50222

DRAWING
C3.38

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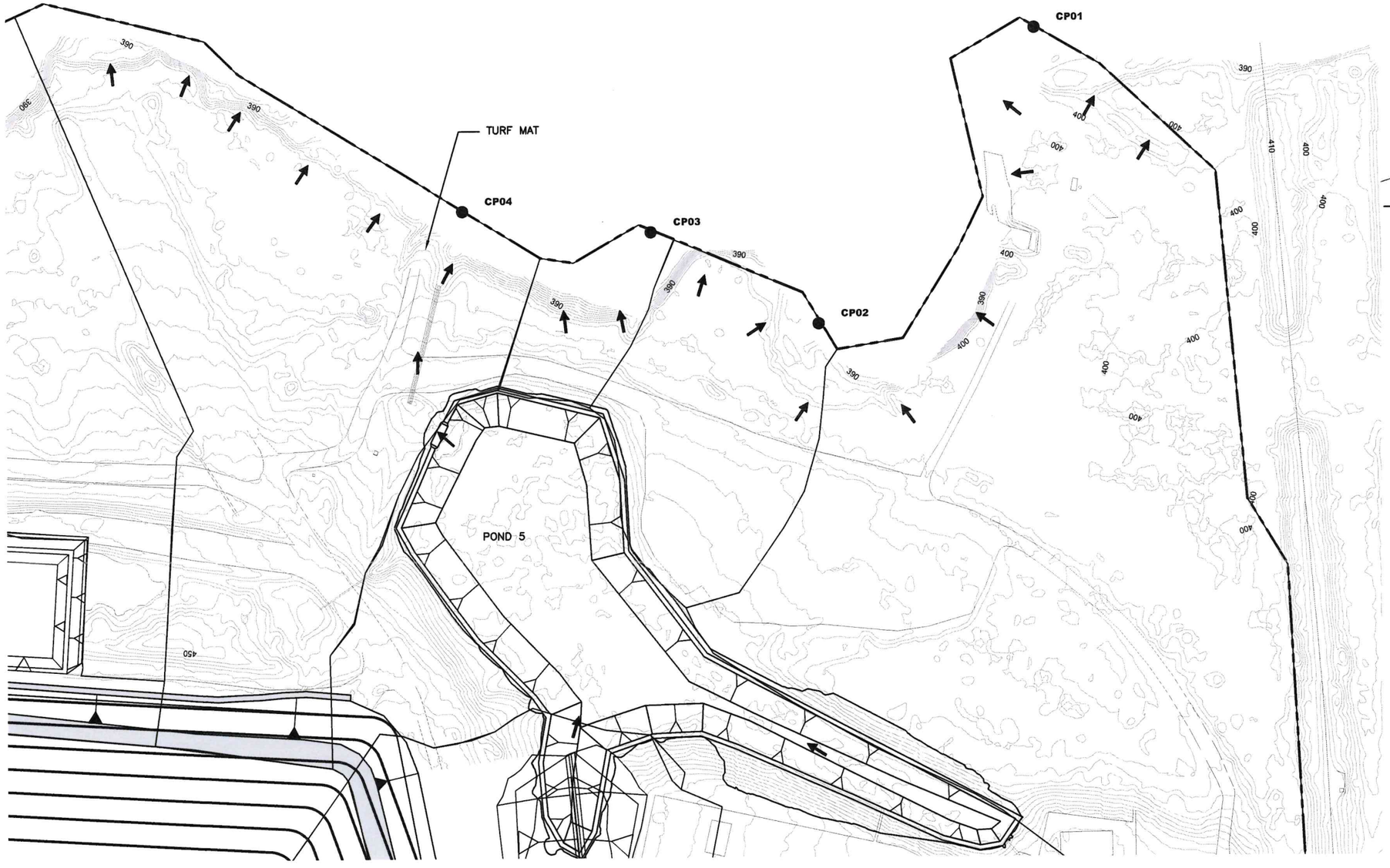

0 100 200
SCALE IN FEET

LEGEND

400 EXISTING 2' GROUND CONTOUR

500 PROPOSED 10' FINAL COVER CONTOUR

COMPARISON POINT

FLOW DIRECTION

NOTES:

1. EXISTING CONTOURS COMPILED BY HYDREX DRONE DIVISION, FROM AERIAL SURVEY FLOWN MARCH 5, 2025.
2. PERMIT BOUNDARY NOT SHOWN FOR CLARITY.

STATE OF TEXAS
FELIPE ANTONIO WESCOUP
103826
LICENSED
PROFESSIONAL ENGINEER

3/31/2026

REVISIONS			
REV	DATE	DESCRIPTION	DWN BY

CP-1 THROUGH CP-4

WASTE MANAGEMENT OF TEXAS, INC.
SKYLINE LANDFILL

BIGGS & MATHEWS ENVIRONMENTAL
1700 ROBERT ROAD, STE. 100
MANSFIELD, TEXAS 76063
817-563-1144

TBPELS FIRM NO. F-256 AND NO. 10194895
TBPG FIRM NO. 50222

DRAWING
C3.39

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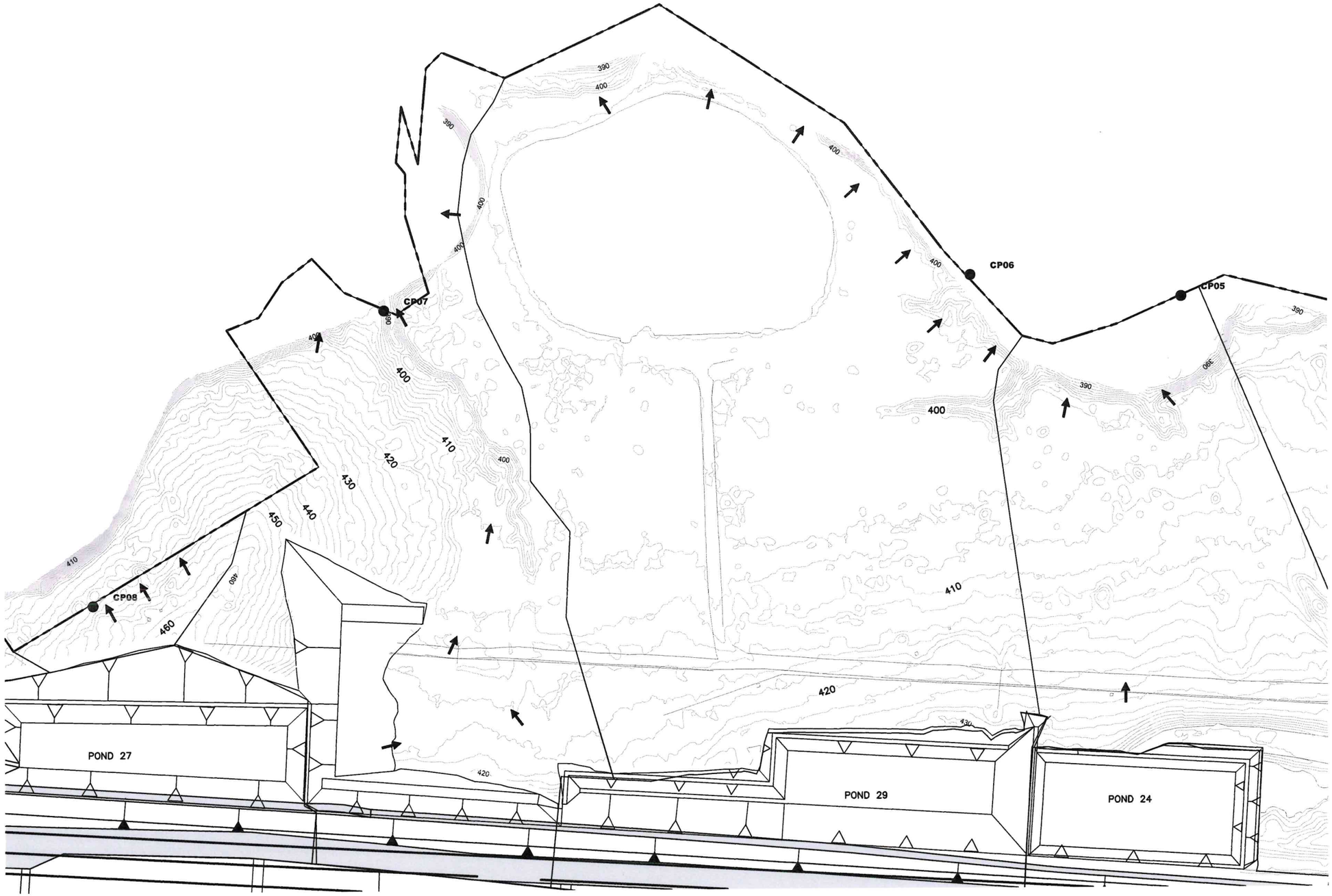

0 100 200
SCALE IN FEET

LEGEND

420 EXISTING 2' GROUND CONTOUR

COMPARISON POINT

FLOW DIRECTION

NOTES:

1. EXISTING CONTOURS COMPILED BY HYDREX DRONE DIVISION, FROM AERIAL SURVEY FLOWN MARCH 5, 2025.
2. PERMIT BOUNDARY NOT SHOWN FOR CLARITY.

STATE OF TEXAS
FELIPE ANTONIO WESCOUP
103826
LICENSED
PROFESSIONAL ENGINEER

3/31/2026

CP-5 THROUGH CP-7

WASTE MANAGEMENT OF TEXAS, INC. SKYLINE LANDFILL

REVISIONS			
REV	DATE	DESCRIPTION	DWN BY

BIGGS & MATHEWS ENVIRONMENTAL
1700 ROBERT ROAD, STE. 100
MANSFIELD, TEXAS 76063
817-563-1144

TBPELS FIRM NO. F-256 AND NO. 10194895
TBPG FIRM NO. 50222

DRAWING
C3.40

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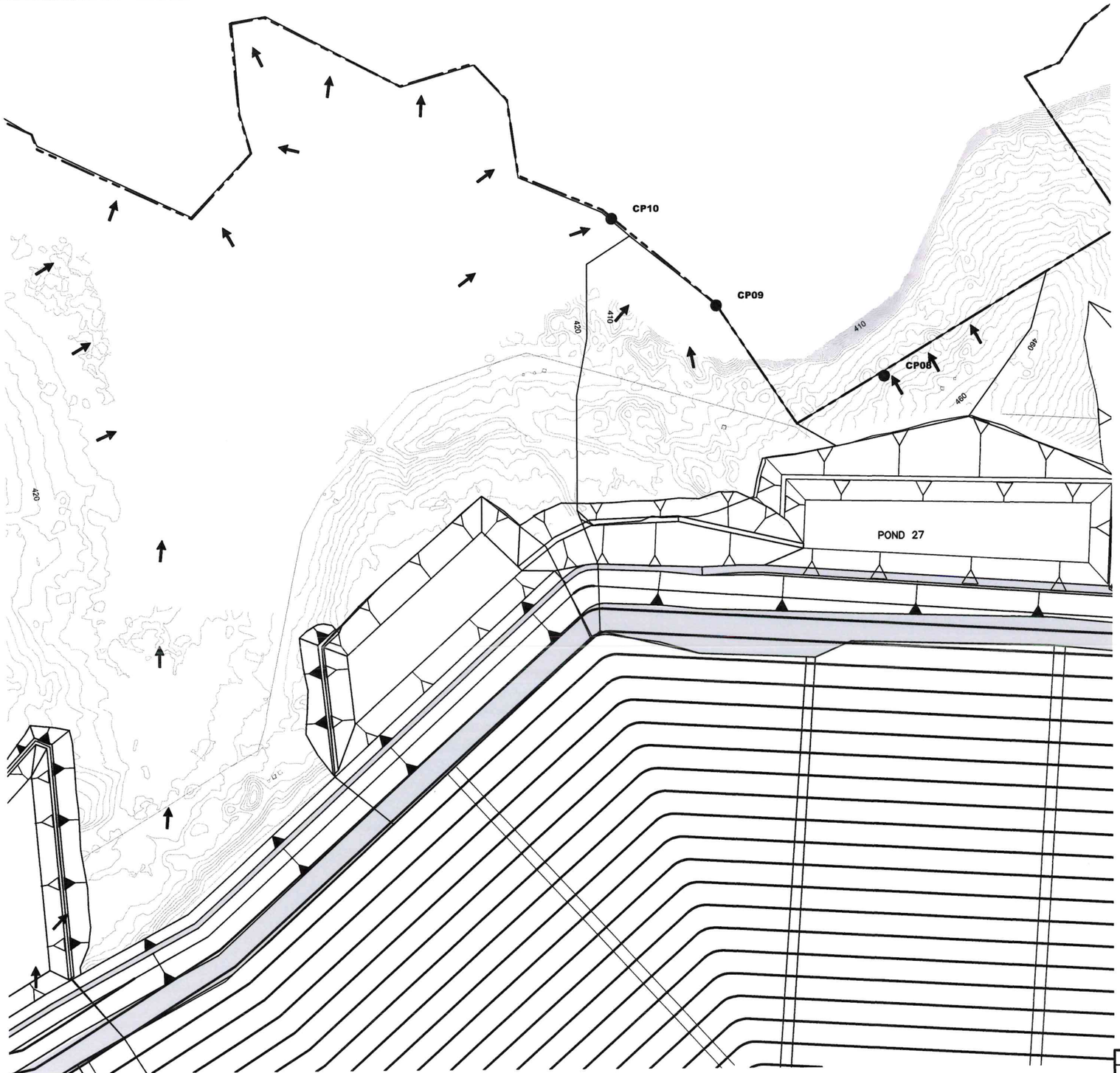

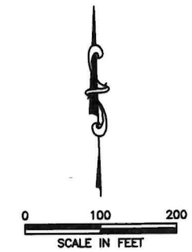

LEGEND

420 — EXISTING 2' GROUND CONTOUR

● COMPARISON POINT

→ FLOW DIRECTION

NOTES:

1. EXISTING CONTOURS COMPILED BY HYDREX DRONE DIVISION, FROM AERIAL SURVEY FLOWN MARCH 5, 2025.
2. PERMIT BOUNDARY NOT SHOWN FOR CLARITY.

STATE OF TEXAS
FELIPE ANTONIO WESCOUP
103826
LICENSED
PROFESSIONAL ENGINEER

3/31/2026

REVISIONS			
REV	DATE	DESCRIPTION	DWN BY

CP-8 THROUGH CP-10

WASTE MANAGEMENT OF TEXAS, INC. SKYLINE LANDFILL

BIGGS & MATHEWS ENVIRONMENTAL
1700 ROBERT ROAD, STE. 100
MANSFIELD, TEXAS 76063
817-563-1144

TBPELS FIRM NO. F-256 AND NO. 10194895
TBPG FIRM NO. 50222

DRAWING
C3.41

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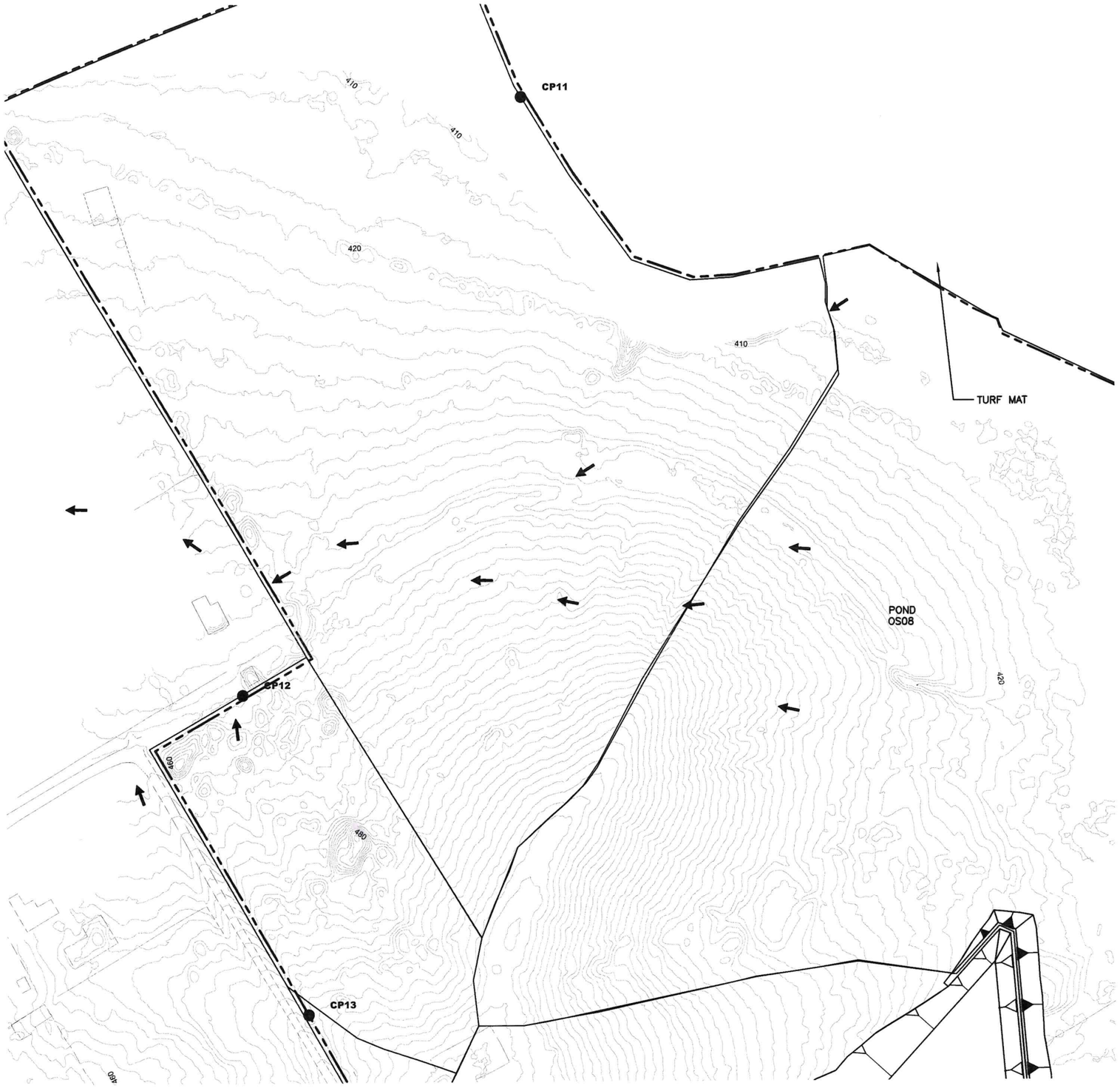

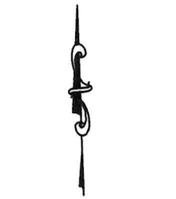

LEGEND

460 — EXISTING 2' GROUND CONTOUR

● COMPARISON POINT

→ FLOW DIRECTION

NOTES:

1. EXISTING CONTOURS COMPILED BY HYDREX DRONE DIVISION, FROM AERIAL SURVEY FLOWN MARCH 5, 2025.
2. PERMIT BOUNDARY NOT SHOWN FOR CLARITY.



3/31/2026

REVISIONS			
REV	DATE	DESCRIPTION	DWN BY

CP-11 THROUGH CP-13

WASTE MANAGEMENT OF TEXAS, INC.
SKYLINE LANDFILL

BIGGS & MATHEWS ENVIRONMENTAL
1700 ROBERT ROAD, STE. 100
MANSFIELD, TEXAS 76063
817-563-1144

TBPELS FIRM NO. F-256 AND NO. 10194895
TBPG FIRM NO. 50222

DRAWING
C3.42

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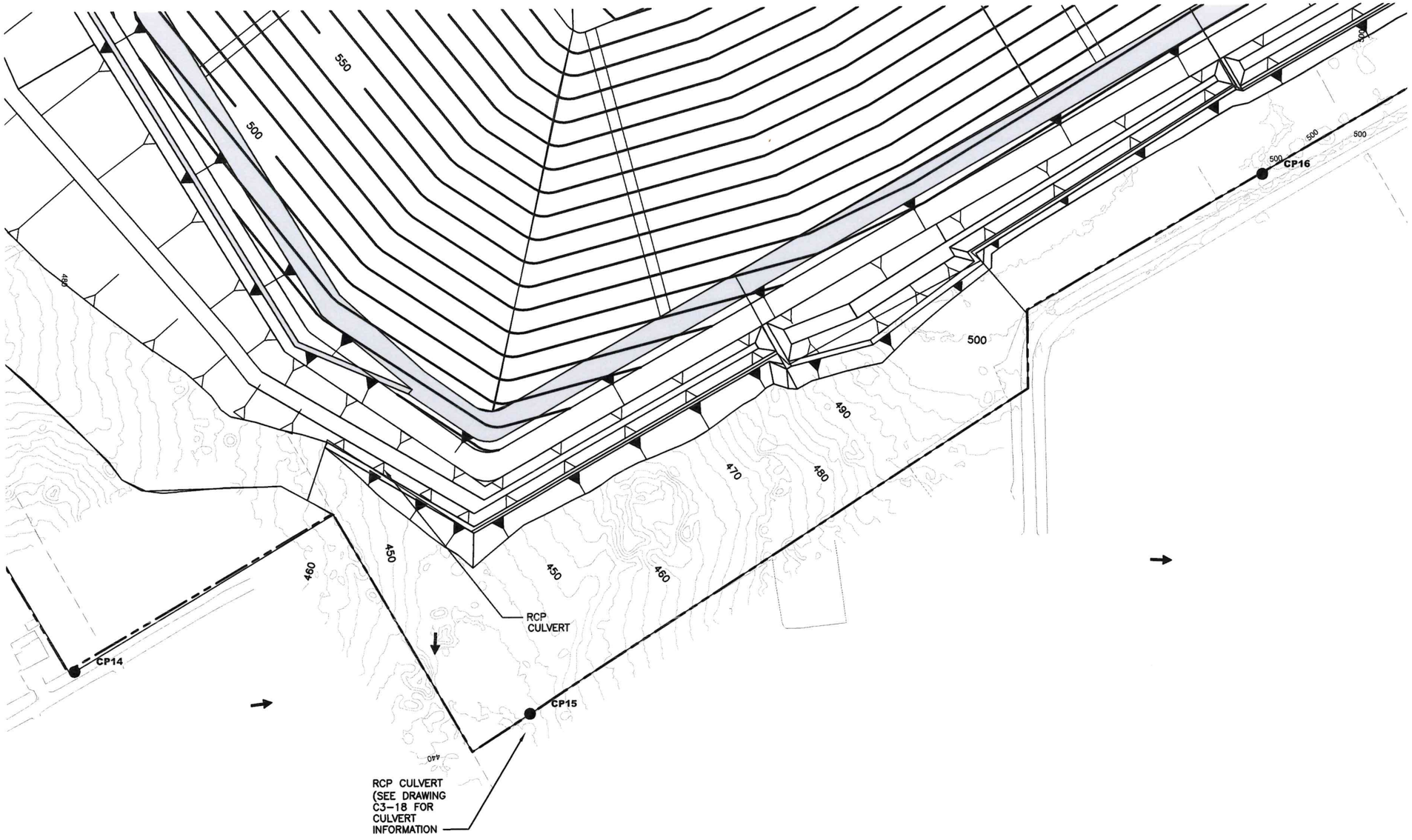

0 100 200
SCALE IN FEET

LEGEND

500 EXISTING 2' GROUND CONTOUR

COMPARISON POINT

FLOW DIRECTION

NOTES:

1. EXISTING CONTOURS COMPILED BY HYDREX DRONE DIVISION, FROM AERIAL SURVEY FLOWN MARCH 5, 2025.
2. PERMIT BOUNDARY NOT SHOWN FOR CLARITY.

STATE OF TEXAS
FELIPE ANTONIO WESCOUP
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3/31/2026

CP-14 THROUGH CP-16

WASTE MANAGEMENT OF TEXAS, INC.
SKYLINE LANDFILL

REVISIONS			
REV	DATE	DESCRIPTION	DWN BY

BIGGS & MATHEWS ENVIRONMENTAL
1700 ROBERT ROAD, STE. 100
MANSFIELD, TEXAS 76063
817-563-1144

TBPELS FIRM NO. F-256 AND NO. 10194895
TBPG FIRM NO. 50222

DRAWING
C3.43

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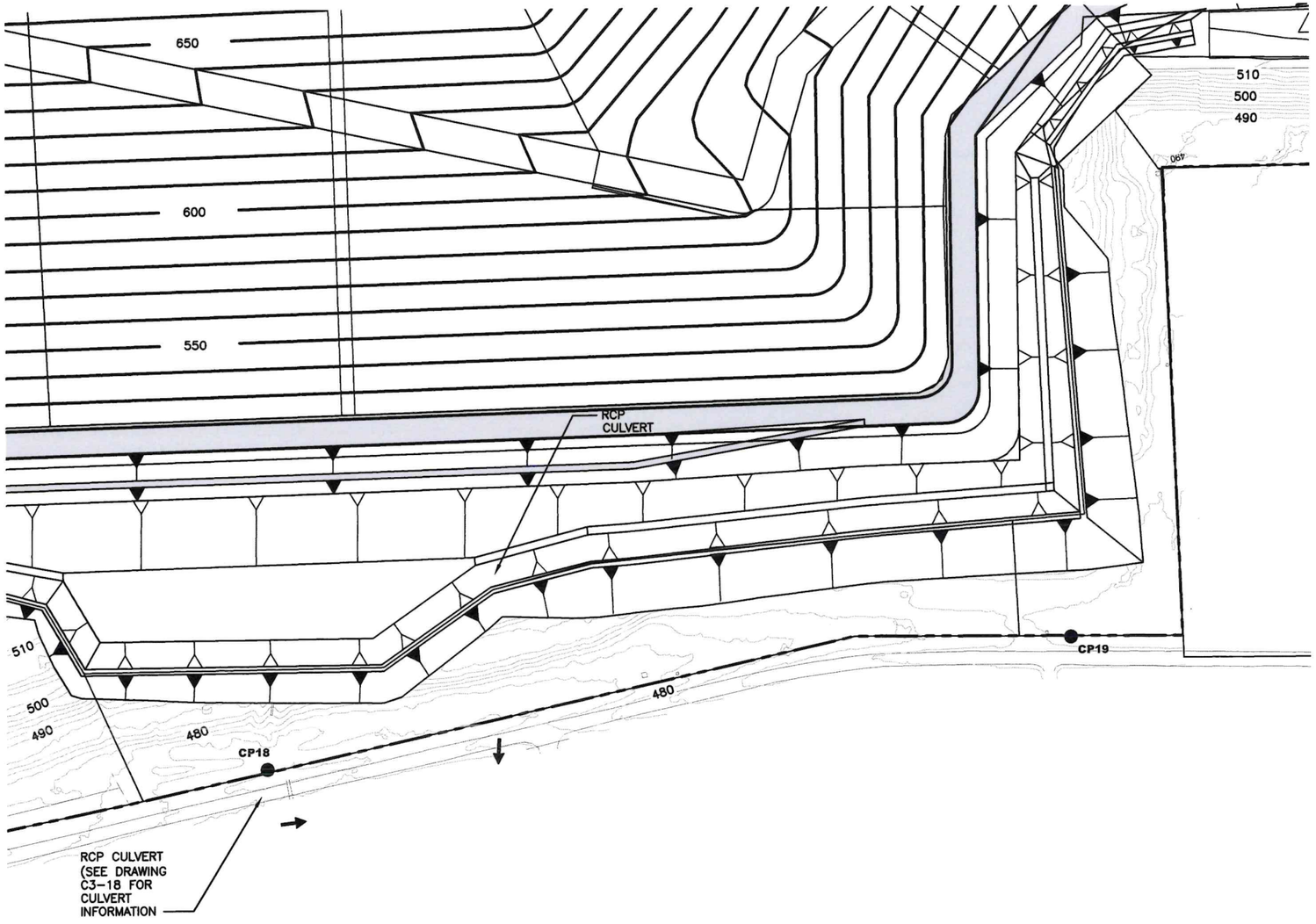

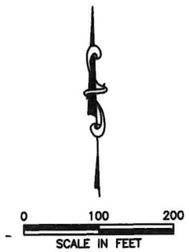

LEGEND

500 — EXISTING 2' GROUND CONTOUR

COMPARISON POINT

FLOW DIRECTION

NOTES:

1. EXISTING CONTOURS COMPILED BY HYDREX DRONE DIVISION, FROM AERIAL SURVEY FLOWN MARCH 5, 2025.
2. PERMIT BOUNDARY NOT SHOWN FOR CLARITY.

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CP-18 AND CP-19

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TBPG FIRM NO. 50222

DRAWING
C3.44

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LEGEND

460 — EXISTING 2' GROUND CONTOUR

● COMPARISON POINT

→ FLOW DIRECTION

NOTES:

1. EXISTING CONTOURS COMPILED BY HYDREX DRONE DIVISION, FROM AERIAL SURVEY FLOWN MARCH 5, 2025.
2. PERMIT BOUNDARY NOT SHOWN FOR CLARITY.

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CP-20 THROUGH CP-24

WASTE MANAGEMENT OF TEXAS, INC.
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TBPG FIRM NO. 50222

DRAWING C3.45

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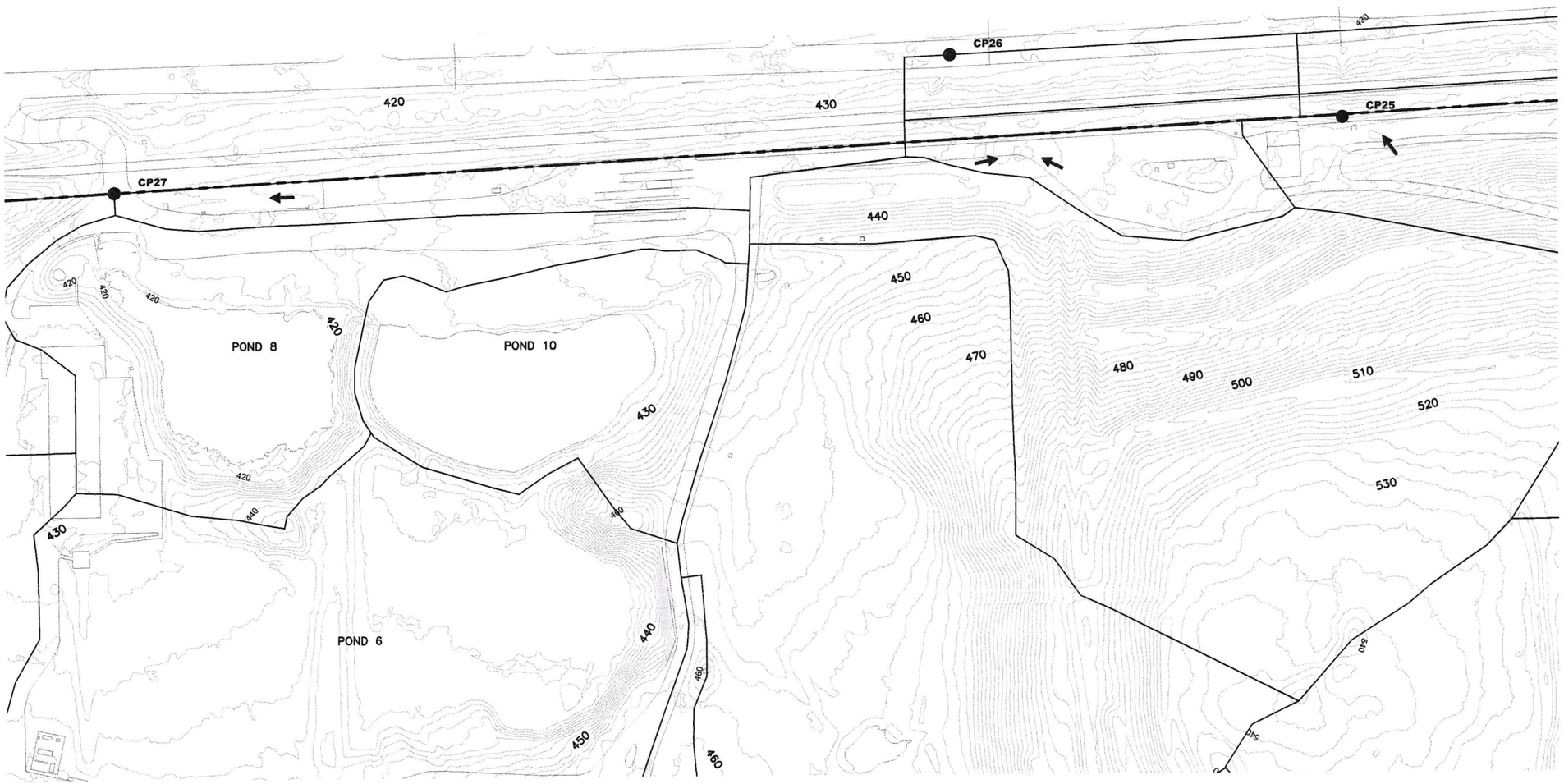

0 100 200
SCALE IN FEET

LEGEND

COMPARISON POINT

FLOW DIRECTION

NOTES:

1. EXISTING CONTOURS COMPILED BY HYDREX DRONE DIVISION, FROM AERIAL SURVEY FLOWN MARCH 5, 2025.
2. PERMIT BOUNDARY NOT SHOWN FOR CLARITY.

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CP-25 THROUGH CP-27

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TBPELS FIRM NO. F-256 AND NO. 10194895
TBPG FIRM NO. 50222

DRAWING
C3.46

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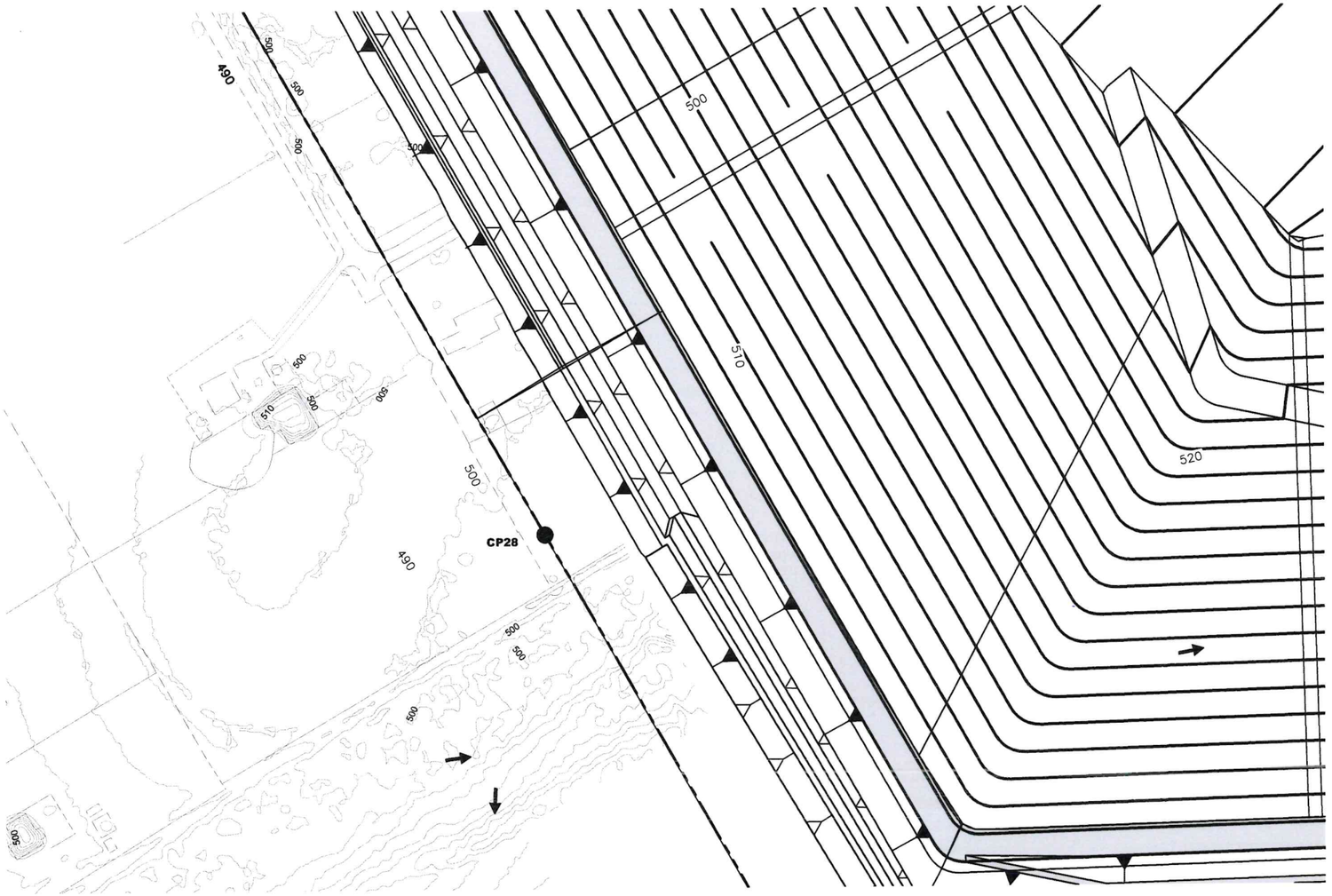

0 100 200
SCALE IN FEET

LEGEND

500 — EXISTING 2' GROUND CONTOUR

COMPARISON POINT

FLOW DIRECTION

NOTES:

1. EXISTING CONTOURS COMPILED BY HYDREX DRONE DIVISION, FROM AERIAL SURVEY FLOWN MARCH 5, 2025.
2. PERMIT BOUNDARY NOT SHOWN FOR CLARITY.

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CP-28

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817-563-1144

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TBPG FIRM NO. 50222

DRAWING
C3.47

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WASTE MANAGEMENT SKYLINE LANDFILL
DALLAS AND ELLIS COUNTIES, TEXAS
PERMIT AMENDMENT APPLICATION NO. MSW 42E

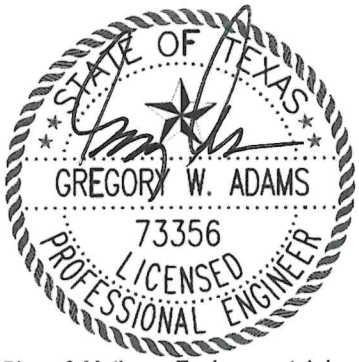
PART III – FACILITY INVESTIGATION AND DESIGN

ATTACHMENT D
WASTE MANAGEMENT UNIT DESIGN

Prepared for

WASTE MANAGEMENT OF TEXAS, INC.

March 2026



Biggs & Mathews Environmental, Inc.
Firm Registration No. F-256
3/31/2026

Prepared by

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

TEXAS BOARD OF PROFESSIONAL ENGINEERS AND LAND SURVEYORS
FIRM REGISTRATION NO. F-256 AND NO. 10194895

TEXAS BOARD OF PROFESSIONAL GEOSCIENTISTS
FIRM REGISTRATION NO. 50222

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30 TAC §330.63(d)

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2 STORAGE AND TRANSFER UNITS 2

3 LANDFILL UNIT DESIGN 4

Attachment D1 – Site Layout Plans

Attachment D2 – Cross Sections

Attachment D3 – Construction Design Details

Attachment D4 – Site Life Calculations

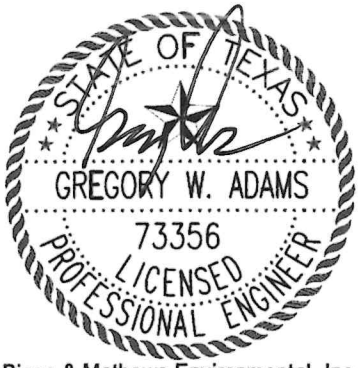
Attachment D5 – Geotechnical Design

Attachment D6 – Leachate and Contaminated Water Management Plan

Attachment D7 – Liner Quality Control Plan

Attachment D8 – Final Cover Quality Control Plan

Attachment D9 – Alternate Final Cover Demonstration



Biggs & Mathews Environmental, Inc.
Firm Registration No. F-256
3/31/2026

1 WASTE MANAGEMENT UNIT DESIGN

30 TAC §330.63(d)

The Waste Management Skyline Landfill is a Type I solid waste disposal and recycling facility. The proposed permit boundary encompasses 858.7 acres of which 488.7 acres are designated for waste disposal. The waste management unit design is provided in the Attachments D1 through D9.

2 STORAGE AND TRANSFER UNITS

30 TAC §330.63(d)(1)

The storage and transfer units have been designed for the rapid processing and minimum detention of solid waste at the facility and will be managed to prevent nuisances and fire hazards. The design of the storage and transfer units provides spill or release containment and accounts for precipitation from the 25-year, 24-hour rainfall event. The storage and transfer units include the large item staging area, reusable materials staging area, citizen's convenience area, leachate storage facility, mud grate facility, and liquid stabilization area.

2.1 Large Item Staging Area

A staging area for large items and white goods may be provided near the active working face. Large items and white goods include ovens, dishwashers, freezers, air conditioners, and other large items. Any rainfall runon or runoff near the active working face will be contained within the active area and handled as contaminated water, as discussed in Part IV. These items will be recycled every 180 days or less, or disposed of at the active working face within 180 days of acceptance at the facility. The procedures for the acceptance, storage, processing, and disposal of large items, including items containing chlorinated fluorocarbons, are addressed in Part IV.

2.2 Reusable Materials Staging Area

A staging area for reusable materials such as brick, concrete, and asphalt may be provided over lined areas. The size of the stockpiles will depend on the amount of materials received at any given time. Since these materials will continuously be reused for site operations, there is no time limit on the storage.

2.3 Citizen's Convenience Area

A current and future citizen's convenience area for waste drop-off is located within the site entrance facilities, as shown on Drawing D1.2. Operational characteristics and procedures for the citizen's convenience area are addressed in Part IV.

2.4 Leachate Storage Facility

Primary leachate storage will be provided by the leachate sumps, which are located within each landfill cell. Leachate will be pumped from the sumps through a leachate forcemain to a direct connection to publicity owned treatment works (POTW). Leachate passes through existing storage tanks which provide a temporary leachate storage in the event that the direct connection to the POTW is not functional. Leachate will be transferred into tanker trucks for transport when the POTW connection is not available.

The leachate storage facility is located near the maintenance facility, as shown in Attachment D1, Drawing D1.2. The storage facility consists of one 24,500-gallon storage tank and one 17,000-gallon storage tank. The calculations in Attachment D6 demonstrate that the secondary containment area provides containment, with 6 inches of freeboard, for the storage tanks and precipitation from the 25-year, 24-hour storm event.

2.5 Mud Grate Facility

The mud grate is located along the entrance road, as shown on Drawing D1.2. The mud grate is a concrete structure with a series of metal grates that function as mud removal devices. As vehicles drive across the mud grate, mud from tires drops through the grates into a mud box. The accumulated mud is periodically removed from the mud box and placed in the active working face.

2.6 Liquid Waste Stabilization Area

Sludges, grease trap waste, grit trap waste, Class 2 liquid industrial waste, liquid waste from drilling activities, or liquid wastes from municipal sources may be accepted at the Skyline Landfill. Refer to Part IV, Appendix IVB. The facility may perform on-site liquid processing/stabilization of sludges, grease trap wastes, grit trap wastes, Class 2 liquid industrial waste, liquid waste from drilling activities or liquids from municipal sources. Stabilization of liquids in this context is the addition of drying or bulking agents as described below to liquids waste so that the mixture passes the paint filter test. The facility will provide a stabilization basin placed within an existing lined cell. The basin will be secured during waste placement operations and soil will be graded around the basin to ensure that stormwater runoff is directed away from the basin. The container will be placed so that a minimum of one foot of the container extends above the surrounding soil. The bottom of the container will be at least 10 feet above the top of the protective cover soil component of the lining system and founded in the waste.

Once the basin is in place, trucks will discharge directly into the basin. Lime, fly ash, cement kiln dust, Portland cement, sawdust, dirt, auto fluff, or any combination of these materials may be used for liquid stabilization. Mixing will be accomplished with a backhoe or other appropriate machinery. Each batch of stabilized material will be tested for free liquids in accordance with Method 9095 (Paint Filter Liquids Test), as described in "Test Methods for Evaluating Solid Wastes, Physical/Chemical Methods" (EPA Publication Number SW-846), as amended. Upon verification of the stabilized material passing the paint filter test, the mixture will be removed from the basin and deposited in the active face for landfilling on the day it is received. The procedures for acceptance, processing, odor control, and stabilizing liquid wastes accepted at the facility are addressed in Part IV, Appendix IVE.

3 LANDFILL UNIT DESIGN

30 TAC §§330.63(d)(4)

3.1 All Weather Operation

The landfill interior access roads shown on Drawing D1.1 are constructed of crushed stone, gravel, concrete rubble, masonry rubble, wood chips, or other similar materials to provide access to the disposal area during all weather conditions. To enhance operating efficiency during wet weather, a disposal area close to the all weather roads may be reserved for wet weather operations. The wet weather area will move as the operations progress.

Site personnel will maintain the landfill access road for all weather access. Stockpiles of crushed stone, gravel, concrete rubble, masonry demolition debris, wood chips or other similar material will be available for use in maintaining passable access roads. Grading equipment or other appropriate equipment will be used as necessary to control or remove mud accumulations on the landfill access roads around the landfill and the landfill entrance road.

Tracking of mud onto public access roads is minimized by the all-weather surfaces of the interior access roads and the landfill entrance road. The landfill entrance road is a 36-foot-wide concrete paved roadway and provides mud control for waste hauling vehicles prior to exiting the site and returning to public access roads. Additional mud control is provided by a mud grate facility.

3.2 Landfilling Methods

The development method for the landfill is a combination of area-excavation fill followed by aerial fill to the proposed landfill completion grades. The drawings in Attachment D1 show the excavation, final grades, drainage structures, and entrance facilities. Final cover placement will generally follow the sequence of development as shown on Attachment D1, Drawing D1.2, and will be ongoing as the site as developed. The landfill will be closed according to the closure plan provided in Attachment H.

3.3 Site Life Projection

Once expanded, the total remaining landfill volume available for waste disposal is approximately 126,075,000 cubic yards (waste and daily cover), which will provide an estimated 24 years of site life. Calculations and assumptions for the waste volume and site life estimate are included in Attachment D4.

3.4 Landfill Cross Sections

Cross sections of the landfill unit are provided in Attachment D2. These sections show the proposed excavation; bottom, side slope, and aerial fill elevations; the permitted fill elevations; the existing ground elevations; and the liner and cover system elevations. Soil borings, monitoring wells, and gas monitoring probes near the sections have been projected onto the sections. The section locations were selected to represent the conditions across the entire site.

3.5 Liner Quality Control Plan

A quality control plan for the liner system prepared in accordance with §330.339 is provided in Attachment D7 and details of the liner system are provided in Attachment D3.

3.6 Final Cover Quality Control Plan

Quality control plans for the final cover systems are provided in Attachment D8 and details of the final cover systems are provided in Attachment D3. The Alternate Final Cover Demonstration is provided in Attachment D9.

WASTE MANAGEMENT SKYLINE LANDFILL
DALLAS AND ELLIS COUNTIES, TEXAS
PERMIT AMENDMENT APPLICATION NO. MSW 42E

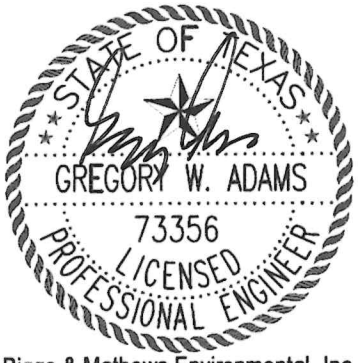
PART III – FACILITY INVESTIGATION AND DESIGN

ATTACHMENT D1
SITE LAYOUT PLANS

Prepared for

WASTE MANAGEMENT OF TEXAS, INC.

March 2026



Biggs & Mathews Environmental, Inc.
Firm Registration No. F-256
3/31/2026

Prepared by

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

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FIRM REGISTRATION NO. F-256 AND NO. 10194895

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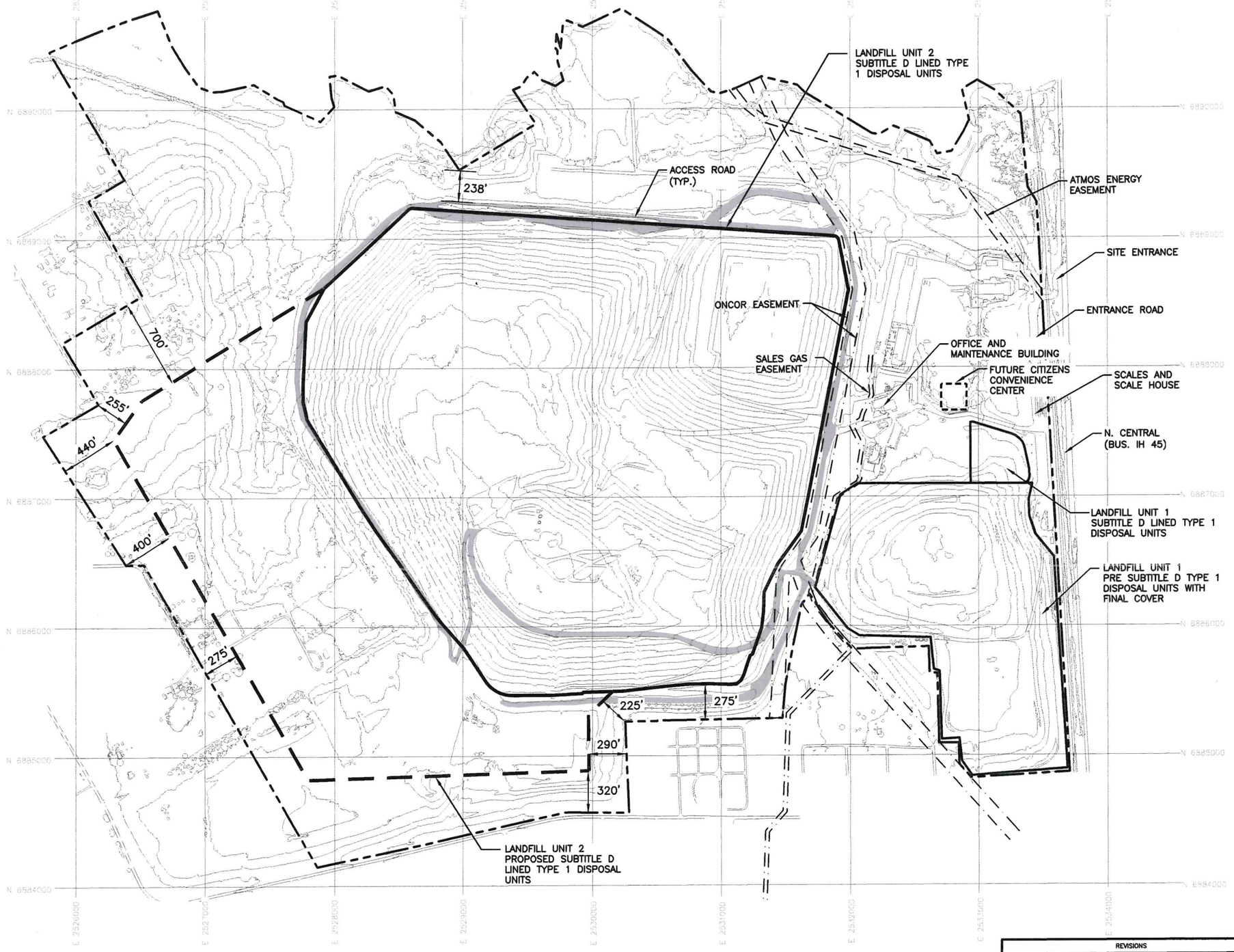
FIRM REGISTRATION NO. 50222



0 400 800
SCALE IN FEET

LEGEND

- PERMIT BOUNDARY
- EXISTING LANDFILL FOOTPRINT
- PROPOSED LANDFILL FOOTPRINT
- EASEMENT
- STATE PLANE GRID NAD 83

NOTE:

1. EXISTING CONTOURS COMPILED BY HYDREX DRONE DIVISION, FROM AERIAL SURVEY FLOWN MARCH 5, 2025.

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SITE PLAN

WASTE MANAGEMENT OF TEXAS, INC.
SKYLINE LANDFILL

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MANSFIELD, TEXAS 76063
817-563-1144

TBPELS FIRM NO. F-256 AND NO. 10194895
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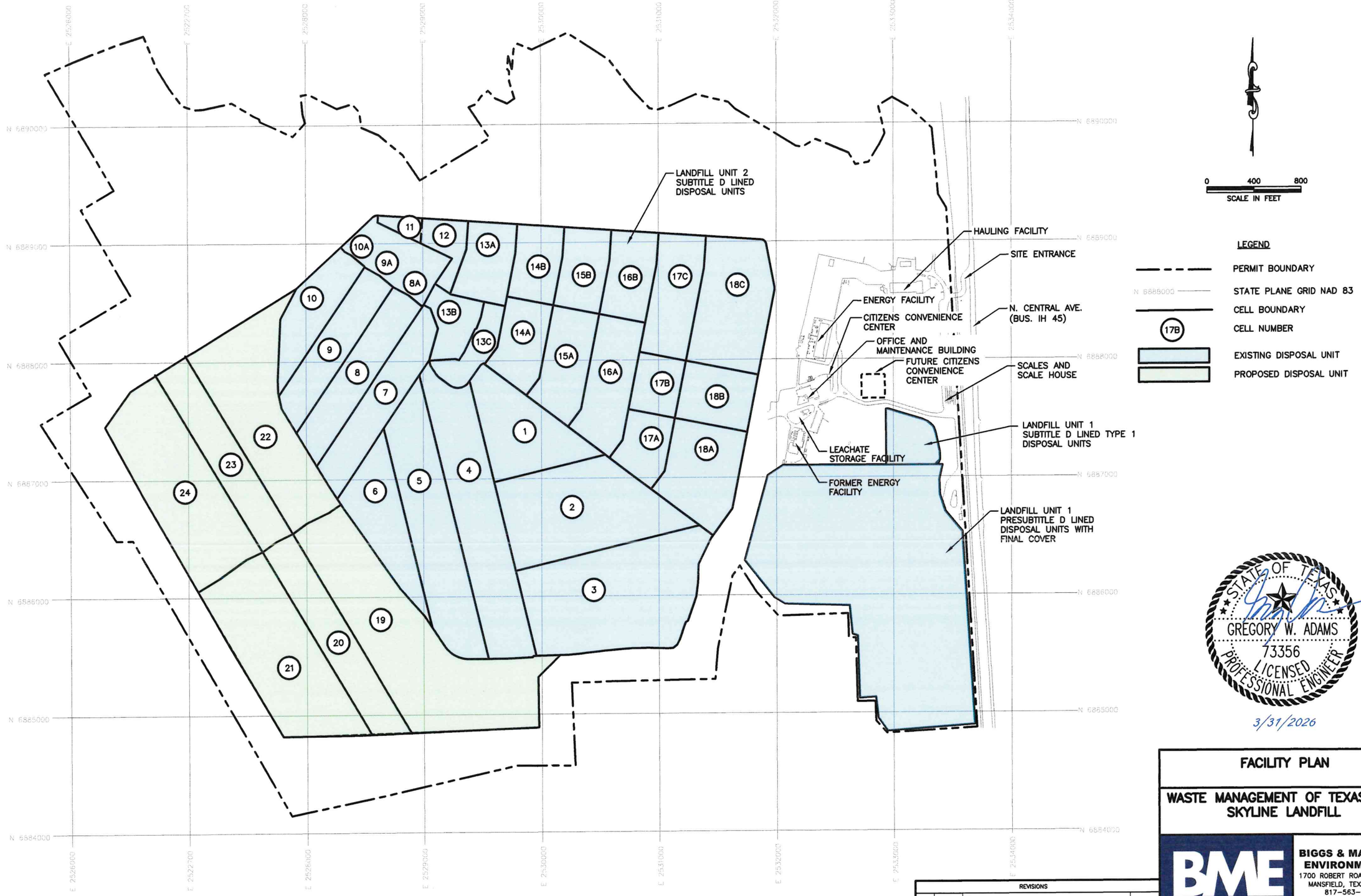
DRAWING
D1.1

O:\Waste Management\Skyline\Solid Waste\P\Drawings\Part III\Att. D\D1.1-GenSitePlan.dwg Layout: D1.1 User: awhite



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FACILITY PLAN

WASTE MANAGEMENT OF TEXAS, INC.
SKYLINE LANDFILL

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1700 ROBERT ROAD, STE. 100
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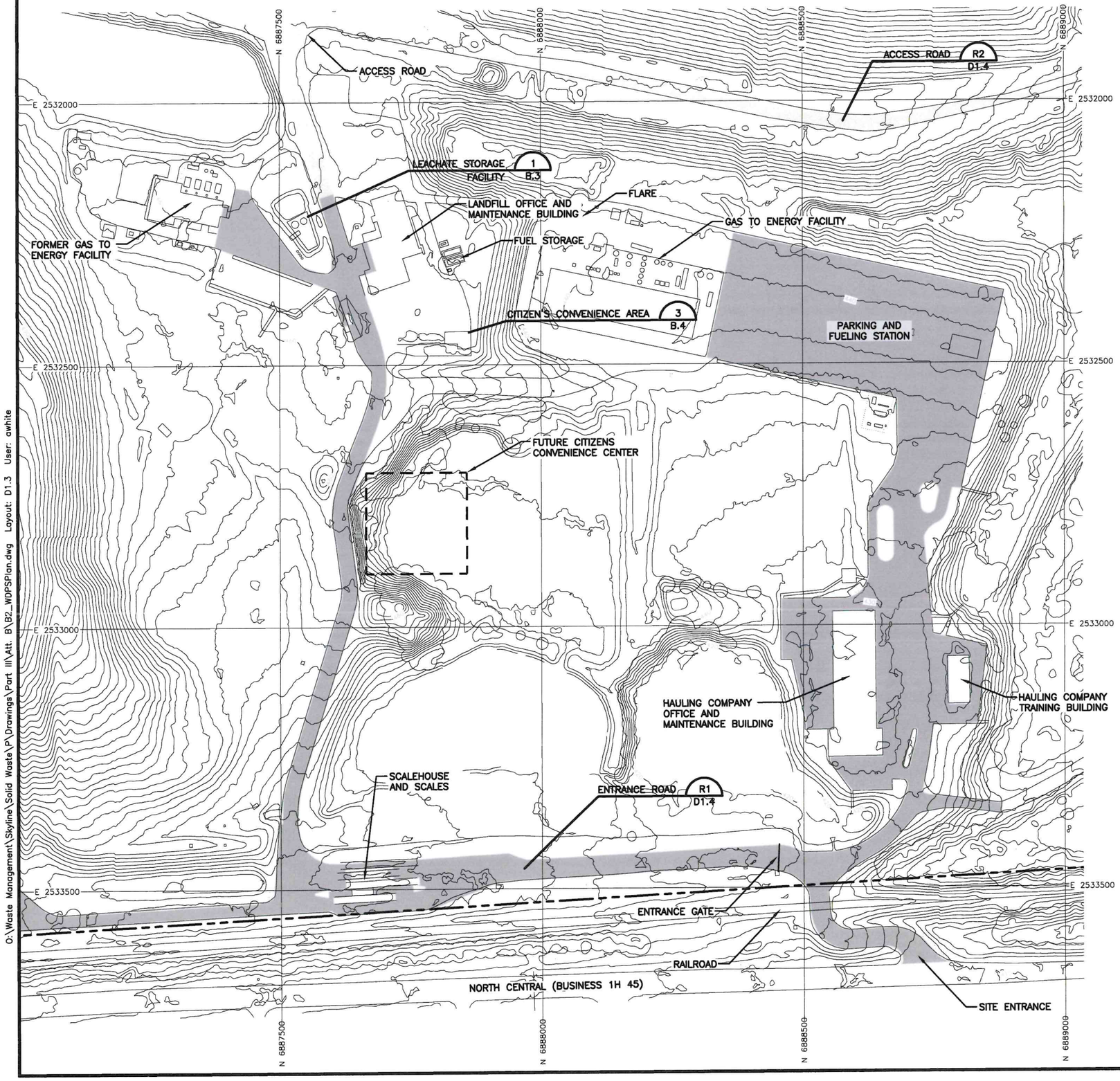
TBPG FIRM NO. 50222

DRAWING D1.2

REVISIONS			
REV	DATE	DESCRIPTION	DWN BY

O:\Waste Management\Skyline\Solid Waste\P\Drawings\Part III\Att. D\D1.2-FacPlan.dwg Layout: D1.2 User: awhite



0 100 200
SCALE IN FEET

LEGEND

- PERMIT BOUNDARY
- E 2532500 — STATE PLANE GRID (NAD 83)
- CONCRETE PAVEMENT
- AGGREGATE PAVEMENT

NOTES:

1. EXISTING CONTOURS COMPILED BY HYDREX DRONE DIVISION FROM AERIAL PHOTOGRAPHY. FLOWN MARCH 5, 2025. COORDINATE SYSTEM IS BASED ON TEXAS STATE PLANE NAD 83 (2011), TEXAS NORTH CENTRAL ZONE, US FEET.
2. THE LANDFILL GAS TO ENERGY FACILITY, CITIZEN'S CONVENIENCE AREA, LEACHATE STORAGE FACILITY, MUD GRATE FACILITY, LANDFILL OFFICE AND MAINTENANCE FACILITY, AND SCALE HOUSE AND SCALES ARE EXISTING.

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WASTE PROCESSING AND STORAGE FACILITIES SCHEMATIC PLAN

WASTE MANAGEMENT OF TEXAS, INC. SKYLINE LANDFILL

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DRAWING D1.3

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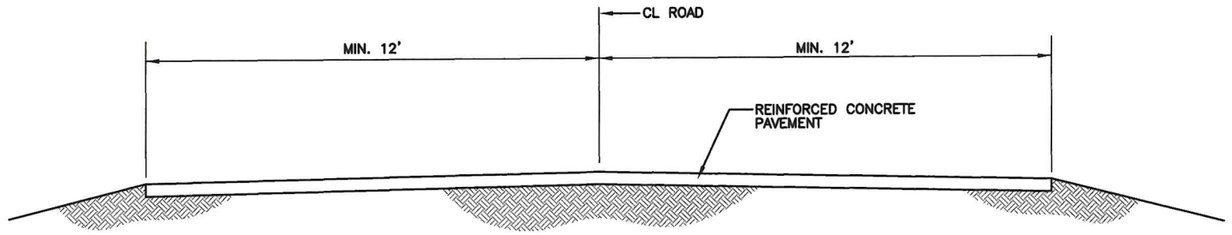


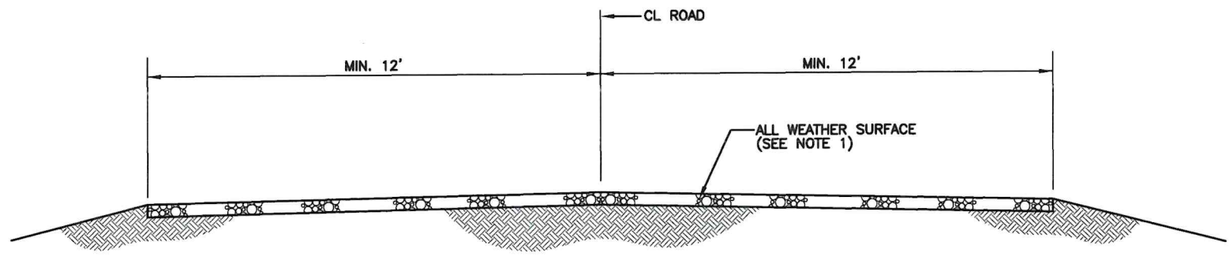
NOTES:

1. EXISTING SITE ENTRANCE ROAD SHALL BE MAINTAINED AS ALL WEATHER SURFACE (CONCRETE SURFACE).
2. EXISTING LANE WIDTHS SHALL BE MAINTAINED. (12'-0" MINIMUM).

ENTRANCE ROAD R1 D1.4

0 2 4

SCALE IN FEET



NOTES:

1. EXISTING LANDFILL ACCESS ROAD SHALL BE MAINTAINED WITH ALL WEATHER SURFACE (CRUSHED STONE, GRAVEL, CONCRETE RUBBLE, MASONRY DEMOLITION DEBRIS, WOOD CHIPS, OR OTHER SIMILAR MATERIALS) WHERE USED AS ACCESS TO WORKING FACE BY WASTE HAUL VEHICLES.
2. PAVEMENT THICKNESS SHALL BE BASED ON TRAFFIC LOADINGS AND SOIL CONDITIONS.

ACCESS ROAD R2 D1.4

0 2 4

SCALE IN FEET

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ROAD DETAILS

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SKYLINE LANDFILL

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TBPELS FIRM NO. F-256 AND NO. 10194895
TBPG FIRM NO. 50222

DRAWING D1.4

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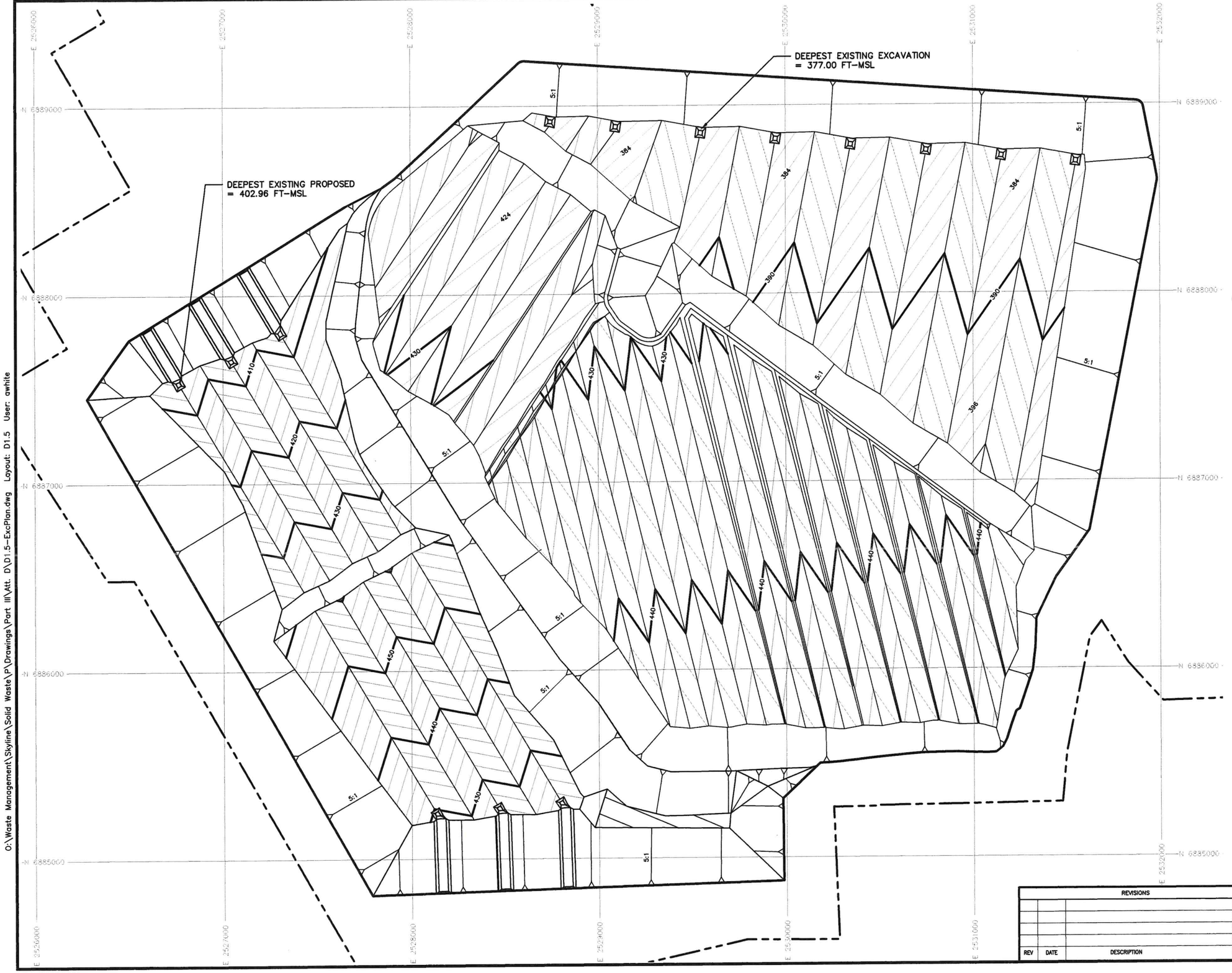

0 250 500
SCALE IN FEET

LEGEND

- PERMIT BOUNDARY
- STATE PLANE GRID NAD 83
- 396 — 2' SUBGRADE CONTOUR
- 390 — 10' SUBGRADE CONTOUR
- SUMP

STATE OF TEXAS
GREGORY W. ADAMS
73356
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3/31/2026

EXCAVATION PLAN

WASTE MANAGEMENT OF TEXAS, INC.
SKYLINE LANDFILL

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817-563-1144

TBPELS FIRM NO. F-256 AND NO. 10194895
TBPG FIRM NO. 50222

DRAWING
D1.5

REVISIONS			
REV	DATE	DESCRIPTION	DWN BY

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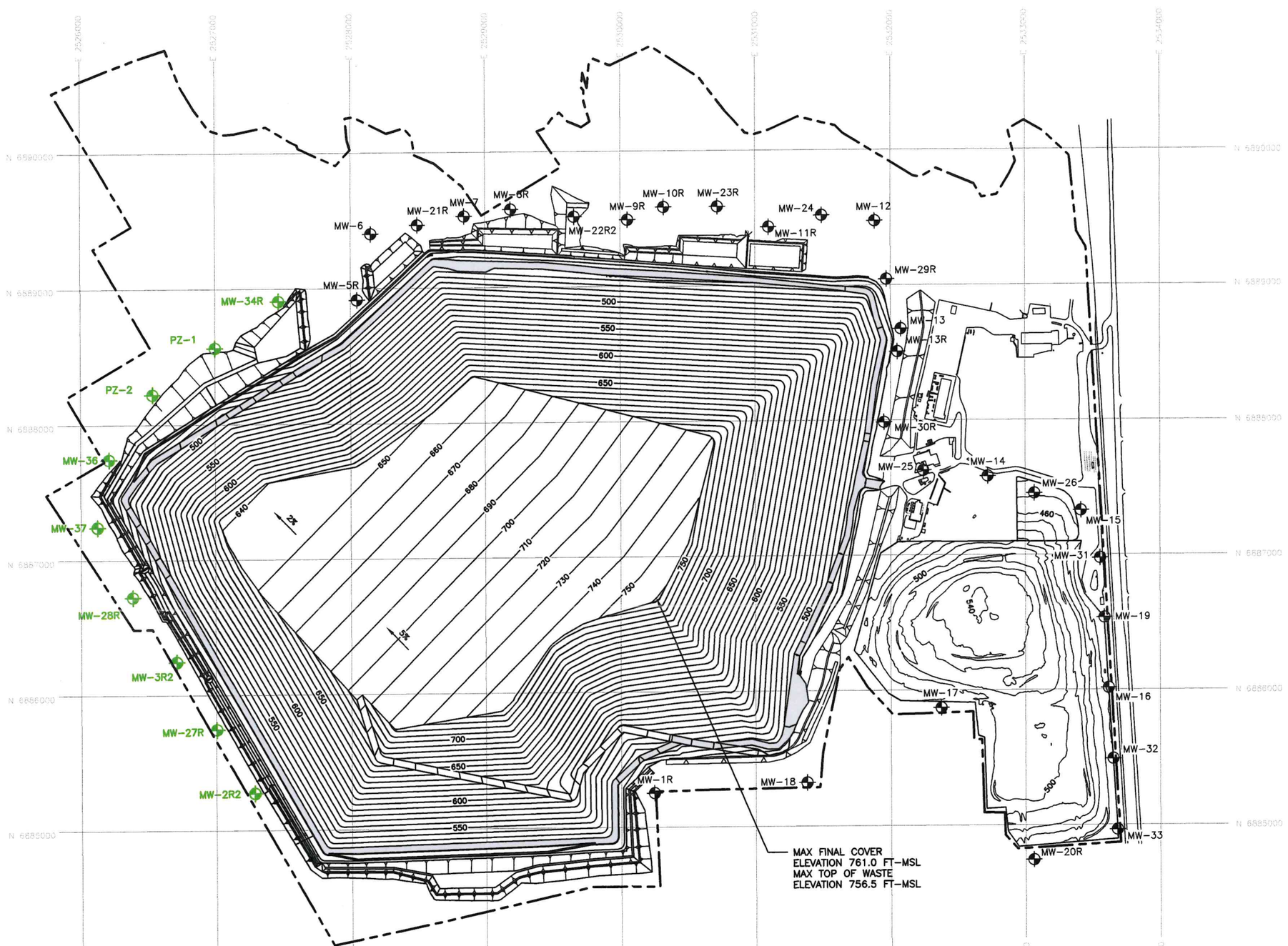


0 400 800

SCALE IN FEET

LEGEND

- PERMIT BOUNDARY
- 740 FINAL COVER CONTOUR
- N 6887000 STATE PLANE GRID
- MW-24 MONITORING WELL
- MW-34R PROPOSED MONITORING WELL
- ACCESS ROAD

STATE OF TEXAS
GREGORY W. ADAMS
73356
LICENSED
PROFESSIONAL ENGINEER

3/31/2026

LANDFILL COMPLETION PLAN

WASTE MANAGEMENT OF TEXAS, INC.
SKYLINE LANDFILL

BIGGS & MATHEWS ENVIRONMENTAL
1700 ROBERT ROAD, STE. 100
MANSFIELD, TEXAS 76063
817-563-1144

TBPELS FIRM NO. F-256 AND NO. 10194895
TBPG FIRM NO. 50222

DRAWING D1.6

REVISIONS			
REV	DATE	DESCRIPTION	DWN BY

O:\Waste Management\Skyline\Solid Waste\P\Drawings\Part III\Att. D\D1.6-FCPlan.dwg Layout: D1.6 User: awhite

WASTE MANAGEMENT SKYLINE LANDFILL
DALLAS AND ELLIS COUNTIES, TEXAS
PERMIT AMENDMENT APPLICATION NO. MSW 42E

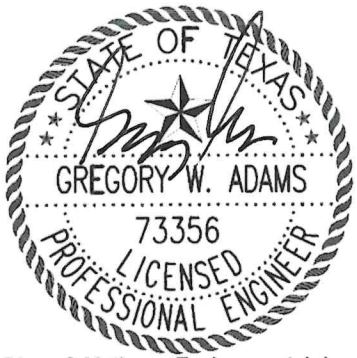
PART III – FACILITY INVESTIGATION AND DESIGN

ATTACHMENT D2
CROSS SECTIONS

Prepared for

WASTE MANAGEMENT OF TEXAS, INC.

March 2026



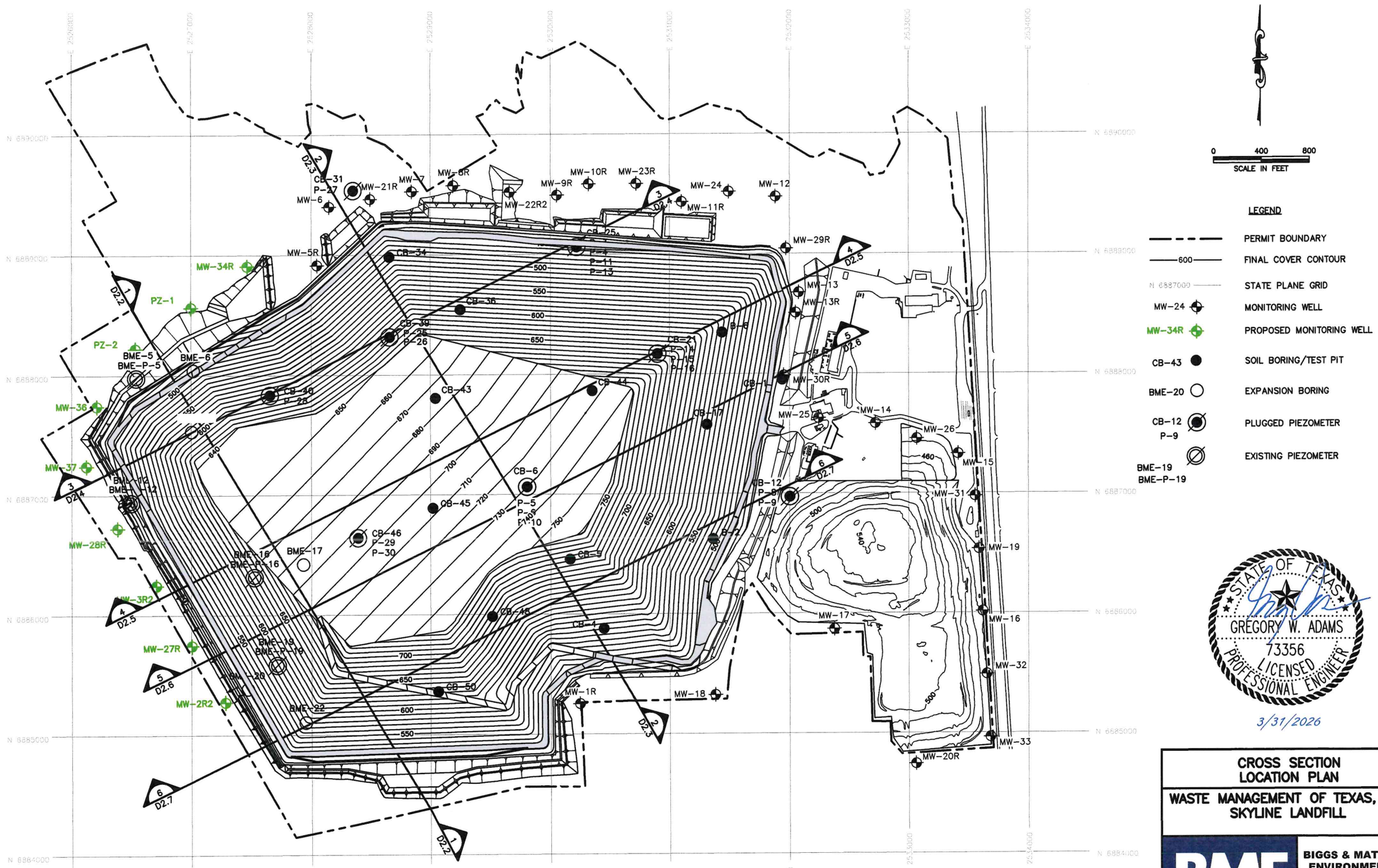
Biggs & Mathews Environmental, Inc.
Firm Registration No. F-256
3/31/2026

Prepared by

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

TEXAS BOARD OF PROFESSIONAL ENGINEERS AND LAND SURVEYORS
FIRM REGISTRATION NO. F-256 AND NO. 10194895

TEXAS BOARD OF PROFESSIONAL GEOSCIENTISTS
FIRM REGISTRATION NO. 50222



0 400 800
SCALE IN FEET

LEGEND

- PERMIT BOUNDARY
- 600 FINAL COVER CONTOUR
- N 6887000 STATE PLANE GRID
- MW-24 MONITORING WELL
- MW-34R PROPOSED MONITORING WELL
- CB-43 SOIL BORING/TEST PIT
- BME-20 EXPANSION BORING
- CB-12 / P-9 PLUGGED PIEZOMETER
- EXISTING PIEZOMETER
- BME-19 / BME-P-19

STATE OF TEXAS
GREGORY W. ADAMS
73356
LICENSED
PROFESSIONAL ENGINEER

3/31/2026

CROSS SECTION LOCATION PLAN

WASTE MANAGEMENT OF TEXAS, INC. SKYLINE LANDFILL

BIGGS & MATHEWS ENVIRONMENTAL
1700 ROBERT ROAD, STE. 100
MANSFIELD, TEXAS 76063
817-563-1144

TBPELS FIRM NO. F-256 AND NO. 10194895
TBPG FIRM NO. 50222

DRAWING D2.1

REVISIONS			
REV	DATE	DESCRIPTION	DWN BY

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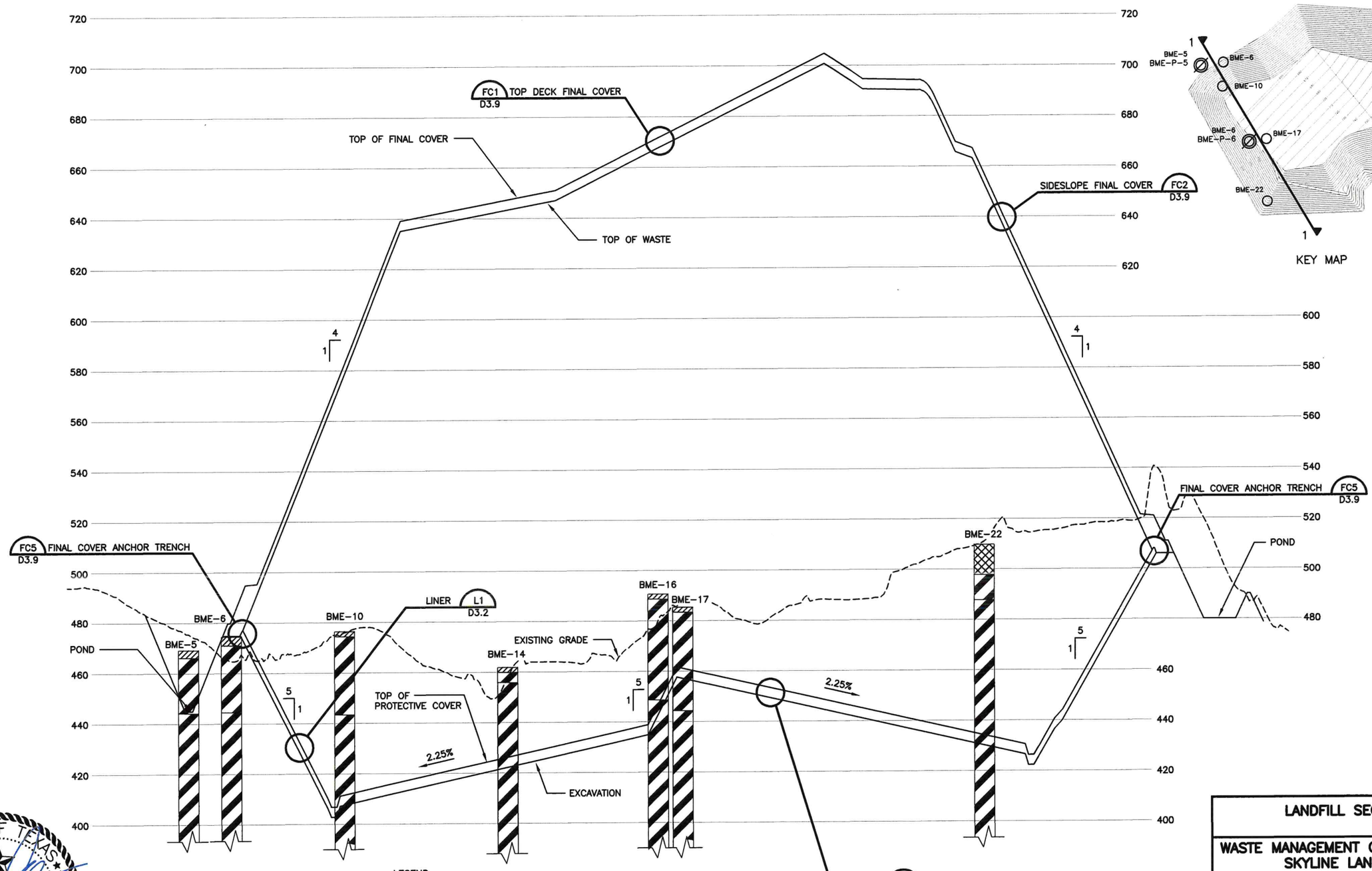

STATE OF TEXAS
GREGORY W. ADAMS
73356
LICENSED
PROFESSIONAL ENGINEER

3/31/2026

REVISIONS			
REV	DATE	DESCRIPTION	DWN BY

LANDFILL SECTION

WASTE MANAGEMENT OF TEXAS, INC.
SKYLINE LANDFILL

BIGGS & MATHEWS ENVIRONMENTAL
1700 ROBERT ROAD, STE. 100
MANSFIELD, TEXAS 76063
817-563-1144

TBPELS FIRM NO. F-256 AND NO. 10194895
TBPG FIRM NO. 50222

DRAWING
D2.2

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760
740
720
700
680
660
640
620
600
580
560
540
520
500
480
460
440
420
400
380

FC1 TOP DECK FINAL COVER D3.9

SIDESLOPE FINAL COVER FC2 D3.9

TOP OF FINAL COVER

TOP OF WASTE

EXISTING WASTE

4 1

4 1

FC5 FINAL COVER ANCHOR TRENCH D3.9

POND

5 1

5 1

CB-31

CB-34

CB-39

CB-43

CB-6

CB-5

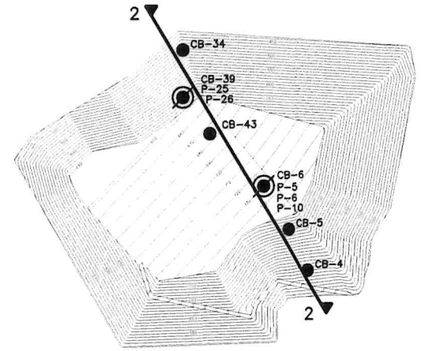
CB-4

TOP OF PROTECTIVE COVER

EXCAVATION

LINER L1 D3.2

EXISTING DRAINAGE CHANNEL



KEY MAP

LEGEND

- Fill
- Clay (CL)
- Clay (CH)
- Claystone (Unweathered Taylor Marl)

LANDFILL SECTION 2 D2.3

0 200 400 SCALE IN FEET HORIZONTAL

0 20 40 SCALE IN FEET VERTICAL

STATE OF TEXAS
GREGORY W. ADAMS
73356
LICENSED
PROFESSIONAL ENGINEER

3/31/2026

LANDFILL SECTION

WASTE MANAGEMENT OF TEXAS, INC. SKYLINE LANDFILL

BIGGS & MATHEWS ENVIRONMENTAL
1700 ROBERT ROAD, STE. 100
MANSFIELD, TEXAS 76063
817-563-1144

TBPELS FIRM NO. F-256 AND NO. 10194895

TBPG FIRM NO. 50222

DRAWING D2.3

REVISIONS			
REV	DATE	DESCRIPTION	DWN BY

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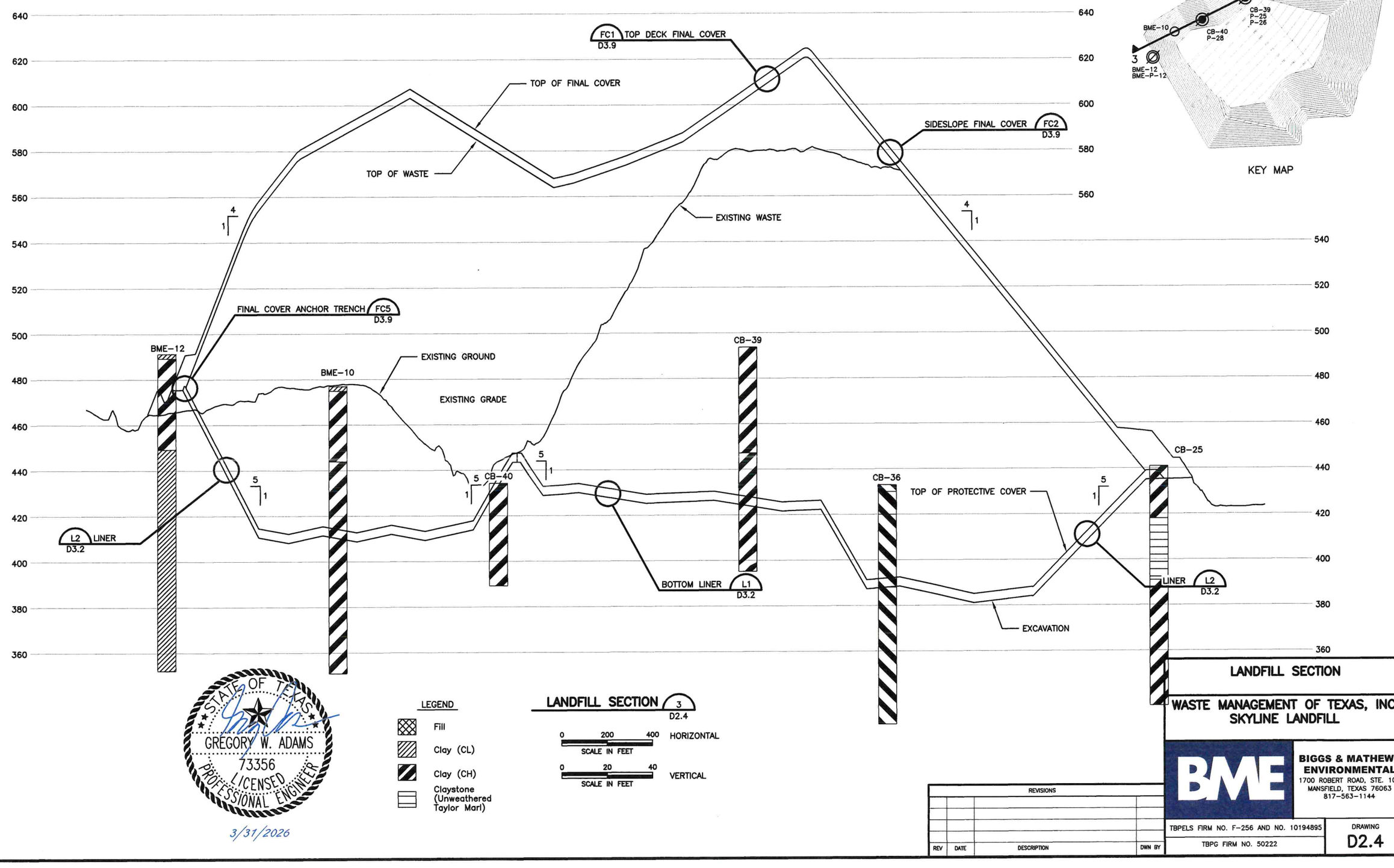

KEY MAP

LEGEND

- Fill
- Clay (CL)
- Clay (CH)
- Claystone (Unweathered Taylor Marl)

LANDFILL SECTION 3 D2.4

0 200 400 HORIZONTAL
SCALE IN FEET

0 20 40 VERTICAL
SCALE IN FEET

STATE OF TEXAS
GREGORY W. ADAMS
73356
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PROFESSIONAL ENGINEER
3/31/2026

REVISIONS			
REV	DATE	DESCRIPTION	DWN BY

LANDFILL SECTION

WASTE MANAGEMENT OF TEXAS, INC.
SKYLINE LANDFILL

BIGGS & MATHEWS ENVIRONMENTAL
1700 ROBERT ROAD, STE. 100
MANSFIELD, TEXAS 76063
817-563-1144

TBPELS FIRM NO. F-256 AND NO. 10194895
TBPG FIRM NO. 50222

DRAWING D2.4

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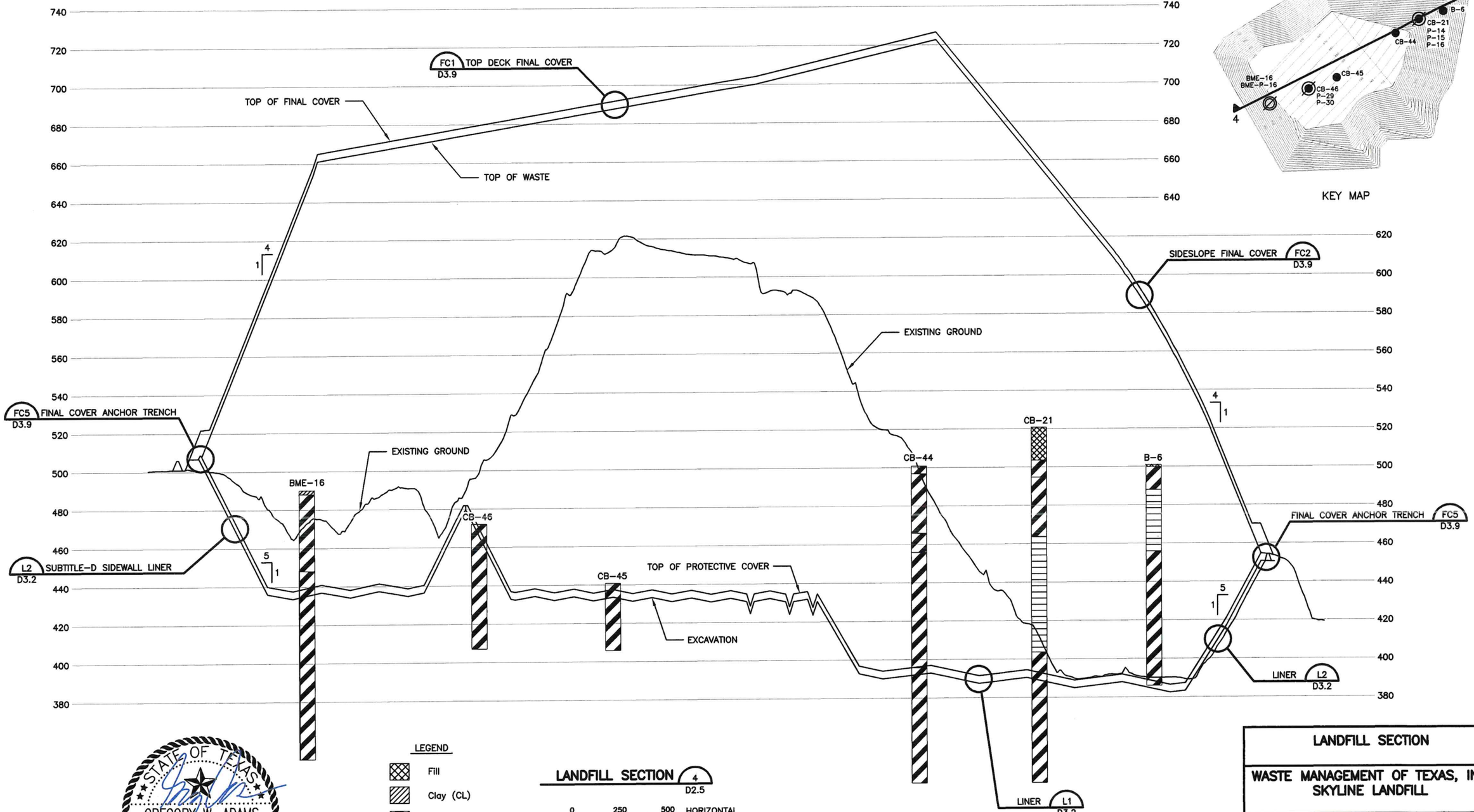

KEY MAP

LEGEND

- Fill
- Clay (CL)
- Clay (CH)
- Claystone (Unweathered Taylor Marl)

LANDFILL SECTION 4 D2.5

0 250 500 HORIZONTAL
SCALE IN FEET

0 25 50 VERTICAL
SCALE IN FEET

STATE OF TEXAS
GREGORY W. ADAMS
73356
LICENSED
PROFESSIONAL ENGINEER
3/31/2026

REVISIONS			
REV	DATE	DESCRIPTION	DWN BY

LANDFILL SECTION

WASTE MANAGEMENT OF TEXAS, INC. SKYLINE LANDFILL

BIGGS & MATHEWS ENVIRONMENTAL
1700 ROBERT ROAD, STE. 100
MANSFIELD, TEXAS 76063
817-563-1144

TBPELS FIRM NO. F-256 AND NO. 10194895
TBPG FIRM NO. 50222

DRAWING D2.5

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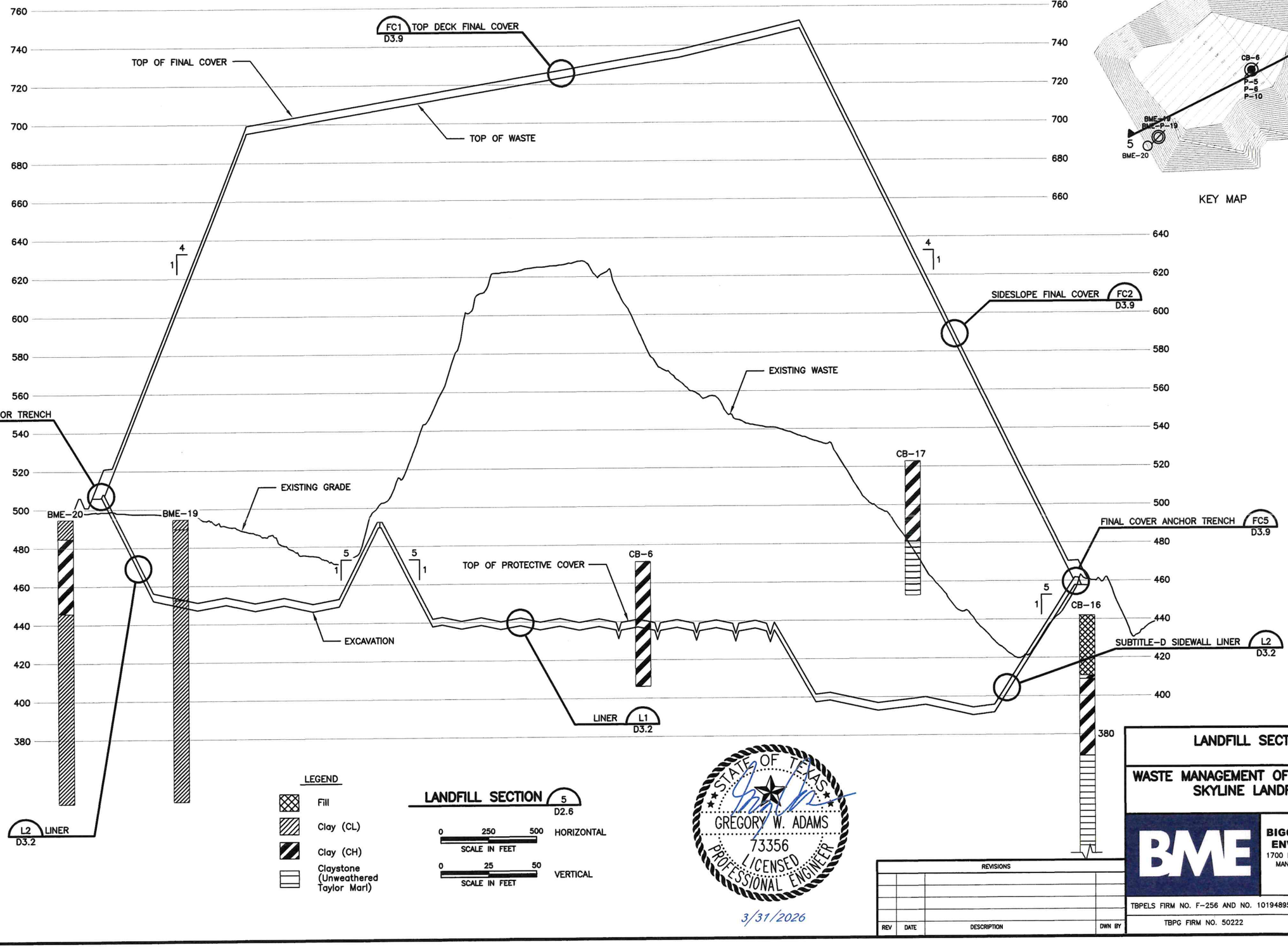

KEY MAP

STATE OF TEXAS
GREGORY W. ADAMS
73356
LICENSED PROFESSIONAL ENGINEER
3/31/2026

REVISIONS			
REV	DATE	DESCRIPTION	DWN BY

LANDFILL SECTION

WASTE MANAGEMENT OF TEXAS, INC.
SKYLINE LANDFILL

BIGGS & MATHEWS ENVIRONMENTAL
1700 ROBERT ROAD, STE. 100
MANSFIELD, TEXAS 76063
817-563-1144

TBPELS FIRM NO. F-256 AND NO. 10194895
TBPG FIRM NO. 50222

DRAWING
D2.6

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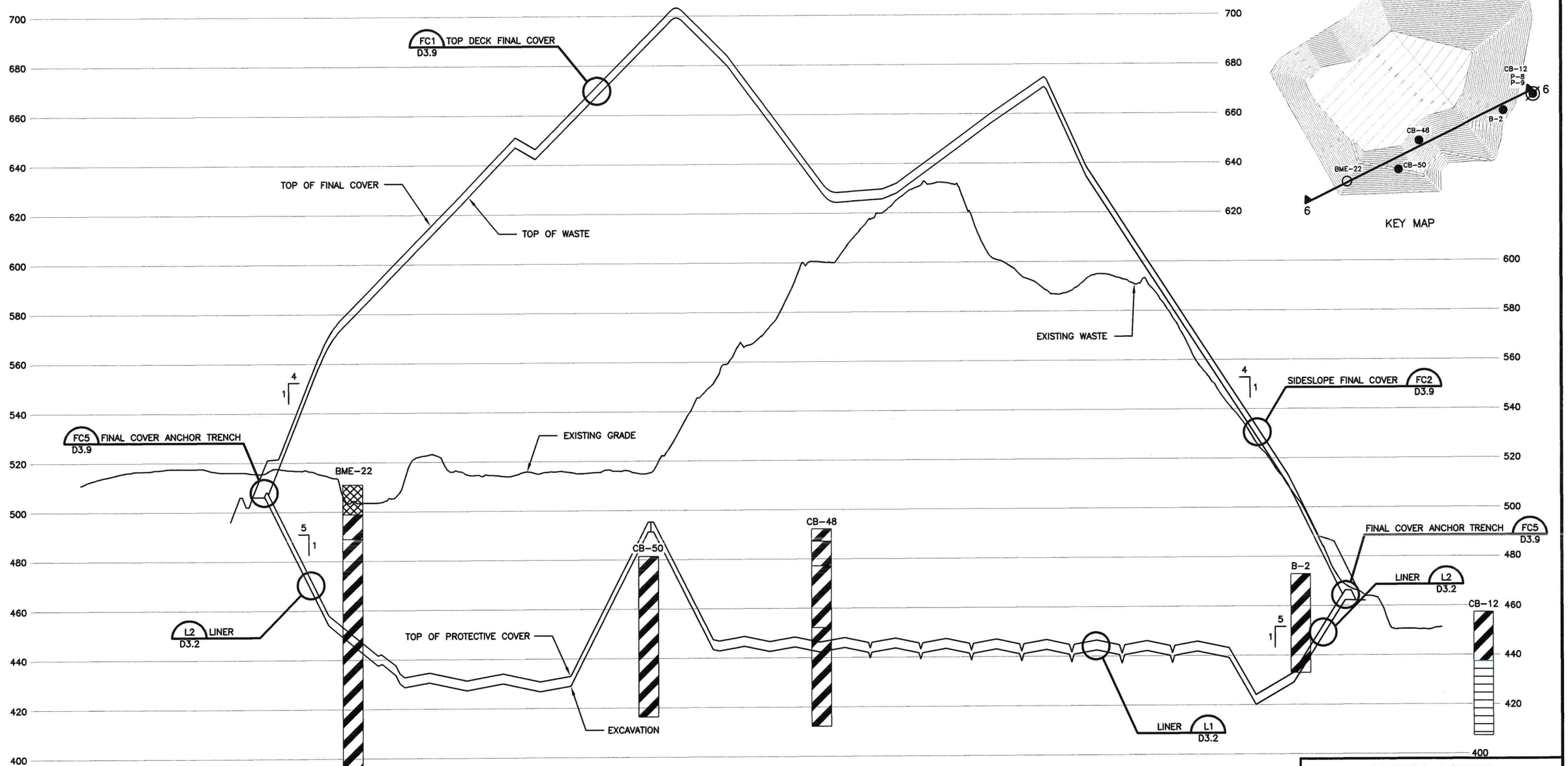

KEY MAP

LEGEND

- Fill
- Clay (CL)
- Clay (CH)
- Claystone (Unweathered Taylor Marl)

LANDFILL SECTION 6 D2.7

0 200 400 HORIZONTAL
SCALE IN FEET

0 20 40 VERTICAL
SCALE IN FEET

STATE OF TEXAS
GREGORY W. ADAMS
73356
LICENSED
PROFESSIONAL ENGINEER

3/31/2026

REVISIONS			
REV	DATE	DESCRIPTION	DWN BY

LANDFILL SECTION

WASTE MANAGEMENT OF TEXAS, INC. SKYLINE LANDFILL

BIGGS & MATHEWS ENVIRONMENTAL
1700 ROBERT ROAD, STE. 100
MANSFIELD, TEXAS 76063
817-563-1144

TBPELS FIRM NO. F-256 AND NO. 10194895
TBPG FIRM NO. 50222

DRAWING D2.7

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WASTE MANAGEMENT SKYLINE LANDFILL
DALLAS AND ELLIS COUNTIES, TEXAS
PERMIT AMENDMENT APPLICATION NO. MSW 42E

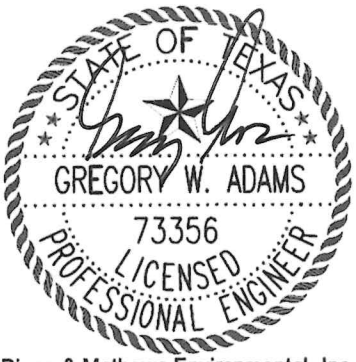
PART III – FACILITY INVESTIGATION AND DESIGN

ATTACHMENT D3
CONSTRUCTION DESIGN DETAILS

Prepared for

WASTE MANAGEMENT OF TEXAS, INC.

March 2026



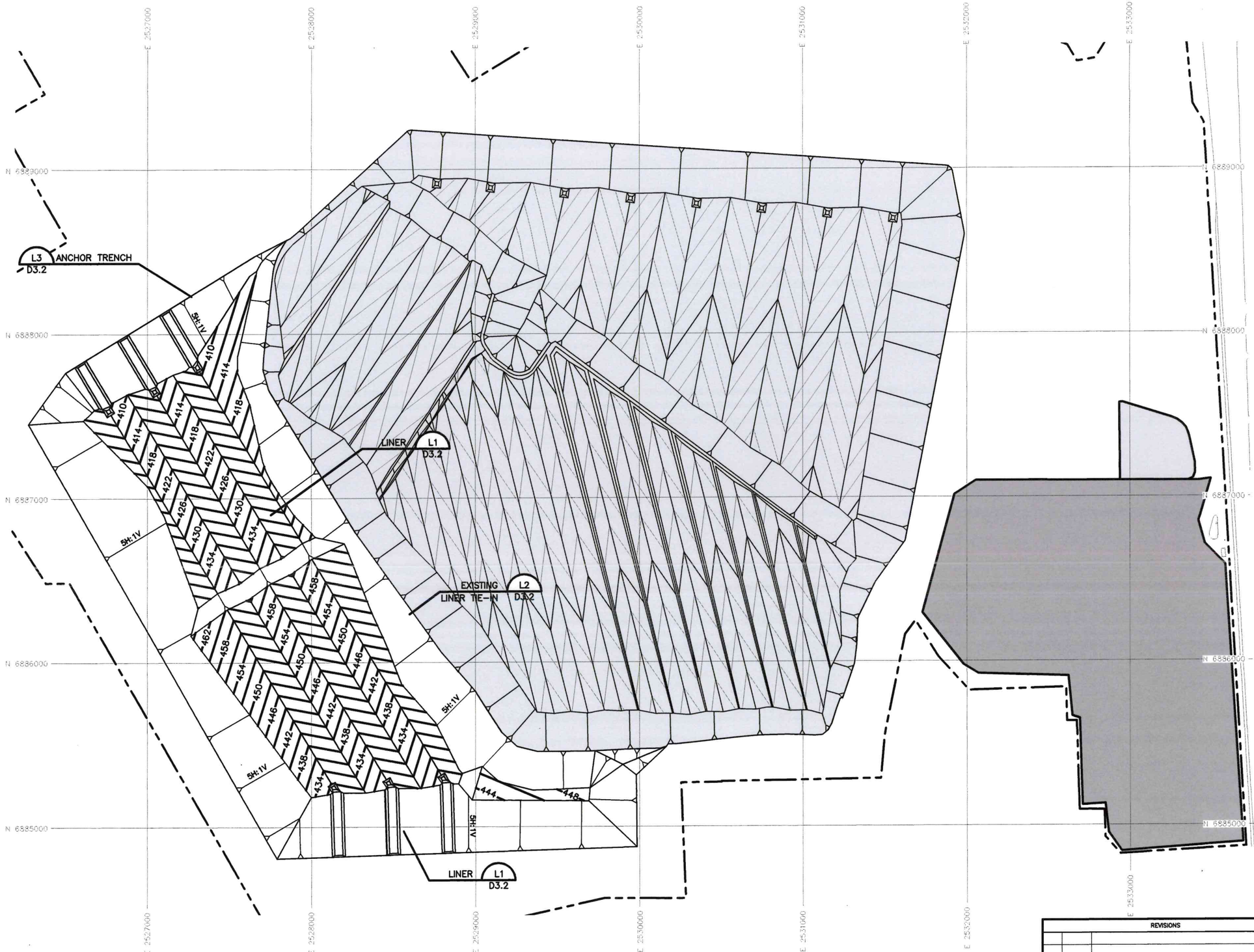
Biggs & Mathews Environmental, Inc.
Firm Registration No. F-256
3/31/2026

Prepared by

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

TEXAS BOARD OF PROFESSIONAL ENGINEERS AND LAND SURVEYORS
FIRM REGISTRATION NO. F-256 AND NO. 10194895

TEXAS BOARD OF PROFESSIONAL GEOSCIENTISTS
FIRM REGISTRATION NO. 50222



0 300 600
SCALE IN FEET

LEGEND

- PERMIT BOUNDARY
- LANDFILL FOOTPRINT
- N 323,000 STATE PLANE GRID (NAD 83)
- 434 PROPOSED 2' TOP OF LINER CONTOUR
- EXISTING SUBTITLE D LINERS
- EXISTING PRE SUBTITLE D LINERS

STATE OF TEXAS
GREGORY W. ADAMS
73356
LICENSED PROFESSIONAL ENGINEER

3/31/2026

LINER PLAN

WASTE MANAGEMENT OF TEXAS, INC. SKYLINE LANDFILL

REVISIONS

REV	DATE	DESCRIPTION	DWN BY

BIGGS & MATHEWS ENVIRONMENTAL
1700 ROBERT ROAD, STE. 100
MANSFIELD, TEXAS 76063
817-563-1144

TBPELS FIRM NO. F-256 AND NO. 10194895
TBPG FIRM NO. 50222

DRAWING D3.1

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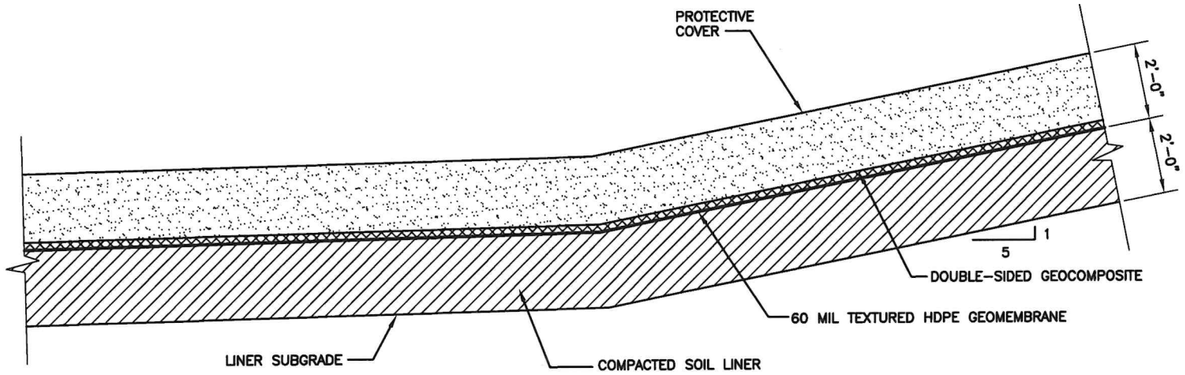
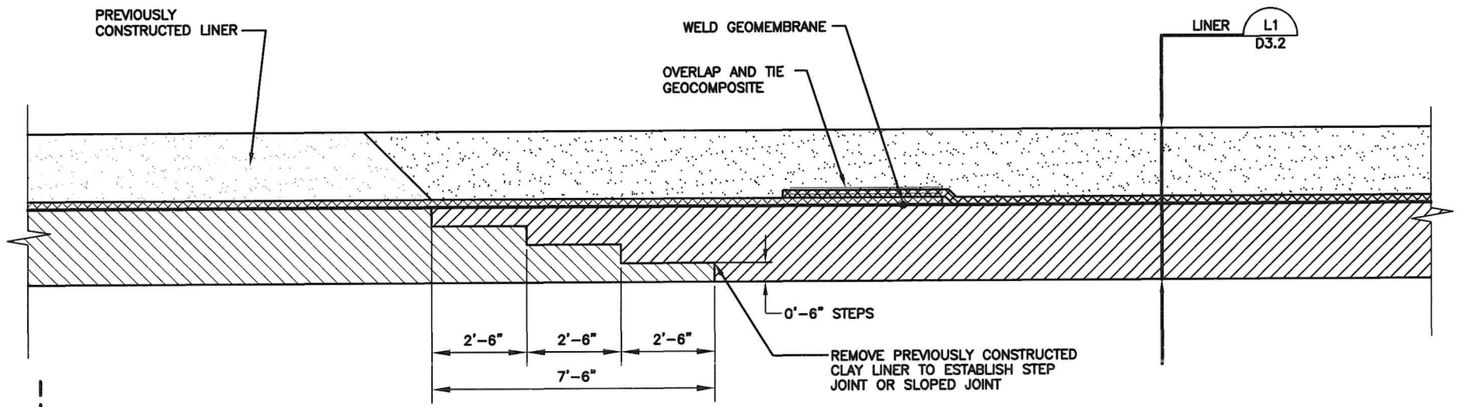


LINER L1 D3.2

0 2 4

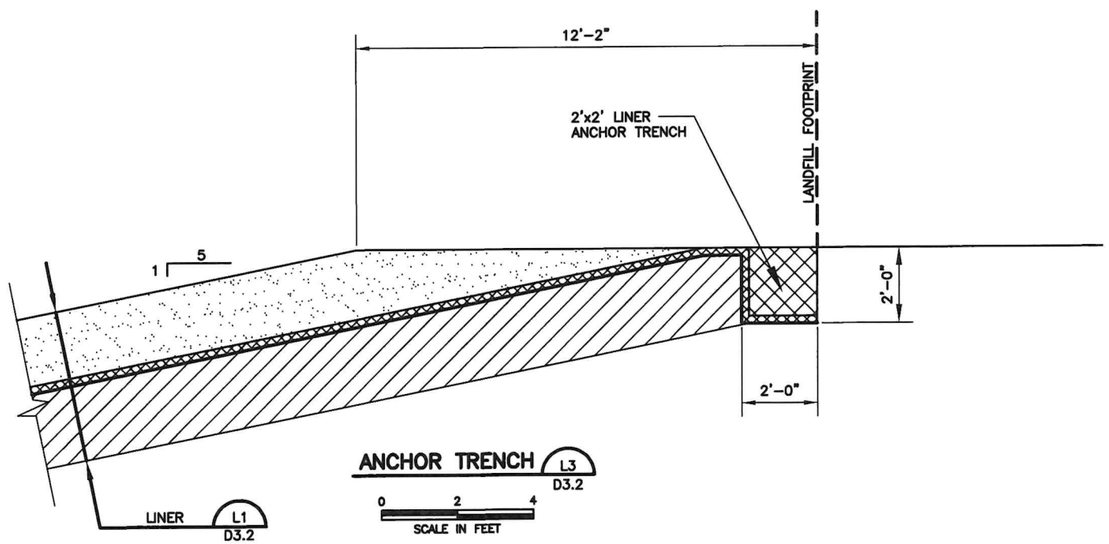
SCALE IN FEET



EXISTING LINER TIE-IN L2 D3.2

0 2 4

SCALE IN FEET



ANCHOR TRENCH L3 D3.2

0 2 4

SCALE IN FEET

NOTES:

1. REFER TO ATTACHMENT D7 FOR LINER INSTALLATION AND MATERIAL REQUIREMENTS.

STATE OF TEXAS
GREGORY W. ADAMS
73356
LICENSED
PROFESSIONAL ENGINEER

3/31/2026

REVISIONS			
REV	DATE	DESCRIPTION	DWN BY

LINER DETAILS

WASTE MANAGEMENT OF TEXAS, INC. SKYLINE LANDFILL

BIGGS & MATHEWS ENVIRONMENTAL
1700 ROBERT ROAD, STE. 100
MANSFIELD, TEXAS 76063
817-563-1144

TBPELS FIRM NO. F-256 AND NO. 10194895
TBPG FIRM NO. 50222

DRAWING D3.2

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RISER VAULT (TYP) LCS3 D3.5

SUMP RISER PIPES (TYP) LCS1 D3.4

LEACHATE SUMP (TYP) LCS1 D3.5

LCS2 D3.4 LEACHATE TRENCH (TYP)

LCS1 D3.5 LEACHATE SUMP (TYP)

SUMP RISER PIPES (TYP) LCS1 D3.4

RISER VAULT (TYP) LCS3 D3.4

LEACHATE STORAGE TANKS

E 2527000 E 2528000 E 2529000 E 2530000 E 2531000 E 2532000 E 2533000

N 6889000 N 6888000 N 6887000 N 6886000 N 6885000

0 300 600
SCALE IN FEET

LEGEND

- PERMIT BOUNDARY
- LANDFILL FOOTPRINT
- N 6887000 — STATE PLANE GRID (NAD 83)
- 434 — PROPOSED 2' TOP OF PROTECTIVE COVER CONTOUR
- EXISTING SUBTITLE D LINER WITH LEACHATE COLLECTION SYSTEM

STATE OF TEXAS
GREGORY W. ADAMS
73356
LICENSED
PROFESSIONAL ENGINEER

3/31/2026

LEACHATE COLLECTION SYSTEM PLAN

WASTE MANAGEMENT OF TEXAS, INC. SKYLINE LANDFILL

BIGGS & MATHEWS ENVIRONMENTAL
1700 ROBERT ROAD, STE. 100
MANSFIELD, TEXAS 76063
817-563-1144

TBPELS FIRM NO. F-256 AND NO. 10194895
TBPG FIRM NO. 50222

DRAWING D3.3

REVISIONS			
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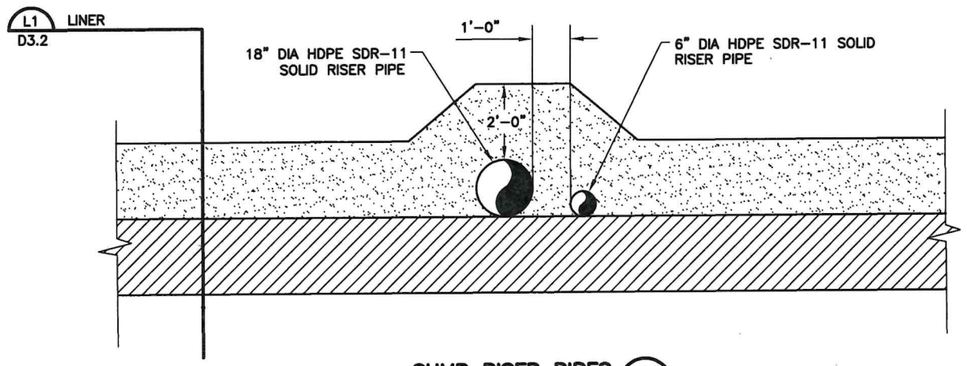
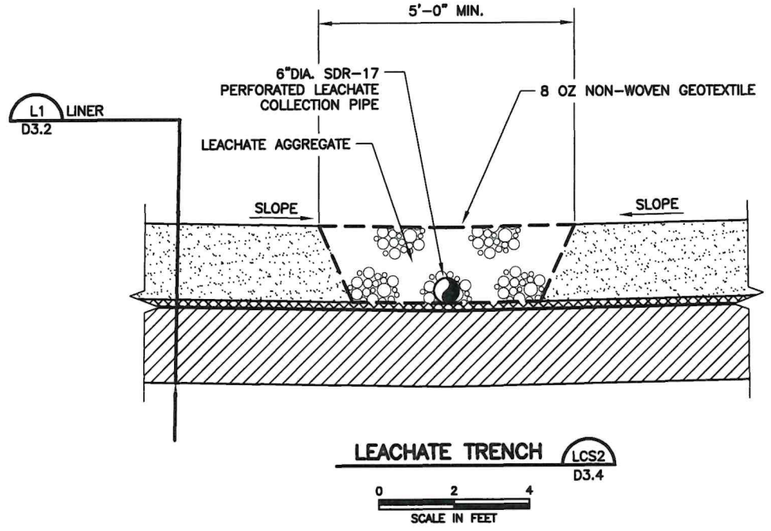


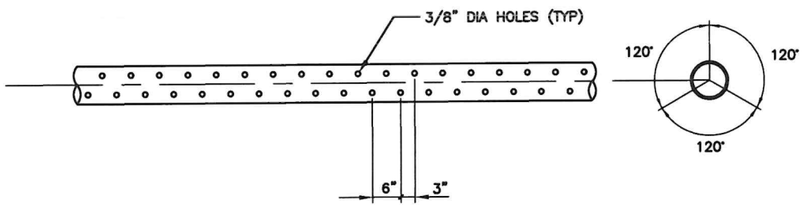
SUMP RISER PIPES LCS1 D3.4

0 2 4
SCALE IN FEET



LEACHATE TRENCH LCS2 D3.4

0 2 4
SCALE IN FEET



PERFORATED PIPE LCS3 D3.4

NTS

NOTE:

PERFORATION SCHEDULE APPLIES TO BOTH 6" LEACHATE COLLECTION PIPE AND 18" SUMP PIPE.

NOTES:

1. REFER TO ATTACHMENTS D6 AND D7 FOR INSTALLATION AND MATERIAL REQUIREMENTS.

STATE OF TEXAS
GREGORY W. ADAMS
73356
LICENSED
PROFESSIONAL ENGINEER

3/31/2026

REVISIONS			
REV	DATE	DESCRIPTION	DWN BY

LEACHATE COLLECTION SYSTEM DETAILS

WASTE MANAGEMENT OF TEXAS, INC. SKYLINE LANDFILL

BIGGS & MATHEWS ENVIRONMENTAL
1700 ROBERT ROAD, STE. 100
MANSFIELD, TEXAS 76063
817-563-1144

TBPELS FIRM NO. F-256 AND NO. 10194895
TBPG FIRM NO. 50222

DRAWING D3.4

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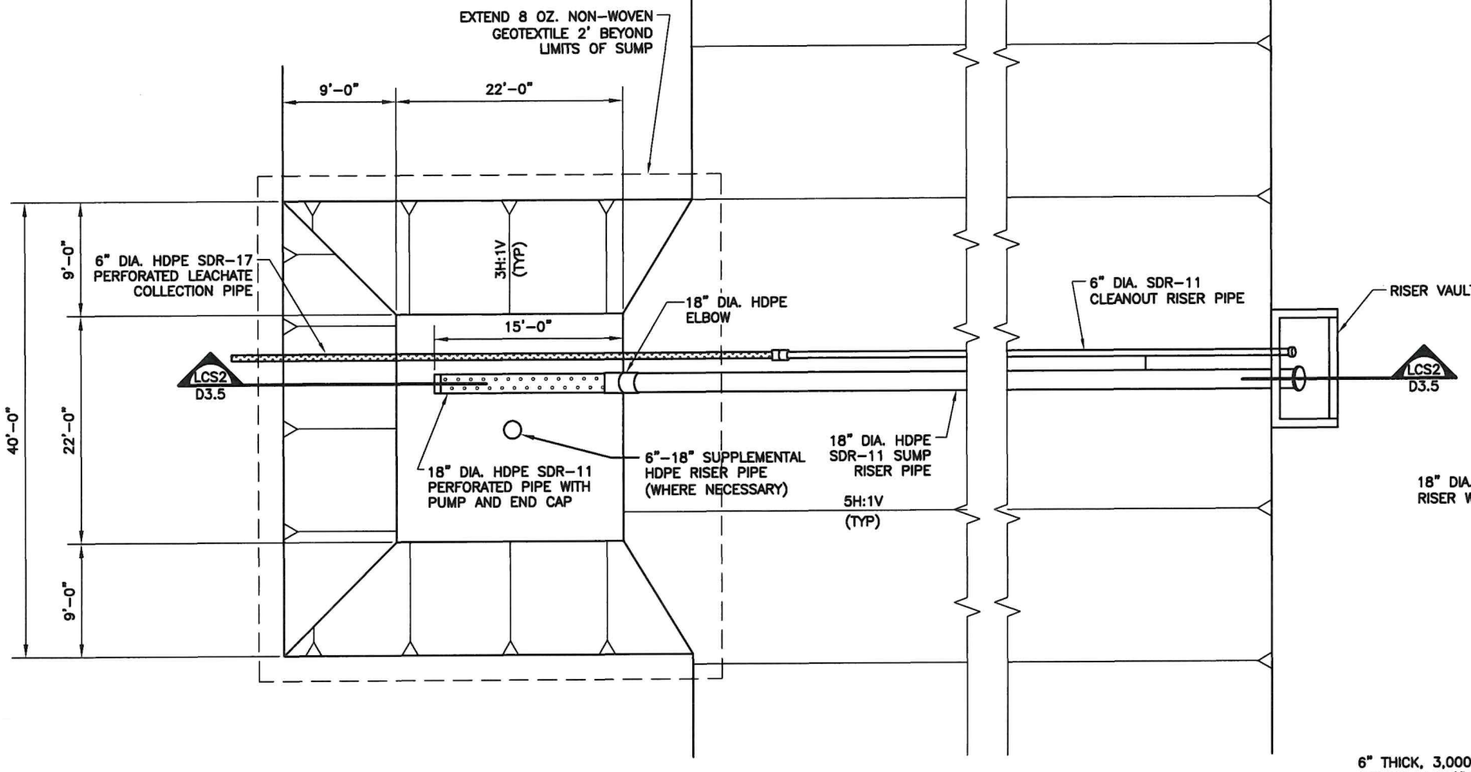
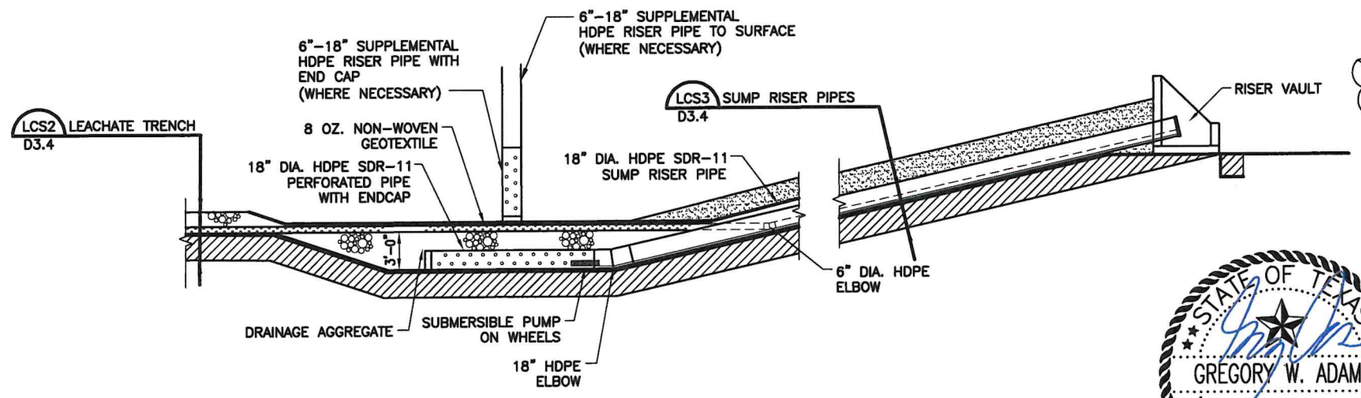


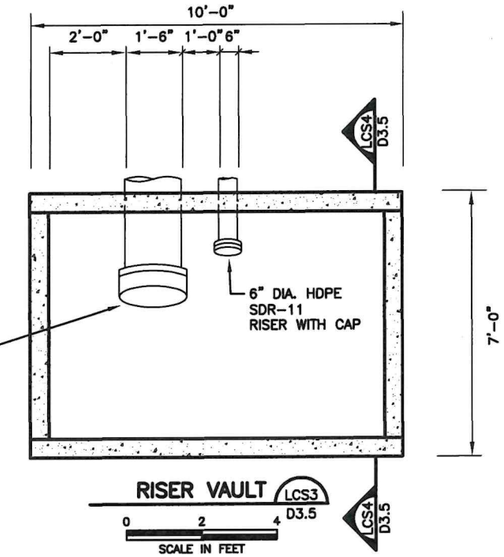
LEACHATE SUMP LCS1 D3.5

NTS



LEACHATE SUMP SECTION LCS2 D3.5

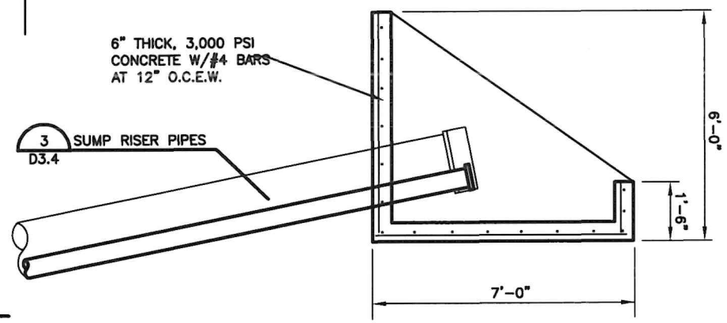
NTS



RISER VAULT LCS3 D3.5

0 2 4

SCALE IN FEET



RISER VAULT SECTION LCS4 D3.5

0 2 4

SCALE IN FEET

STATE OF TEXAS
GREGORY W. ADAMS
73356
LICENSED
PROFESSIONAL ENGINEER

3/31/2026

REVISIONS			
REV	DATE	DESCRIPTION	DWN BY

LEACHATE COLLECTION SYSTEM DETAILS

WASTE MANAGEMENT OF TEXAS, INC. SKYLINE LANDFILL

BIGGS & MATHEWS ENVIRONMENTAL
1700 ROBERT ROAD, STE. 100
MANSFIELD, TEXAS 76063
817-563-1144

TBPELS FIRM NO. F-256 AND NO. 10194895
TBPG FIRM NO. 50222

DRAWING D3.5

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0 250 500
SCALE IN FEET

LEGEND

- PERMIT BOUNDARY
- FLOOR DRAIN
- SIDEWALL DRAIN
- FLOW DIRECTION
- N 6889000 STATE PLANE GRID (NAD 83)
- EXISTING LINED AREA WITH DEWATERING SYSTEM

NOTE:

1. CONTOURS DEPICT EXCAVATION GRADES.
2. SIDEWALL DRAIN LOCATIONS ARE APPROXIMATE. ACTUAL LOCATION TO BE DETERMINED BASED ON FIELD CONDITIONS.

STATE OF TEXAS
GREGORY W. ADAMS
73356
LICENSED
PROFESSIONAL ENGINEER

3/31/2026

TEMPORARY DEWATERING PLAN

WASTE MANAGEMENT OF TEXAS, INC. SKYLINE LANDFILL

BME

BIGGS & MATHEWS ENVIRONMENTAL
1700 ROBERT ROAD, STE. 100
MANSFIELD, TEXAS 76063
817-563-1144

TBPELS FIRM NO. F-256 AND NO. 10194895
TBPG FIRM NO. 50222

DRAWING D3.6

REVISIONS			
REV	DATE	DESCRIPTION	DWN BY

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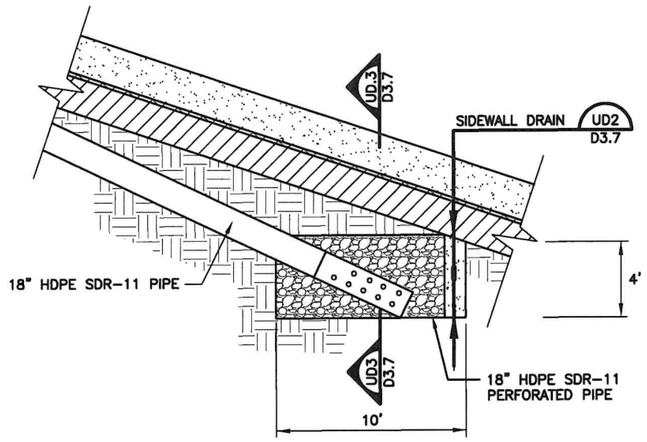
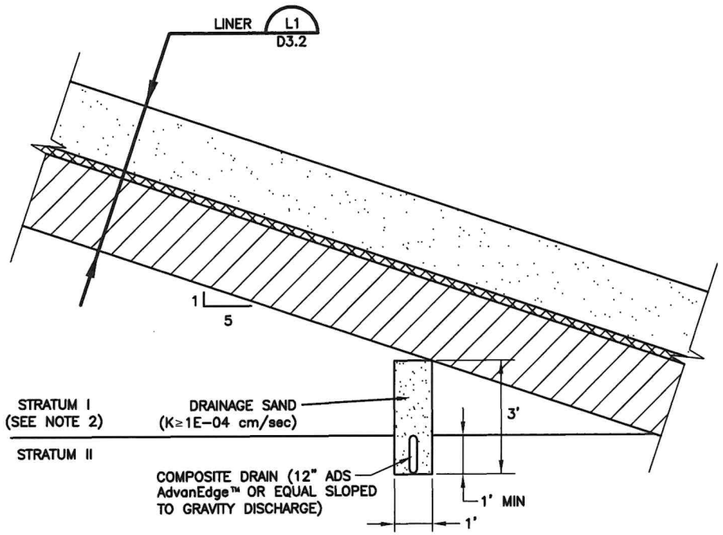


DEWATERING SUMP AND RISER UD1 D3.7

(SEE NOTE 3)

0 4 8

SCALE IN FEET



SIDEWALL DRAIN UD2 D3.7

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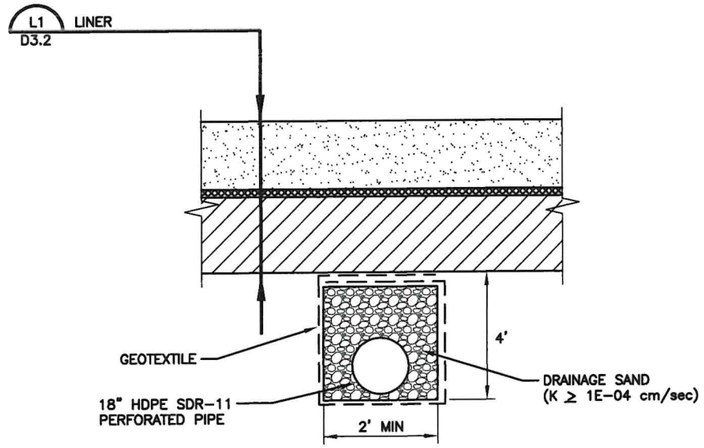

DEWATERING SUMP UD3 D3.7

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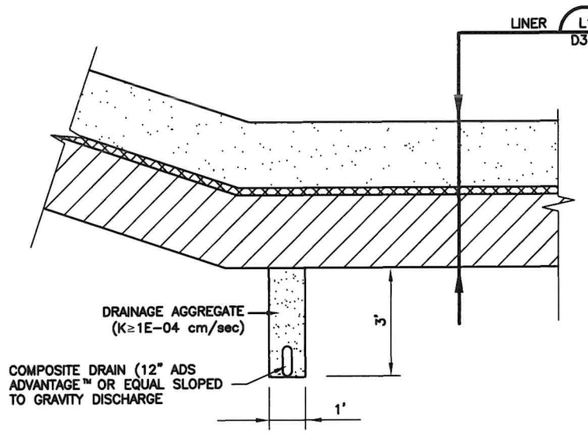

FLOOR DRAIN UD4 D3.7

0 2 4

SCALE IN FEET

NOTES:

1. REFER TO ATTACHMENT D7 FOR INSTALLATION AND MATERIAL REQUIREMENTS.
2. SIDEWALL DRAIN LOCATION TO BE DETERMINED IN THE FIELD BASED ON THE ACTUAL LOCATION OF STRATUM I AND II.
3. A DEWATERING SUMP WILL ONLY BE REQUIRED WHEN SIDEWALL DRAIN CANNOT BE GRAVITY DRAINED TO AN ADJACENT OPEN EXCAVATION.

STATE OF TEXAS
GREGORY W. ADAMS
73356
LICENSED
PROFESSIONAL ENGINEER

3/31/2026

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DEWATERING DETAILS

WASTE MANAGEMENT OF TEXAS, INC. SKYLINE LANDFILL

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1700 ROBERT ROAD, STE. 100
MANSFIELD, TEXAS 76063
817-563-1144

TBPELS FIRM NO. F-256 AND NO. 10194895
TBPG FIRM NO. 50222

DRAWING D3.7

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FINAL COVER PLAN

WASTE MANAGEMENT OF TEXAS, INC. SKYLINE LANDFILL

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817-563-1144

TBPELS FIRM NO. F-256 AND NO. 10194895
TBPG FIRM NO. 50222

DRAWING D3.8

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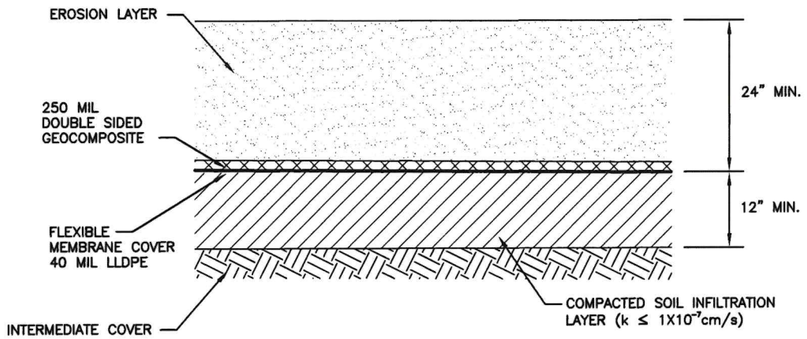

TOP DECK FINAL COVER FC1 D3.9

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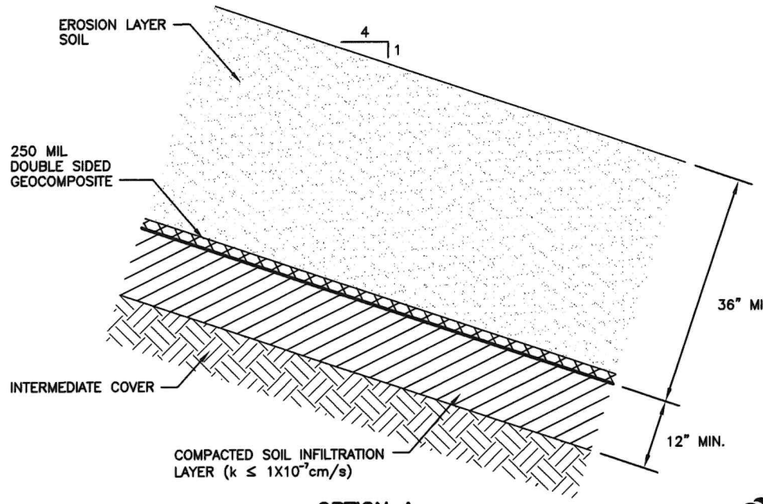
SCALE IN FEET



OPTION A
SIDESLOPE FINAL COVER FC2 D3.9

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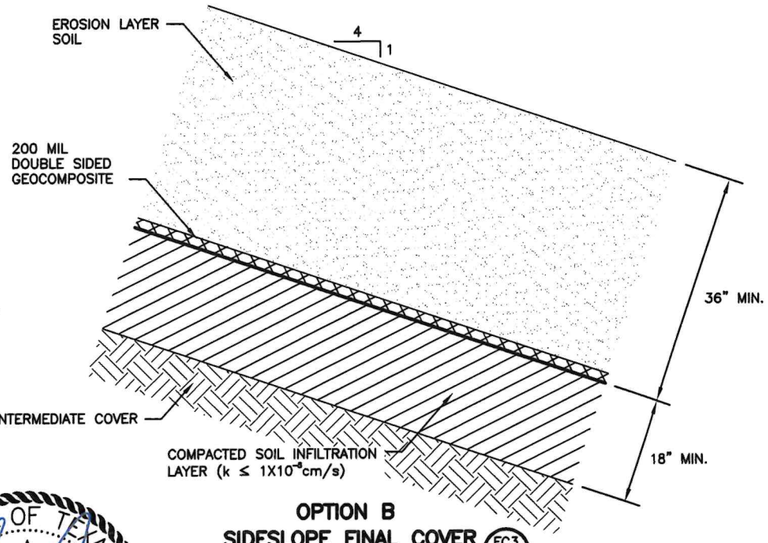
SCALE IN FEET



OPTION B
SIDESLOPE FINAL COVER FC3 D3.9

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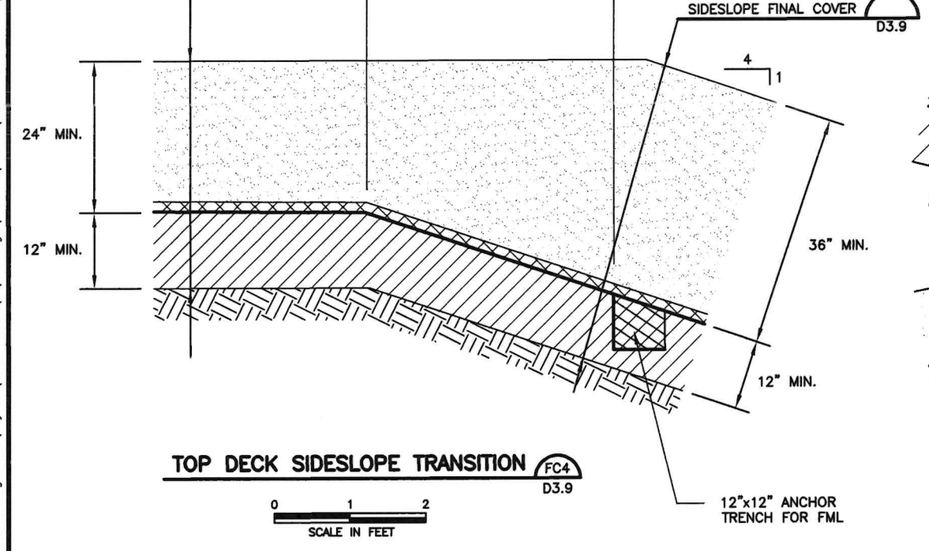

TOP DECK SIDESLOPE TRANSITION FC4 D3.9

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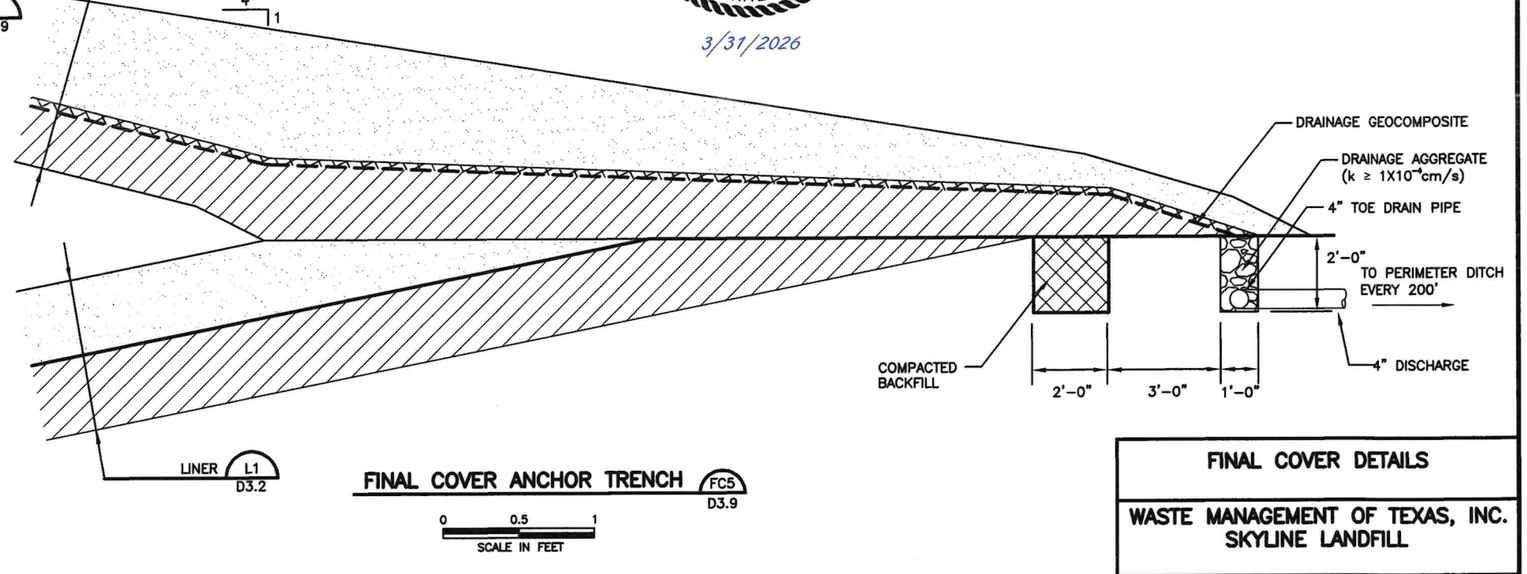

FINAL COVER ANCHOR TRENCH FC5 D3.9

0 0.5 1
SCALE IN FEET

NOTE:

1. REFER TO ATTACHMENT D8 FOR COVER INSTALLATION AND MATERIAL.

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FINAL COVER DETAILS

WASTE MANAGEMENT OF TEXAS, INC.
SKYLINE LANDFILL

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TBPELS FIRM NO. F-256 AND NO. 10194895
TBPG FIRM NO. 50222

DRAWING D3.9

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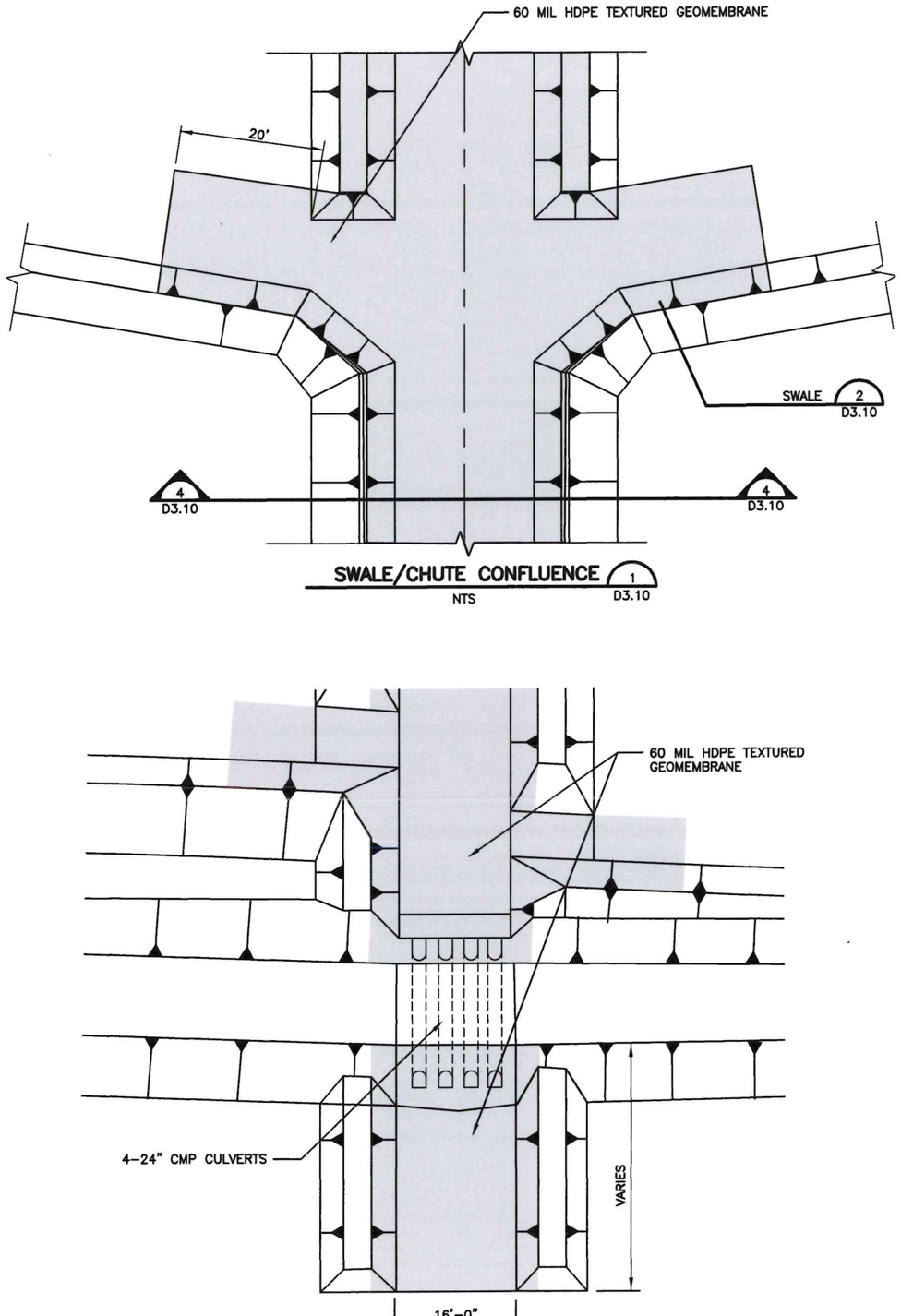
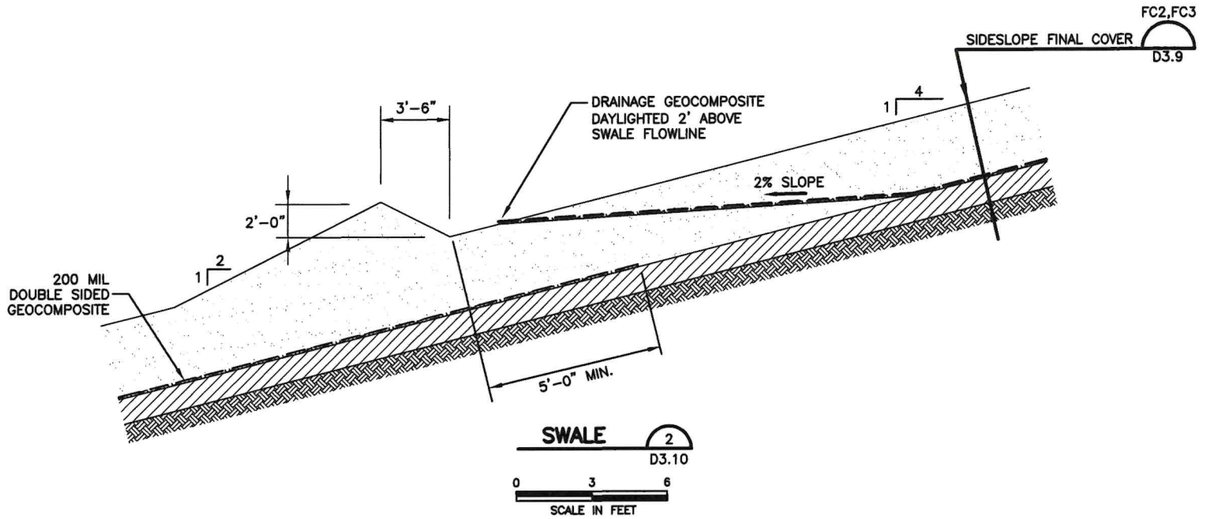


SWALE/CHUTE CONFLUENCE 1 D3.10

NTS



SWALE 2 D3.10

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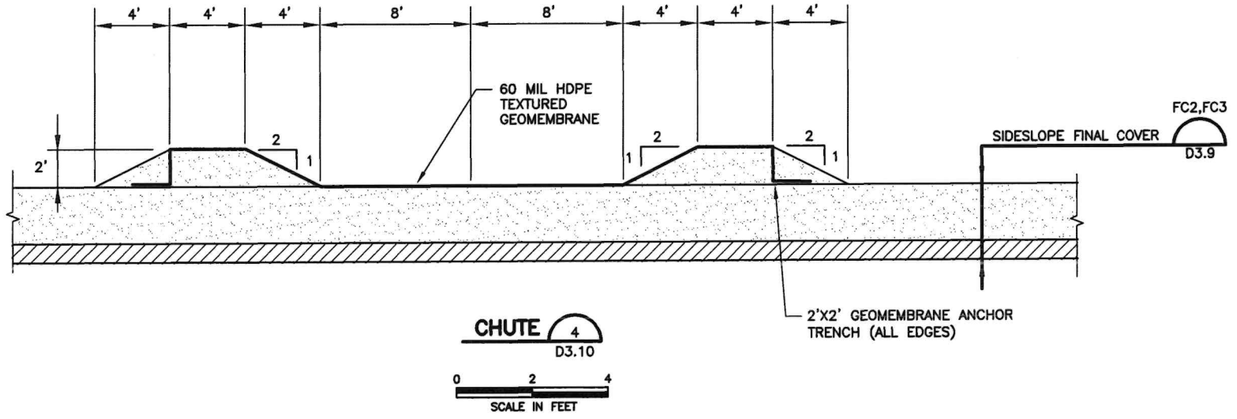
SCALE IN FEET



CHUTE 4 D3.10

0 2 4

SCALE IN FEET

CHUTE OUTLET 3 D3.10

NTS

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DRAINAGE DETAILS

WASTE MANAGEMENT OF TEXAS, INC. SKYLINE LANDFILL

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817-563-1144

TBPELS FIRM NO. F-256 AND NO. 10194895

TBPG FIRM NO. 50222

DRAWING D3.10

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WASTE MANAGEMENT SKYLINE LANDFILL
DALLAS AND ELLIS COUNTIES, TEXAS
PERMIT AMENDMENT APPLICATION NO. MSW 42E

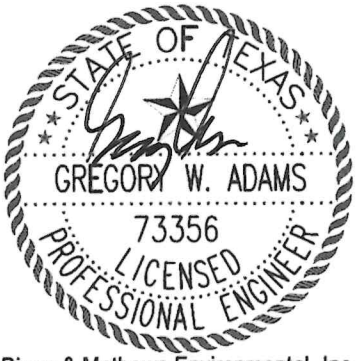
PART III – FACILITY INVESTIGATION AND DESIGN

ATTACHMENT D4
SITE LIFE CALCULATIONS

Prepared for

WASTE MANAGEMENT OF TEXAS, INC.

December 2025



Biggs & Mathews Environmental, Inc.
Firm Registration No. F-256
3/31/2026

Prepared by

BIGGS & MATHEWS ENVIRONMENTAL
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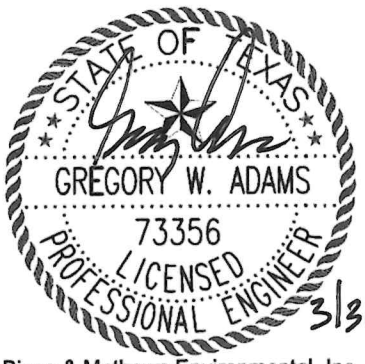
TEXAS BOARD OF PROFESSIONAL ENGINEERS AND LAND SURVEYORS
FIRM REGISTRATION NO. F-256 AND NO. 10194895

TEXAS BOARD OF PROFESSIONAL GEOSCIENTISTS
FIRM REGISTRATION NO. 50222



3/31/2026

Biggs & Mathews Environmental, Inc.
Firm Registration No. F-256

CONTENTS

1 SOLID WASTE GENERATION 1

2 SOLID WASTE COMPACTION 2

3 LANDFILL CAPACITY 3

4 SITE LIFE CALCULATIONS 4

1 SOLID WASTE GENERATION

30 TAC §330.63(d)(4)(D)

The Skylne Landfill will accept waste generated in Dallas, Ellis, and surrounding Texas counties. The Skyline Landfill will initially receive approximately 6,090 tons of waste a per day. The facility will accept waste 6 days per week (312 days per year). The facility projects that the waste acceptance rate will increase 1 percent per year for the life of the facility.

2 SOLID WASTE COMPACTION

An airspace utilization factor (ratio of tons of waste accepted to in-place cubic yard volume of waste disposed plus weekly and intermediate cover material) of 0.75 was used to calculate the projected site life based on the total landfill capacity.

3 LANDFILL CAPACITY

The landfill capacity is defined as the volume between the top of protective cover to the bottom of final cover, and was estimated using Civil 3D® computer software to be 126,075,000 cubic yards and the remaining capacity was estimated to be 71,314,000 cubic yards.

4 SITE LIFE CALCULATIONS

The waste acceptance rate will increase at an annual rate of 1%.
Beginning Waste Accepted = 1,900,000 tons
Airspace Utilization Factor = 0.75
The facility accepts waste 312 days per year (6 days a week).

AUF:	0.75	Total waste capacity =	71,314,141 cy
Year 1 Waste:	1,900,000 tons	Total waste tonnage =	53,485,606 tons
Days Operating	312		

Year	Annual Waste (tons)	Daily Waste (tons/day)	Accumulated Waste (tons)	Remaining Capacity (tons)	Annual Waste (cy)	Accumulated Waste (cy)	Remaining Capacity (cy)
1	1,900,000	6,090	1,900,000	51,585,606	2,533,333	2,533,333	68,780,808
2	1,919,000	6,151	3,819,000	49,666,606	2,558,667	5,092,000	66,222,141
3	1,938,190	6,212	5,757,190	47,728,416	2,584,253	7,676,253	63,637,888
4	1,957,572	6,274	7,714,762	45,770,844	2,610,096	10,286,349	61,027,792
5	1,977,148	6,337	9,691,910	43,793,696	2,636,197	12,922,546	58,391,595
6	1,996,919	6,400	11,688,829	41,796,777	2,662,559	15,585,105	55,729,036
7	2,016,888	6,464	13,705,717	39,779,889	2,689,184	18,274,289	53,039,852
8	2,037,057	6,529	15,742,774	37,742,832	2,716,076	20,990,365	50,323,776
9	2,057,428	6,594	17,800,202	35,685,404	2,743,237	23,733,602	47,580,539
10	2,078,002	6,660	19,878,204	33,607,402	2,770,669	26,504,272	44,809,869
11	2,098,782	6,727	21,976,986	31,508,620	2,798,376	29,302,648	42,011,493
12	2,119,770	6,794	24,096,756	29,388,850	2,826,360	32,129,008	39,185,133
13	2,140,968	6,862	26,237,723	27,247,882	2,854,623	34,983,631	36,330,510
14	2,162,377	6,931	28,400,101	25,085,505	2,883,170	37,866,801	33,447,340
15	2,184,001	7,000	30,584,102	22,901,504	2,912,001	40,778,802	30,535,339
16	2,205,841	7,070	32,789,943	20,695,663	2,941,121	43,719,923	27,594,218
17	2,227,899	7,141	35,017,842	18,467,764	2,970,533	46,690,456	24,623,685
18	2,250,178	7,212	37,268,020	16,217,585	3,000,238	49,690,694	21,623,447
19	2,272,680	7,284	39,540,701	13,944,905	3,030,240	52,720,934	18,593,207
20	2,295,407	7,357	41,836,108	11,649,498	3,060,543	55,781,477	15,532,664
21	2,318,361	7,431	44,154,469	9,331,137	3,091,148	58,872,625	12,441,516
22	2,341,545	7,505	46,496,013	6,989,592	3,122,060	61,994,684	9,319,457
23	2,364,960	7,580	48,860,973	4,624,632	3,153,280	65,147,965	6,166,176
24	2,388,610	7,656	51,249,583	2,236,023	3,184,813	68,332,778	2,981,363
25	2,412,496	7,732	53,662,079	-176,473	3,216,661	71,549,439	-235,298

WASTE MANAGEMENT SKYLINE LANDFILL
DALLAS AND ELLIS COUNTIES, TEXAS
PERMIT AMENDMENT APPLICATION NO. MSW 42E

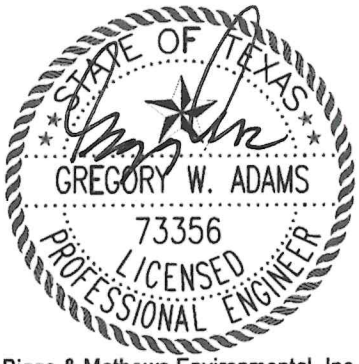
PART III – FACILITY INVESTIGATION AND DESIGN

ATTACHMENT D5
GEOTECHNICAL DESIGN

Prepared for

WASTE MANAGEMENT OF TEXAS, INC.

March 2026



Biggs & Mathews Environmental, Inc.
Firm Registration No. F-256

3/31/2026

Prepared by

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TEXAS BOARD OF PROFESSIONAL ENGINEERS AND LAND SURVEYORS
FIRM REGISTRATION NO. F-256 AND NO. 10194895

TEXAS BOARD OF PROFESSIONAL GEOSCIENTISTS
FIRM REGISTRATION NO. 50222

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1 GEOTECHNICAL TESTING 1

2 SUBSURFACE MATERIALS 2

3 EARTHWORK 4

4 CONSTRUCTION BELOW THE GROUNDWATER TABLE 5

5 SETTLEMENT AND HEAVE ANALYSIS 7

6 SLOPE STABILITY ANALYSES 8

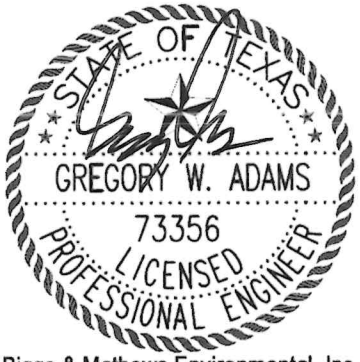
7 LINER CONSTRUCTION 11

8 COVER CONSTRUCTION 13

APPENDIX D5A – SETTLEMENT/HEAVE ANALYSIS

APPENDIX D5B – SLOPE STABILITY ANALYSES

APPENDIX D5C – INTERFACE FRICTION TEST RESULTS



Biggs & Mathews Environmental, Inc.
Firm Registration No. F-256

3/31/2026

1 GEOTECHNICAL TESTING

30 TAC §330.63(e)(5)

The geotechnical report is based on the field explorations described in Attachment E. Geotechnical tests were performed on samples recovered from the borings to evaluate the physical and engineering properties of the subsurface materials. The results of the laboratory tests are provided in Attachment E, Appendix E8.

Test results from previous field explorations and soil liner construction at the Skyline landfill were used to augment the test results from this investigation. Test results from the current and previous explorations were used to classify the soils according to the Unified Soil Classification System (USCS) and to evaluate the engineering properties of the soils. Unit dry weight, natural moisture content Atterberg Limits and particle size analyses tests were performed to determine the physical and index properties of the soils. Triaxial tests were used to determine strength properties for slope stability and consolidation tests were used in the settlement and heave analysis.

Hydraulic conductivity tests were performed on undisturbed samples from the explorations on the units that will form the bottom and sides of the proposed excavation. All the Stratum II samples were too small to extract samples for horizontal testing. Therefore, field tests from previous explorations were used to determine the horizontal permeability of the excavation sidewall soils. The laboratory and field test results were used to evaluate the hydrogeologic parameters of the site and the hydraulic conductivity of engineered fill constructed from on-site materials.

2 SUBSURFACE MATERIALS

30 TAC §330.63(e)(5)

Multiple subsurface investigations have been performed at the site as described in Attachment E. The general site stratigraphy is summarized in the table below.

Generalized Site Stratigraphy

Geologic Unit	Lithology	Average Depth to Top of Unit (ft)	Average Thickness of Unit (ft)
Stratum I - Weathered Taylor Marl	Clay and weathered shale	Surface outcrop	28
Stratum II – Unweathered Taylor Marl	Shale, clayey	28	425

2.1 Material Properties

The laboratory test results are included in Attachment E, Appendix E8 and are summarized on the Average Properties of On-Site Materials table in Section 2.2. These test results were reviewed along with the boring logs to develop generalized soil properties for use in the analyses. As shown on the cross sections in Attachment D2, the excavations will encounter mostly clay.

2.2 Material Requirements

On-site soils will be required for construction of the compacted soil liner and protective cover components of the liner system, and for the infiltration layer and erosion layer components of the final cover system. On-site soils will also be required for operational cover (daily and intermediate) and general earth fill. Typical material requirements for the various landfill components are summarized in the Typical Soil Requirements for Landfill Construction table below.

The soil liner and final cover infiltration layer must be constructed from soils that can be compacted to form a low hydraulic conductivity barrier. The classification and hydraulic conductivity test results indicate that the Stratum I and Stratum II soils excavated from the site will be satisfactory for use as compacted soil liner and infiltration layer material. Their effectiveness for soil liner has been demonstrated during the construction of Cells 1 through 18.

Protective cover and erosion layer soils must not contain large rocks. Operational cover soils must not have been previously mixed with waste materials and erosion layer material must be capable of sustaining vegetation. The test results and boring logs indicate that any of the soil material excavated from the site will be suitable for use as operational and protective cover and that the surficial soils will be suitable for use as the upper layer of the final cover system erosion layer.

General earth fill used to construct the site roads and embankments should consist of clayey soils. The classification test results indicate that the on-site soils are suitable for use as structural fill material.

Average Properties of On-Site Materials[1]

Unit	USCS Classification	Liquid Limit %	Plastic Limit %	Plasticity Index %	Passing 200 Sieve %	Moisture Content %	Unit Dry Weight (pcf)	Lab Permeability[2] (cm/sec)
I	CH	73	22	51	95	20.8	102.2	2.0×10^{-7}
II	CH or CL	53	19	34	95	17.4	106.7	4.8×10^{-9}

[1]Refer to laboratory test summary in Attachment E, Appendix E8 for source data.

[2]Average lab permeability calculated based on arithmetic mean.

Typical Soil Requirements for Landfill Construction

Landfill Component	Classification	LL	PI	% - 200	Hydraulic Conductivity cm/sec	Material Source
Soil Liner	SC, CL, CH, MH	30 min	15 min	30 min	1×10^{-7} max	On-site
Infiltration Layer	SC, CL, CH, MH	30 min	15 min	30 min	1×10^{-7} max	
Protective Cover	SP, SW, SM, SC, CL, CH, ML, MH	No large rocks				
Erosion Layer	SC, CL, CH, SM, ML, CL-ML	30 min	15 min	30 min	NA	
Operational Cover (Daily Cover, Intermediate Cover)	SP, SC, CL, CH, CL-ML, MH, ML	Not mixed with waste				
General Fill	SC, CL, CH, ML, CL-ML, MH	NA	5 min	15 min	NA	

3 EARTHWORK

30 TAC §330.337(e)

3.1 Excavation

The cross sections in Attachment D2 show that the excavation will be up to 88 feet below the surrounding ground surface. The excavation may encounter any of the materials identified in Stratums I and II. The excavated materials should be visually classified and may be stockpiled separately according to the construction material properties outlined in the Typical Soil Requirements for Landfill Construction table. Prior to use the soils will be tested for suitability in accordance with Attachment D7 and Attachment D8. Excavation and construction below the groundwater table is discussed in Section 4 and the stability of excavation slopes is discussed in Section 6.

3.2 Earth Fill

General fill should consist of clayey soils, which are free of organic or other objectionable materials. General fill should be spread in maximum 9-inch-thick loose lifts. General fill should be compacted to a minimum of 95 percent of maximum dry density as defined by the standard Proctor test (ASTM D698), within a range of 2 percentage points below to 4 percentage points above optimum moisture content. A minimum of one standard Proctor test should be performed on each representative soil used as general fill material.

4 CONSTRUCTION BELOW THE GROUNDWATER TABLE

30 TAC §330.337

4.1 Groundwater Elevations

Groundwater may be encountered in the landfill excavation within the Stratum I materials. The highest recorded groundwater elevations for the site are included in Attachment D7, Appendix D7A.

4.2 Temporary Dewatering System

As shown in Attachment D3, Drawing D3.7, the excavation will extend below the highest recorded groundwater elevations in the Stratum I materials, including a portion of side slopes. Consequently, the liners will be constructed below the highest measured groundwater elevations at the locations shown in Drawing D3.7. Areas where the liner is to be constructed below the highest measured groundwater elevations will be dewatered during and after construction by a temporary dewatering system. The temporary dewatering system on the side slopes will consist of drainage trenches with either prefabricated composite drains encased in sand or drainage pipe encased in aggregate. The side slope dewatering trenches will discharge into open sumps beyond the lined areas or closed sumps beneath the lined areas. The groundwater will be pumped from the sumps into the perimeter drainage system. The temporary dewatering system will be operated until sufficient ballast has been placed to offset the hydrostatic forces.

The anticipated location of the temporary dewatering system is shown in Attachment D3, Drawing D3.7. The actual location of the dewatering system will be adjusted based upon where the Stratum I and II interface is exposed in the subgrade. The design procedures and typical details of the temporary dewatering system are provided in Appendix D7B. Design and installation of the temporary dewatering system will be documented in the Soils and Liner Evaluation Report (SLER) in accordance with Attachment D7, Section 9.2. The facility will submit a Ballast Evaluation Report (BER) to the TCEQ once it is determined that ballasting or dewatering is no longer necessary. If the TCEQ does not provide a response within 14 days of the date of receipt of the BER, the facility will discontinue dewatering and/or ballasting operations.

4.3 Hydrostatic Uplift

Liners constructed below the groundwater table may experience hydrostatic pressure. Resistance to uplift from hydrostatic forces will be provided by the weight of the protective cover, waste, daily cover, intermediate cover, and final cover system. The temporary dewatering system will be operated to keep the groundwater lowered until sufficient ballast has been placed to offset hydrostatic forces.

The ballast requirements for each cell must be based on the highest recorded groundwater elevations as shown in Attachment D7, Appendix D7A. For example, ballast calculations

provided in Attachment D7, Appendix D7C show the height of solid waste that must be placed to offset the hydrostatic forces with a minimum factor of safety of 1.5.

The highest recorded groundwater elevations must be updated before the construction of each cell and adjusted upward if necessary. The ballast design must be verified to be adequate for the design groundwater elevations prior to the construction of each cell. Ballast calculation, placement, and documentation procedures are provided in Attachment D7.

Once the required height of compacted waste has been achieved for each cell area, temporary groundwater control measures will be decommissioned, and the groundwater allowed to rebound. The facility will submit a BER to the TCEQ once it is determined that ballasting or dewatering is no longer necessary. If the TCEQ does not provide a response within 14 days of the date of receipt of the BER, the facility will discontinue dewatering or ballasting operations. Operational procedures for ballast placement are discussed in Part IV. Documentation requirements are discussed in Attachment D7.

5 SETTLEMENT AND HEAVE ANALYSIS

30 TAC §330.337(e)

5.1 Subgrade Heave

Heave or rebound can occur in cohesive soils after the removal of overburden. Heave occurs relatively soon after excavating the overburden and is directly related to the depth of the excavation. The potential heave in the subgrade beneath the floor of the landfill was calculated from the recompression index and the unit weights of the overburden soils. The predicted heave is no greater than 5 inches and should be relatively uniform over the landfill floor. Since the heave should occur during and soon after excavation it will not adversely affect the performance of the liner system. Subgrade heave calculations are presented in Appendix D5A.

5.2 Subgrade Settlement

Settlement may occur due to consolidation of cohesive soils from the weight of the landfill components (i.e., liner, solid waste, and final cover systems). The predicted maximum differential settlement is less than 2 inches. The settlement of the liner should be generally uniform and is within the strain tolerance of the liner system. Furthermore, subgrade settlement will occur slowly as the waste is deposited allowing redistribution of stresses within the layers. Any differential settlement should be distributed over the distance from near the center of the fill where the waste thickness is greater to the perimeter where the fill thickness is less. Subgrade settlement calculations are presented in Appendix D5A.

5.3 Solid Waste Settlement

Consolidation and decomposition can produce settlement within the solid waste. Primary consolidation results from stress increase and occurs soon after load application and secondary consolidation results from the decomposition of solid waste. Due to the length of time that it will take to construct and fill the landfill, most of the consolidation in the waste will have occurred prior to construction of the final cover system. Minor settlement that occurs after the construction of the final cover system will be corrected by the addition of erosion layer material in accordance with Attachment I.

6 SLOPE STABILITY ANALYSES

30 TAC §330.337(e)

Slope stability analyses were performed on representative sections to predict the stability of the excavation slope, liner slope, interim waste slope, final waste slope and final cover slope. Excavation and liner slope sections were developed to represent the critical subsurface conditions that may be encountered.

The geometry of the sections was developed from the proposed excavation and final cover plans and from data on logs of borings drilled in the vicinity of each section. Water surface elevations were assumed at the highest recorded water levels.

The Summary of Material Weight and Strength Properties summarizes the unit weights and strength parameters that were used for the stability analyses. The unit weights and strength parameters for the Stratum I – II soils were selected based on a review of the historic and expansion boring logs and laboratory and field test results for the Skyline Landfill. The unit weights and strength parameters for solid waste were selected based on engineering judgment and published values. The strength parameters for the liner and cover geosynthetics were selected based on the most critical interface included in the Summary of Interface Friction Tests table.

Summary of Material Weight and Strength Properties[1]

Material	Description	Wet Weight (pcf)	Total Stress		Effective Stress	
			Cohesion (psf)	Friction (deg)	Cohesion (psf)	Friction (deg)
Stratum I	Clay and Weathered Shale	123.8	475	19	446	22.5
Stratum II	Shale, Clayey	125.3	3715	18	1598	28.4
Liner/Infiltration	Compacted Clay	115.0	475	19*	446	22.5
Protective Cover/ Erosion	Compacted Clay	109.3	475	19	446	22.5
Liner w/ GS	Soil / Geosynthetics[2]	N/A	59	31.8	1409	11.4
Solid Waste	Solid Waste	50	250	23	250	23

[1]Strength parameters for each material type represent internal strength except for geosynthetics which represent interface strength.

The Summary of Material Weight and Strength Properties table summarizes the strength parameters for the liner and cover geosynthetic materials that were selected based on the direct shear test results included in Appendix D5C. The direct shear test results were conducted by TRI/Environmental, Inc. with on-site soils and geosynthetics used for prior liner construction at the Skyline Landfill. The normal stresses applied to the direct shear box at each interface were 100-500 psf and 5,000-15,000 psf to represent the solid waste overburden stress for the conditions analyzed. The strength parameters for the 100-500 psf normal stress range were used for the veneer slope stability calculations. The strength

parameters for the 5,000-15,000 normal stress range were used for the interim waste and final waste slope stability analyses.

Summary of Interface Friction Tests

Material Interface	100-500 psf Normal Stress		5,000-15,000 psf Normal Stress	
	Cohesion (psf)	Friction (deg)	Cohesion (psf)	Friction (deg)
Protective Cover/Geocomposite	12	32.6	811	12.8
Geocomposite/Geomembrane/Soil Liner	59	31.8	1409	11.4
Geomembrane/Soil Liner	60	31.8	273	13.5

The excavation slope was analyzed for short-term conditions using total stress parameters and long-term conditions using effective stress parameters. The interim waste slope was analyzed for short-term conditions using total stress parameters. The final waste slope was analyzed for long-term conditions using effective stress parameters. The excavation slope with existing municipal solid waste surcharge was analyzed for long term conditions using effective stress parameters.

GEOSTASE, a computer program developed to model slope stability, was used to analyze the stability of the excavation slopes, interim waste slopes, excavation slope with municipal solid waste surcharge, and final waste slopes. The liner system and final cover systems were analyzed using the infinite slope method found in the Corps of Engineers "Design and Construction of Levees" Manual, EM 1110-2-1913.

Results of the stability analyses indicate that the proposed slopes are stable under the conditions analyzed. The Summary of Slope Stability Analyses table summarizes the results of the analyses and compares the calculated factor of safety to the recommended minimum factor of safety. The recommended minimum factors of safety were selected from EM 1110-2-1913. Slope stability analyses are provided in Appendix D5B.

Summary of Slope Stability Analyses

Condition	Minimum Calculated Factor of Safety	Recommended Factor of Safety	Acceptable Factor of Safety
Excavated Slope			
Short Term	2.7	1.3	Yes
Long Term	2.9	1.5	Yes
Excavation with Surcharge Circular	2.8	1.3	Yes
Excavation with Surcharge Block	2.6	1.3	Yes
Interim Waste Slope			
Circular Arc Failure	1.7	1.3	Yes
Sliding Block Failure	2.5	1.3	Yes
Final Waste Slope			
Circular Arc Failure	2.1	1.5	Yes
Sliding Block Failure	2.5	1.5	Yes
Liner Veneer			
Protective Cover/Geocomposite	3.5	1.3	Yes
Geocomposite/Geomembrane	4.4	1.3	Yes
Geomembrane/Soil Liner	4.5	1.3	Yes
Final Cover Veneer (Side Slope)			
Alternative Final Cover			
Erosion Layer/Geocomposite	2.9	1.5	Yes
Geocomposite/Infiltration Layer	2.9	1.5	Yes
Subtitle D Final Cover			
Erosion Layer/Geocomposite	2.9	1.5	Yes
Geocomposite/Geomembrane	3.9	1.5	Yes
Geomembrane/Infiltration Layer	3.9	1.5	Yes

The excavation with existing municipal solid waste surcharge, interim and final waste slope stabilities were analyzed for two failure modes, circular arc and block. Excavation stability was performed using only the circular arc failure mode. Material properties used for each of the analyses are tabulated on the drawing and in the detailed printout provided by GEOSTASE for each of the analyses.

The slope stability analyses are only valid for the conditions that were analyzed. Any changes to the excavation plan, dewatering system, ballast system, liner system, final cover system or landfill completion plan will necessitate that the slope stability analyses be revised to reflect the actual conditions. Interim 3H:1V waste slopes shall not exceed 380 feet in height. Waste must be placed and properly compacted in horizontal lifts not greater than 15 feet thick. Temporary construction slopes should not be steeper than the interim slopes and concentrated loadings such as heavy equipment and soil stockpiles should not be placed near the crest of slopes unless additional slope stability analyses are performed.

7 LINER CONSTRUCTION

30 TAC §330.331

The composite liner system will consist of a 2-foot-thick compacted soil liner overlain by a 60-mil HDPE geomembrane, a geocomposite drainage layer, and a 2-foot-thick layer of protective soil cover. The liner details are provided in Attachment D3.

7.1 Subgrade Preparation

The liner subgrade must be firm and stable. Prior to beginning liner construction, the subgrade should be proof-rolled with heavy, rubber-tired construction equipment to detect soft areas. Isolated soft areas should be undercut then backfilled with compacted earth fill in accordance with the requirements for general fill. Low areas should be brought to the design grades with general fill that is placed and compacted in accordance with the requirements in Section 4.

7.2 Compacted Soil Liner

The soil liner material must consist of relatively homogeneous cohesive materials, which are free of debris, rocks greater than 1-inch in diameter, plant materials, frozen materials, foreign objects, and organic material. Clay will be available from landfill excavations or on-site borrow sources to provide material for the compacted soil liners. Laboratory tests indicate that the remolded cohesive soils will meet the compacted soil liner requirements listed in 30 TAC §330.339(c)(5). The soil liner properties summarized in the table below are specified in Attachment D7.

Soil Liner Properties

Test	Specifications
In-Place Density	95% of Standard Proctor (ASTM D 698)
In-Place Moisture Content	Standard Proctor Optimum Moisture Content (OMC) or greater
Hydraulic Conductivity	1.0×10^{-7} cm/sec or less
Plasticity Index	15 minimum
Liquid Limit	30 minimum
Percent Passing No. 200 Mesh Sieve	30 minimum
Percent Passing 1-inch Sieve	100

Preconstruction sampling should be performed on soils to be used as liner material. At a minimum, one liquid limit, plastic limit, percent passing the No. 200 sieve, standard Proctor (ASTM D698), and hydraulic conductivity test should be performed for each borrow material type prior to use as liner material.

The soil liner material should be placed in 9-inch loose lifts to produce compacted lift thickness of approximately 6 inches. The material should be compacted to a minimum of 95 percent of the maximum dry density determined by standard Proctor (ASTM D698) at

optimum moisture content or greater. Rocks within the liner should be less than 1 inch in diameter and should not total more than 10 percent by weight. The material should be processed to a maximum particle size of 1 inch or less before water is added to adjust the moisture content. Soil processing may be achieved using a disc or soil pulverizer. Water should be applied as necessary to the material and worked into the material with a disc, pulverizer, or other suitable equipment. Water used for the soil liner compaction must not be contaminated by waste or any objectionable material.

The soil liner must be compacted with a pad/tamping-foot or prong-foot roller. A footed roller is necessary to achieve bonding between lifts, to reduce the clod size, and to achieve a blending of the soil matrix through kneading action. The compactor should weigh at least 40,000 pounds and make at least four passes across the area being compacted. A pass is defined as one pass of the compactor, front and rear drums. The Caterpillar 815 and 825 are examples of equipment typically used to achieve satisfactory results. The lift thickness shall be controlled to achieve total penetration into the top of the previously compacted lift; therefore, the lift thickness must not be greater than the pad or prong length. Cleaning devices on the compaction roller must be in place and maintained to prevent the prongs or pad feet from becoming clogged to the point that they cannot achieve full penetration. Soil liner shall not be compacted with a bulldozer, rubber-tired (pneumatic) roller, flat-wheel roller, scraper, truck, or any tracked equipment unless it is used to pull a footed roller.

7.3 Protective Cover

The protective cover should be constructed of soils that are free of debris, large rock, plant materials, frozen materials, foreign objects, and organic material. Soil will be available from landfill excavations or on-site borrow sources to provide material for protective cover.

7.4 Liner Testing and Documentation

Construction Quality Assurance (CQA) testing of the soil liner must be performed as the liner is being constructed. Liner system testing is addressed in Attachment D7. The construction methods and test procedures documented in the SLER must be consistent with the requirements of Attachment D7.

8 COVER CONSTRUCTION

30 TAC §§330.165, 330.457

8.1 Daily/Intermediate Cover

The daily and intermediate cover should be constructed of soils that are free of waste and debris. Suitable cover soils should be available from on-site sources such as the landfill excavations or on-site borrows. Requirements for the placement of daily and intermediate cover are provided in Part IV.

8.2 Final Cover

The final cover system will consist of a compacted soil infiltration layer overlain by a geocomposite or geomembrane and an erosion layer. The final cover system requirements are provided in Attachment D8 and the final cover system details are provided in Attachment D3.

The compacted soil infiltration layer material should consist of relatively homogeneous cohesive materials that are free of debris, rocks greater than 1 inch in diameter, plant materials, frozen materials, foreign objects, and organic material. The infiltration layer should be constructed directly over the intermediate cover once the waste has reached final grades. The infiltration layer construction procedure should be the same as those outlined in Section 7 for liner construction.

The erosion layer should consist of: (1) topsoil stockpiled during the excavation process, (2) on-site clay which has been amended to be capable of sustaining vegetation, or (3) an imported material suitable to sustain vegetative growth. This layer may be spread and placed in one lift over the drainage layer. After spreading, the layer should be rolled lightly to reduce future erosion, although not to the extent that compaction would inhibit plant growth.

8.3 Final Cover Testing and Documentation

CQA testing of the final cover system should be performed during construction. Final cover system requirements are outlined in Attachment D8.

SKYLINE LANDFILL

APPENDIX D5A
SETTLEMENT/HEAVE ANALYSIS

Settlement/Heave Analysis

Required: Estimate the following:

1) Subgrade heave
2) Subgrade settlement
3) Strain on liner from differential settlement

References:

1) *Essentials of Soil Mechanics and Foundations*, 2nd Edition, McCarthy, Reston Publishing.
2) *TM 5-818-1 Soils and Geology Procedures for Foundation Design of Buildings and Other Structures,* US Army COE, October 1983.
3) Daniel, David E. *Geotechnical Practice for Waste Disposal*, Chapman and Hall, Boundary Row, London, 1993.

Assumptions:

1) Typical material properties are shown below:

Material	Description	Moisture[a] %	Dry Wt[a] pcf	Wet Wt[b] pcf	C_c[c]	C_r[c]	P_c tsf
Stratum I	Clay	20.8	102.5	125.8	na	na	na
Stratum II	Shale	17.4	106.7	128.0	0.055	0.035	20
Erosion Layer	Clay	20.8	102.5	125.8	na	na	na
Liner/Infiltration	Clay	20.8	102.5	125.8	na	na	na
Protective Cover	Shale	17.4	106.7	128.0	na	na	na
Solid Waste	Solid Waste	na	na	50.0	na	na	na

[a] Geometric average from laboratory test values from current investigation

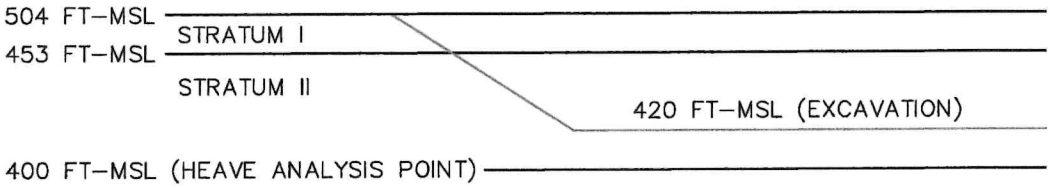
[b] Geometric average from current laboratory tests. Wet Wt = Dry Wt x (1 + Moisture)

[c] From consolidation test for Stratum II

2) Statum II consists of shale that is typically incompressible. The maximum heave will occur where the highest overburden stress exists since the entire base of excavation is in Stratum II. The design section is near the west corner of the new excavation area. It is the deepest excavation in the expansion area and its location is shown on page D5-A-6. The maximum settlement will occur where the highest amount of waste will be placed. This is in the northeast corner of the landfill. This analysis location is shown on page D5-A-6.

Solution: **1) Subgrade Heave**

Heave Analysis Section (see p D5-A-6 for location)



The heave in the subgrade is estimated from the equation:

$$R = [H / (1 + e_o)][C_r \log(P_f / P_o)]$$

where:
- R = heave in feet
- C_r = recompression index
- H = layer thickness in feet
- P_o = initial overburden pressure in tsf
- P_f = final overburden pressure in tsf
- e_o = initial void ratio

Determine the initial and final overburden pressure at the midpoint of the Stratum II.

Stratum	Overburden Layer	H_o ft	H_f ft	Unit Wt pcf	P_o tsf	P_f tsf
II	I	51.0	0.0	125.8	3.21	0.00
	II	26.5	10.0	128.0	1.70	0.64
II Total					**4.90**	**0.64**

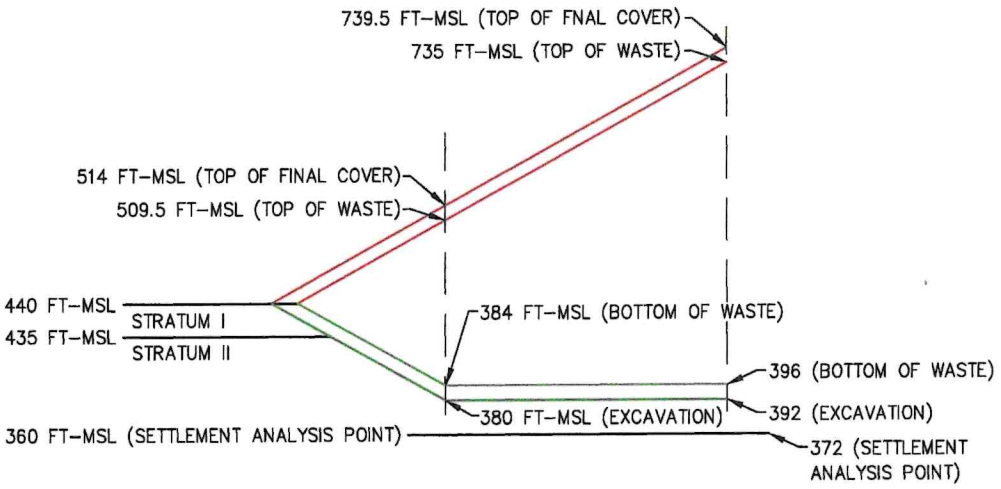
Determine the heave in the subgrade.

Stratum	H ft	P_o tsf	P_f tsf	C_r	e_o	R ft
II	20.0	4.90	0.64	0.035	0.64	-0.38
						-0.38

Maximum subgrade heave = **0.377** **ft**
4.530 **in**

2) Subgrade Settlement

Settlement Analysis Section (see p D5-A-6 for location)



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Settlement is estimated from the equation:

$$S = [H / (1 + e_o)][C_c \log(P_f / P_o)$$

where:
- S = settlement in feet
- C_r = recompression index
- H = layer thickness in feet
- P_o = initial overburden pressure in tsf
- P_f = *final* overburden pressure in tsf
- e_o = initial void ratio

2a) Center of Landfill

Determine the initial and final overburden pressure at the midpoint of the Stratum II layer within the analysis point.

Stratum	Overburden Layer	H_o ft	H_f ft	Unit Wt pcf	P_o tsf	P_f tsf
II	Erosion Layer	0.0	3.0	125.8	0.00	0.19
	Infiltration Layer	0.0	1.5	125.8	0.00	0.09
	Solid Waste	0.0	339.0	50.0	0.00	8.48
	Protective Cover	0.0	2.0	128.0	0.00	0.13
	Compacted Liner	0.0	2.0	125.8	0.00	0.13
	II	10.0	10.0	128.0	0.64	0.64
II Total					**0.64**	**9.65**

Determine settlement in the subgrade.

Stratum	H ft	P_o tsf	P_f tsf	C_r	e_o	S ft
II	20.0	0.64	9.65	0.035	0.64	0.50
						0.50

2b) Toe of Slope

Determine the initial and final overburden pressure at the midpoint of the Stratum II layer within the analysis point.

Stratum	Overburden Layer	H_o ft	H_f ft	Unit Wt pcf	P_o tsf	P_f tsf
II	Erosion Layer	0.0	3.0	125.8	0.00	0.19
	Infiltration Layer	0.0	1.5	125.8	0.00	0.09
	Solid Waste	0.0	125.5	50.0	0.00	3.14
	Protective Cover	0.0	2.0	125.8	0.00	0.13
	Compacted Liner	0.0	2.0	125.8	0.00	0.13
	II	10.0	10.0	128.0	0.64	0.64
II Total					**0.64**	**4.31**

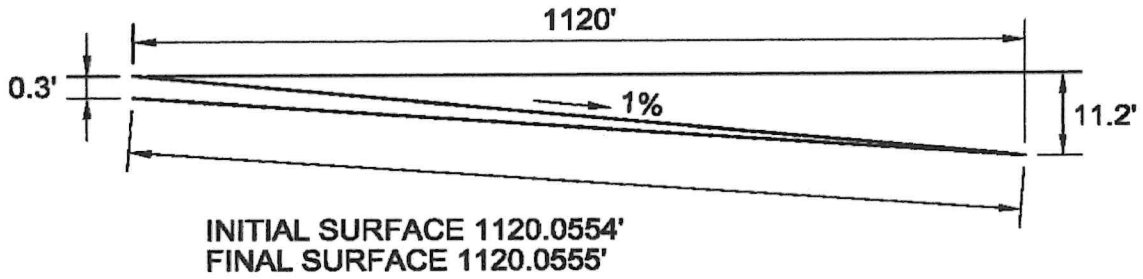
Determine settlement in the subgrade.

Stratum	H ft	P_o tsf	P_f tsf	Cc	e_o	S ft
II	20.0	0.64	4.31	0.035	0.64	0.35
						0.35

Subgrade heave =	**0.377**	**ft**	**4.53 in**
Settlement at center =	**0.503**	**ft**	**6.04 in**
Settlement at toe =	**0.354**	**ft**	**4.24 in**
Differential settlement, ΔS =	**0.149**	**ft**	**1.79 in**

3) Compacted Clay Liner Strain

From Reference 3, the allowable tensile strain in the compacted clay liner is 0.1%. From 2) above, the maximum predicted differential settlement between the toe and center of the analysis area is approximately 1.98 inches. A typical analysis section is shown below.



Initial Surface

Horizontal distance =	932.82	ft
Slope =	1.25%	
Δelevation $_i$=	11.66	ft

$\tan\theta$ = ΔElevation$_i$/Horizontal distance

$\tan\theta$ =	0.01250	
θ =	0.71616	deg
$\cos\theta_i$ =	0.99992	
Initial Surface =	932.8929	ft

Final Surface

Δelevation$_f$ = Δelevation$_i$ + ΔS ft

ΔS =	0.149	ft	see p D5-A-4
Δelevation$_f$ =	11.81		

$\tan\theta$ = Δelevation$_f$/Horizontal Distance

$\tan\theta$ =	0.012660	
θ =	0.72533	deg
$\cos\theta_f$ =	0.99992	
Final Surface =	932.8948	ft

Strain

Strain = ΔL/L
= (Final Surface - Initial Surface)/Initial Surface

=	2.01E-06	ft/ft
=	0.000201	%

Therefore, differential settlement will not be detrimental to the clay liner since the predicted strain, 0.000207% is significantly less than allowable strain of 0.1%.

SKYLINE LANDFILL

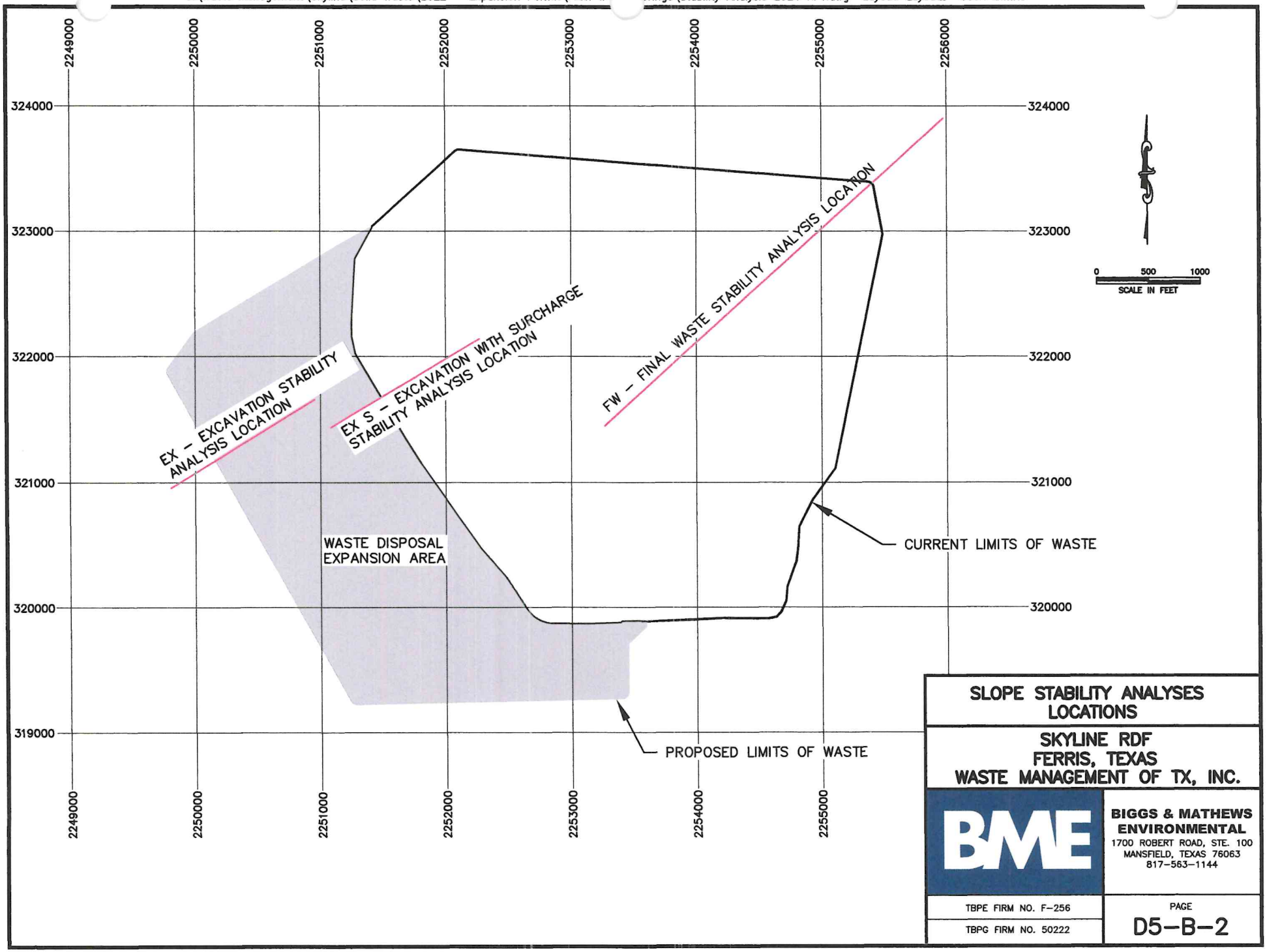
APPENDIX D5B
SLOPE STABILITY ANALYSES

APPENDIX D5-B
SLOPE STABILITY ANALYSES

The results of the stability analyses indicate that the proposed slopes are stable under the conditions analyzed. The table below summarizes the results of the stability analyses and compares the calculated factor of safety to the recommended minimum factor of safety. The recommended minimum factors of safety were selected from the Corps of Engineers "Design and Construction of Levees" manual (EM 1110-2-1913). Locations for the analyses are shown on page D5B.2.

Summary of Slope Stability Analyses

Condition	Analysis Location	Slope (H:V)	Slope Angle (°)	Methodology	Minimum Calculated Factor of Safety	Recommended Factor of Safety	Acceptable Factor of Safety
Excavation	EX	5:1	11.3				
Short Term				C TS	2.7	1.3	Yes
Long Term				C ES	2.9	1.5	Yes
Liner Veneer	EX	5:1	11.3				
Protective Cover/Geocomposite				IS	3.5	1.3	Yes
Geocomposite/Geomembrane				IS	4.4	1.3	Yes
[illegible]omembrane/Soil Liner				IS	4.5	1.3	Yes
E[illegible]vation with Existing Waste Surcharge	EX S	5:1	11.3				
Long Term Circular				C ES	2.8	1.5	Yes
Long Term Block				B ES	2.6	1.5	Yes
Interim Waste Slope	EX	3:1	18.4				
Short Term Circular				C TS	1.7	1.3	Yes
Short Term Block				B TS	2.4	1.3	Yes
Final Waste Slope	FW	4:1	14				
Long Term Circular				C ES	2.1	1.5	Yes
Long Term Block				B ES	2.2	1.5	Yes
Final Cover Veneer	FW	4:1	14				
Alternative Final Cover							
Erosion Layer/Geocomposite				IS	2.9	1.5	Yes
Geocomposite/Infiltration Layer				IS	2.9	1.5	Yes
Subtitle D Final Cover							
Erosion Layer/Geocomposite				IS	2.9	1.5	Yes
Geocomposite/Geomembrane				IS	3.9	1.5	Yes
Geomembrane/Infiltration Layer				IS	3.9	1.5	Yes



SLOPE STABILITY ANALYSES LOCATIONS

SKYLINE RDF
FERRIS, TEXAS
WASTE MANAGEMENT OF TX, INC.

BME
BIGGS & MATHEWS ENVIRONMENTAL
1700 ROBERT ROAD, STE. 100
MANSFIELD, TEXAS 76063
817–563–1144

TBPE FIRM NO. F–256
TBPG FIRM NO. 50222

Slope Stability Analyses Parameters

Required: Select the appropriate soil parameters for the slope stability analyses.

References:

1) *Attachment E - Geology Report,* Skyline Landfill Permit Amendment Application.
2) *Attachment D5, Appendix D5-C - Direct Shear Test Results,* Skyline Landfill Permit Amendment Application.
3) *Attachment D5, Appendix D5-D - Triaxial Shear Test Results, Skyline Landfill Permit Amendment Application.*
4) Qian, X, Koerner, R.M., and Gray, Donald H. *Geotechnical Aspects of Landfill Design and Construction,* Prentice Hall, 2002.

Solution: The following materials may be included in the slope stability analyses.

Material	Description	Moisture[a] %	Dry Wt[a] pcf	Wet Wt[b] pcf
Stratum I	Clay	20.8	102.5	123.8
Stratum II	Shale	17.4	106.7	125.3
Liner/Infiltration	Compacted Clay[c]	26.4	91.0	115.0
Protective Cover/Erosion	Compacted Clay[d]	26.4	86.5	109.3
Liner/Cover	Geosynthetics	N/A	N/A	N/A
Solid Waste	Solid Waste	N/A	N/A	50.0

[a] Reference 1

[b] Wet Wt = Dry Wt x (1 + Moisture)

[c] Typical liner construction values at Skyline Landfill dating back to 2001

[d] 95% of typical liner construction values at Skyline Landfill dating back to 2001

Total stress parameters will be used to analyze short-term stability and effective stress parameters will be used to analyze long-term stability.

Strength parameters shown for the liner/cover geosynthetics are selected based on the 5,000-15,000 normal stress range and geomembrane/soil liner interface (most critical interface) from Reference 2; these parameters are used for the interim and final waste slope stability analyses using PCSTABL6.

Material	Total Stress cohesion (psf)	Total Stress friction (deg)	Effective Stress cohesion (psf)	Effective Stress friction (deg)
Stratum I[b] clay	475	19	446	22.5
Stratum II[b] shale	3715	18	1598	28.4
Liner/Infiltratio/Protective	475	19	446	22.5
Liner/Cover w/ Geosynthetics[a]	59	31.8	1409	11.4
Solid Waste[d]	250	23	250	23

[a] Reference 2

[b] Reference 3

[c] Compacted Clay Liner/Cover will be constructed with Stratum I Clay materials

Interface parameters for the sidewall geosynthetics will be used to evaluate the liner and cover veneer stability. The strength parameters included below are provided by Reference 2 based on the 100-500 psf normal stress range.

Material Interface	Cohesion (psf)	Friction Angle (deg)
Liner Interface		
Protective Cover/Geocomposite	12.0	32.6
Geocomposite/Geomembrane	59.0	31.8
Geomembrane/Soil Liner	60.0	31.8
Final Cover Interface		
Alternate Final Cover		
Erosion Layer/Geocomposite	12.0	32.6
Geocomposite/Infiltration Layer	12.0	32.6
Subtitle D Final Cover		
Erosion Layer/Geocomposite	12.0	32.6
Geocomposite/Geomembrane	59.0	31.8
Geomembrane/Soil Liner	60.0	31.8

Tensile Stress, Anchor Trench, and Veneer Stability Analyses

Required:

1) Check tensile stress in geomembrane.
2) Size geomembrane anchor trench.
3) Perform veneer stability analysis of liner and cover systems.

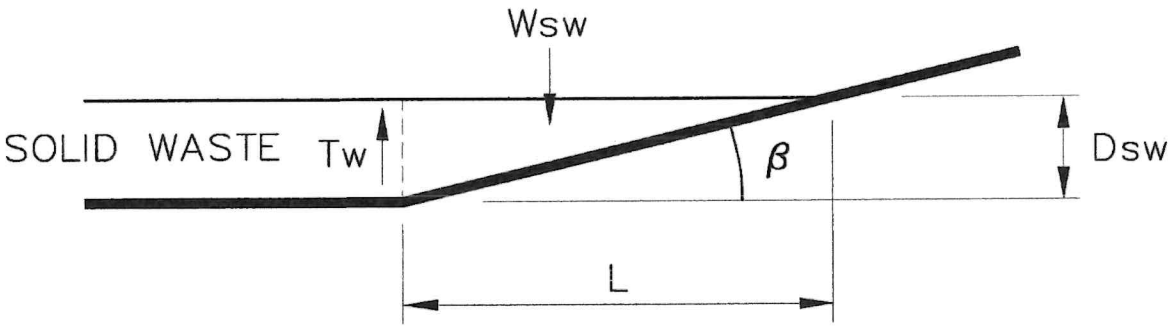
References:

1) *Designing with Geosynthetics,* 2nd Edition, Koerner, Prentice Hall.
2) *An Engineering Manual for Slope Stability Studies*, 2nd Edition, Duncan, Buchignani, Dept. of Civil Engineering, University of California.

Solution:

1) ***Tensile Stress in Geomembrane Floor Liner***

Forces on the liner are shown below:

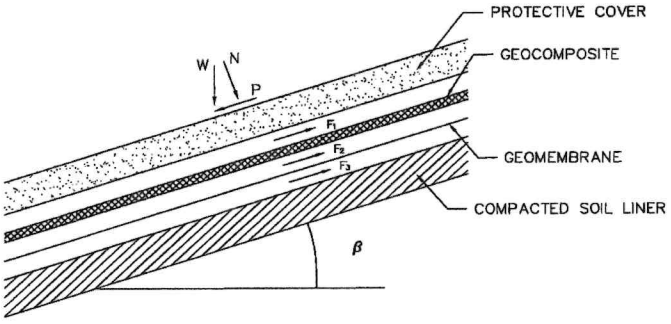


β =	slope angle =	11.3 deg
γ_w =	unit weight of solid waste =	50.0 pcf
Φ =	internal angle of friction for solid waste =	23.0 deg
D =	waste lift thickness =	20.0 ft
L =	length of lift =	100.0 ft
ko =	$1 - \sin \Phi$ =	0.6093

Calculate the forces on the liner:

W_w =	weight of solid waste = $DL\ \gamma_w/2$ =	50,000 plf
T_w =	friction at edge of waste = $k_o(D^2\ \gamma_w/2)\tan \phi$ =	2,586 plf
W =	net force of waste = $W_w - T_w$ =	47,414 plf

Forces within the liner system are shown below"



A_1 =	friction angle between protective cover/geocomp	32.6 deg
A_2 =	friction angle between geocomposite/geomembr	31.8 deg
A_3 =	friction angle between geomembrane/soil liner =	31.8 deg
C_1 =	cohesion between protective cover/geocomposit	12.0 psf
C_2 =	cohesion between geocomposite/geomembrane	59.0 psf
C_3 =	cohesion between geomembrane/soil liner =	60.0 psf

Calculate the forces within the liner system:

N =	normal force on liner = $W\cos\beta$ =	46,495 plf
P =	shearing force on liner = $W\sin\beta$ =	9,291 plf

Calculate the resistance in the liner system:

F_1 = $NtanA_1 + C_1 L/\cos\beta$ = 30,958 plf

Since $F_1 > P$ the protective cover is stable and the entire force P is transferred to the next layer.

F_2 = $NtanA_2 + C_2 L/\cos\beta$ = 34,845 plf

Since $F_2 > P$ the geocomposite is stable and the entire force P is transferred to the next layer.

F_3 = $NtanA_3 + C_3 L/\cos\beta$ = 34,947 plf

Since $F_3 > P$ the geomembrane is stable and the entire force P is transferred to the next layer.

Therefore, there is no tensile stress in the gecomposite or the geomembrane because the resisting forces, F exceed the shearing forces, P.

2) *Anchor Trench*

Since there is no tensile stress in the geosynthetics an anchor trench will not be required for stability. Anchor trenches will be provided for stability of the liner system during protective cover construction.

3) *Veneer Slope Analysis*

Use the procedures and charts from reference 2 to evaluate the stability of the liner and cover systems.

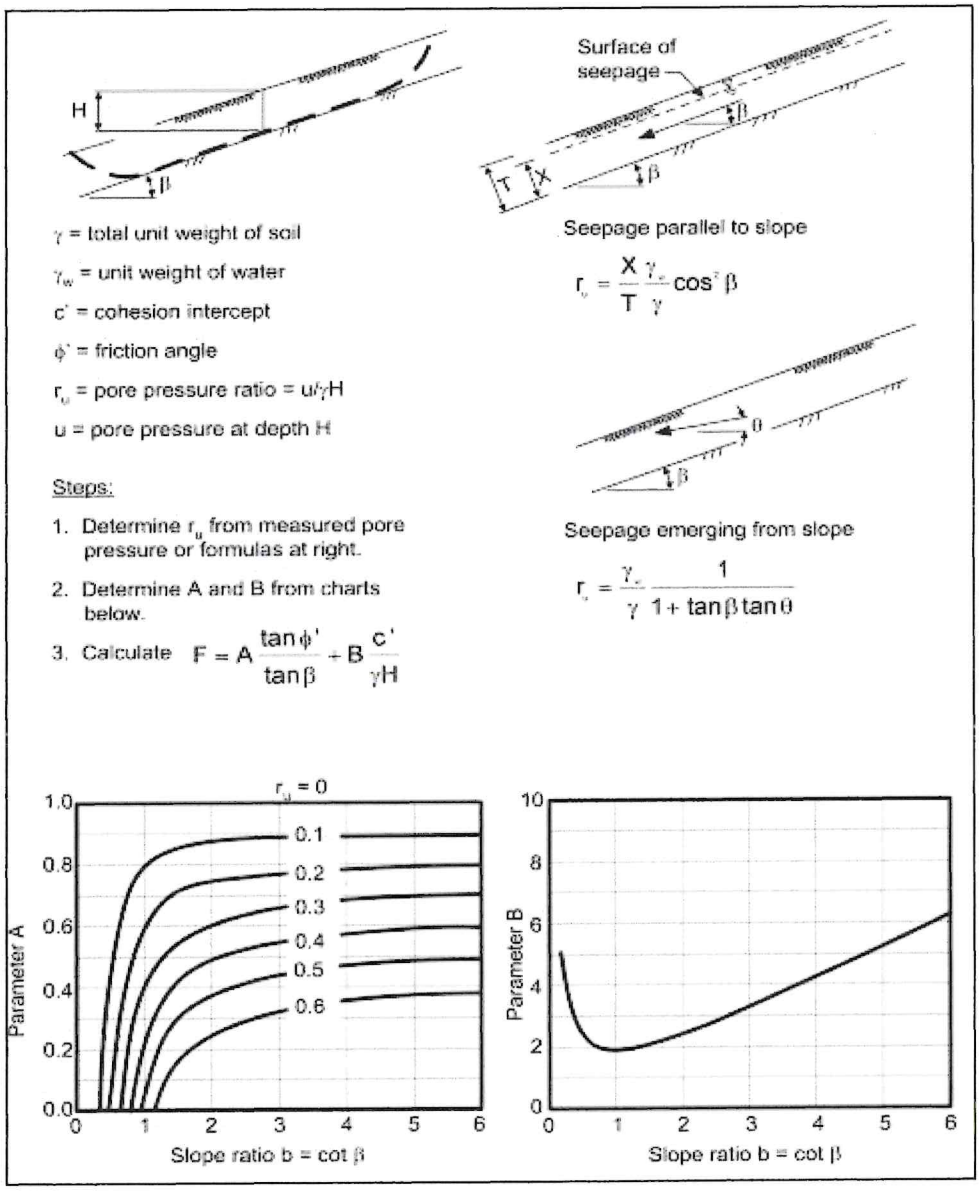


Figure E-7. Slope stability charts for infinite slopes (after Duncan, Buchianani, and DeWet 1987)

Calculate the factor of safety at each interface in the liner system. Assume typical values for interface strength parameters and the unit weight of soil. Assume that there is no pore water pressure because of the presence of the free draining layer of geocomposite.

Protective cover/geocomposite

ϕ =	32.6	deg
β =	11.3	deg
C =	12.0	psf
u =	0.0	
γ =	115.0	pcf
r_u =	0.0	
H =	2.0	ft
a =	1.0	
b =	5.2	

FS @ protective cover/geocomposite = 3.5

Geocomposite/geomembrane

ϕ =	31.8	deg
β =	11.3	deg
C =	59.0	psf
u =	0.0	
γ =	115.0	pcf
r_u =	0.0	
H =	2.0	ft
a =	1.0	
b =	5.2	

FS @ geocomposite/geomembrane = 4.4

Geomembrane/soil liner

ϕ =	31.8	deg
β =	11.3	deg
C =	60.0	psf
u =	0.0	
γ =	115.0	pcf
r_u =	0.0	
H =	2.0	ft
a =	1.0	
b =	5.2	

FS @ geomembrane/soil liner = 4.5

Calculate the factor of safety at each interface in the cover systems. Assume typical values for interface strength parameters and the unit weight of soil. Assume that there is no pore water pressure because of the presence of the free draining layer of geocomposite. NOTE: The final cover slope is 14°.

Alternate Final Cover System

Erosion layer/geocomposite

ϕ =	32.6 deg
β =	14.0 deg
C =	12.0 psf
u =	0.0
γ =	115.0 pcf
r_u =	0.0
H =	1.5 ft
a =	1.0
b =	4.2

FS @ erosion layer/geocomposite = 2.9

Geocomposite/infiltration layer

ϕ =	32.6 deg
β =	14.0 deg
C =	12.0 psf
u =	0.0
γ =	115.0 pcf
r_u =	0.0
H =	1.5 ft
a =	1.0
b =	4.2

FS @ geocomposite/infiltration layer = 2.9

Subtitle D Final Cover System

Erosion layer/geocomposite

ϕ =	32.6 deg
β =	14.0 deg
C =	12.0 psf
u =	0.0
γ =	115.0 pcf
r_u =	0.0
H =	1.5 ft
a =	1.0
b =	4.2

FS @ erosion layer/geocomposite = 2.9

Geocomposite/geomembrane

ϕ =	31.8 deg
β =	14.0 deg
C =	59.0 psf
u =	0.0
γ =	115.0 pcf
r_u =	0.0
H =	1.5 ft
a =	1.0
b =	4.2

FS @ geocomposite/geomembrane = 3.9

Geomembrane/infiltration layer

ϕ =	31.8 deg
β =	14.0 deg
C =	60.0 psf
u =	0.0
γ =	115.0 pcf
r_u =	0.0
H =	1.5 ft
a =	1.0
b =	4.2

FS @ geomembrane/infiltration layer = 3.9

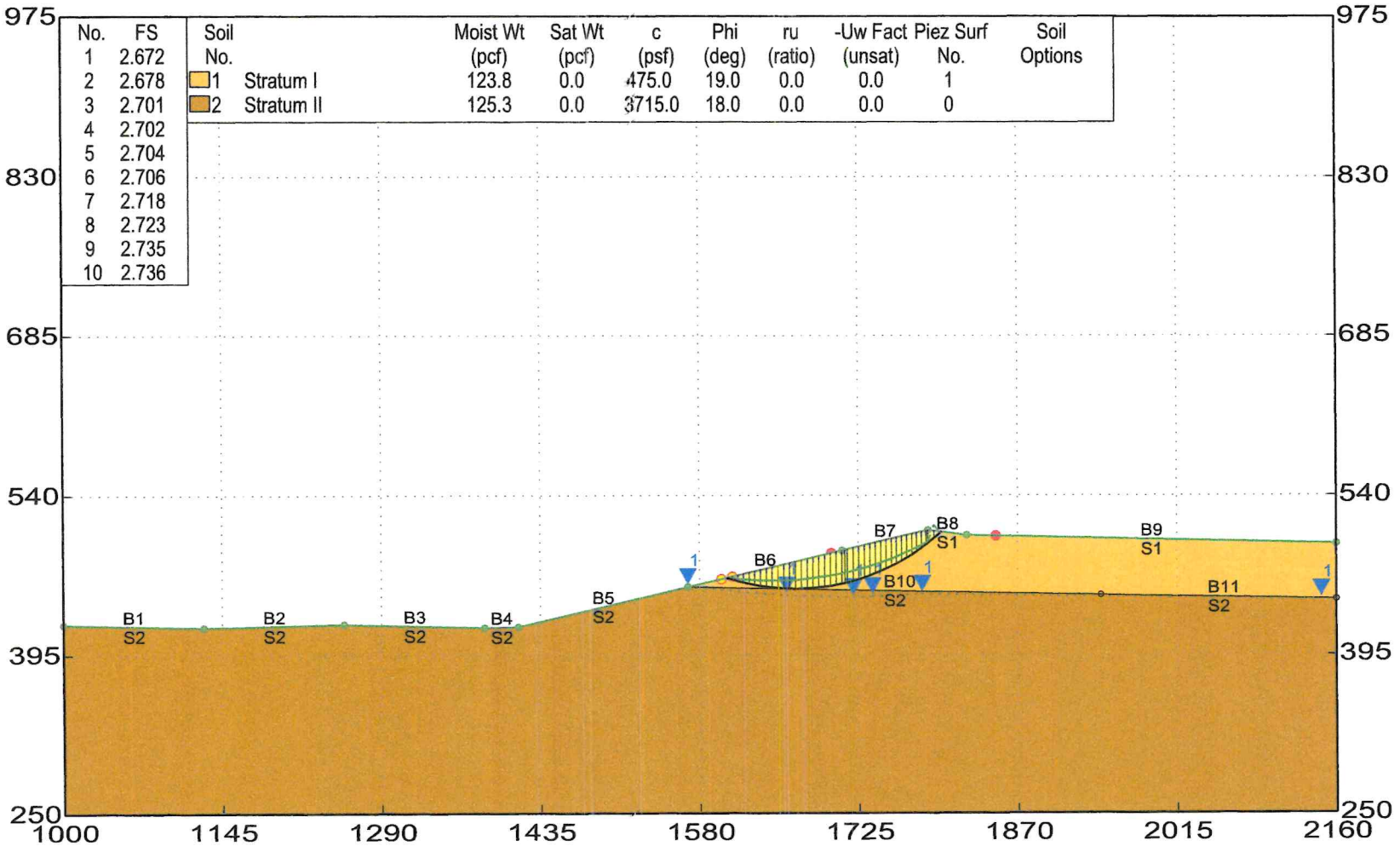
EXCAVATED SLOPE STABILITY – SHORT TERM GEOSTASE INPUT PARAMETERS

This analysis evaluates the short term stability of the excavated sideslope before the liner is installed using a circular failure surface. The geometry for the critical section is shown on the following page. The analysis was performed at Analysis Line EX which is the deepest part of the proposed excavation. Total stress parameters were used to analyze the short term condition for the excavated slope. Material properties for each soil type are tabulated on the following page. The water surface was assumed as the highest recorded groundwater at the site from Appendix D7A. The analysis resulted in a factor of safety greater than 1.3, the generally recognized minimum for short term conditions.

SKYLINE LANDFILL - PERMIT EXPANSION
EXCAVATED SLOPE STABILITY ANALYSIS - SHORT TERM

BIGGS AND MATHEWS ENVIRONMENTAL - WRC

\Excav Ext Slope TOTAL.gsd



GEOSTASE FS = 2.672

Spencer Method

GEOSTASE Slope Stability Analysis

Excav Effec

*** GEOSTASE(R) ***

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** Current Version 4.30.32-Double Precision, Sept 2023 **
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****
SLOPE STABILITY ANALYSIS SOFTWARE (2D & 3D)
Simplified Bishop, Simplified Janbu, or General Equilibrium (GE) Options.
(Spencer, Morgenstern-Price, USACE, and Lowe & Karafiath)
Including Pier/Pile, Planar Reinf, Nail, Tieback, Line Loads
Applied Forces, Fiber-Reinforced Soil (FRS), Distributed Loads
Nonlinear Undrained Shear Strength, Curved Strength Envelope,
Anisotropic Strengths, Water Surfaces, 3-Stage Rapid Drawdown
2- or 3-Stage Pseudo-Static & Simplified Newmark Seismic Analyses.
****

Analysis Date: 4/ 22/ 2024
Analysis Time: 2 :16 PM
Analysis By: BIGGS AND MATHEWS ENVIRONMENTAL - WRC

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Output File Name: O:\Waste Management\Skyline\Solid Waste\2022 - Expansion Permit\PART II (2)\Borings\Stability Analysis\Excavation\Excav Total\Excav Ext Slope TOTAL.OUT
Unit System: English

PROJECT: SKYLINE LANDFILL - PERMIT EXPANSION

DESCRIPTION: EXCAVATED SLOPE STABILITY ANALYSIS - SHORT TERM

PROFILE BOUNDARY DATA

9 Surface Boundaries
11 Total Boundaries

Boundary	X - 1	Y - 1	X - 2	Y - 2	Soil Type

No.	(ft)	(ft)	(ft)	(ft)	Excav Effec Below Bnd
1	1000.000	422.546	1128.022	419.612	2
2	1128.022	419.612	1256.045	422.687	2
3	1256.045	422.687	1384.067	419.744	2
4	1384.067	419.744	1414.697	420.478	2
5	1414.697	420.478	1569.442	456.858	2
6	1569.442	456.858	1709.934	489.887	1
7	1709.934	489.887	1788.408	508.336	1
8	1788.408	508.336	1823.687	503.681	1
9	1823.687	503.681	2160.000	496.000	1
10	1569.442	456.858	1945.689	449.376	2
11	1945.689	449.376	2160.000	445.386	2

User Specified X-Origin = 1000.000(ft)

User Specified Y-Origin = 250.000(ft)

SURFACE BOUNDARY POINT COORDINATES
(Information Only-Not Used Directly)

Point No.	X-COORD	Y-COORD
1	1000.000	422.546
2	1128.022	419.612
3	1256.045	422.687
4	1384.067	419.744
5	1414.697	420.478
6	1569.442	456.858
7	1709.934	489.887
8	1788.408	508.336
9	1823.687	503.681
10	2160.000	496.000

SUBSURFACE BOUNDARY POINT COORDINATES
(Information Only-Not Used Directly)

Point No.	X-COORD	Y-COORD
Surface boundary point 6 and Subsurface boundary point 11 are duplicate points.		
11	1569.442	456.858
12	1945.689	449.376
13	2160.000	445.386

PROFILE BOUNDARY SLOPES AND ANGLES

BND No.	Slope	Angle(Deg.)
1	-0.023	-1.313
2	0.024	1.376
3	-0.023	-1.317
4	0.024	1.373
5	0.235	13.230

		Excav Effec
6	0.235	13.230
7	0.235	13.230
8	-0.132	-7.517
9	-0.023	-1.308
10	-0.020	-1.139
11	-0.019	-1.067

MOHR-COULOMB SOIL PARAMETERS

2 Type(s) of Soil Defined

Soil Number and Description	Moist Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Ratio(ru)	(-Uw) Fact.	Water Surface No.	Water Option
1 Stratum I	123.8	0.0	475.00	19.00	0.000	0.0	1	0
2 Stratum II	125.3	0.0	3715.00	18.00	0.000	0.0	0	0

WATER SURFACE DATA

1 Water Surface(s) Defined

Unit Weight of Water = 62.400 (pcf)

Water Surface No. 1 Specified by 6 Coordinate Points
Phreatic Adjustment Factor = 0.00

Point No.	X-Water (ft)	Y-Water (ft)
1	1569.44	456.86
2	1659.40	449.00
3	1720.28	447.00
4	1737.72	448.00
5	1782.78	450.00
6	2146.31	445.39

TRIAL FAILURE SURFACE DATA

Circular Trial Failure Surfaces Have Been Generated Using A Random Procedure.

Excav Effec

1000 Trial Surfaces Have Been Generated.

1000 Surfaces Generated at Increments of 0.1201(in) Equally Spaced Within the Start Range

Along The Specified Surface Between X =1600.00(ft)
and X =1610.00(ft)

Each Surface ends within a Range Between X =1700.00(ft)
and X =1850.00(ft)

All surfaces are generated left to right for both a left and right sliding slope.

Unless XCLUDE Lines Were Specified, The Minimum Elevation
To Which A Surface Extends Is Y = 250.00(ft)

Specified Maximum Radius = 600.000(ft)

16.000(ft) Line Segments Were Used For Each Trial Failure Surface.

The Spencer Method Was Selected for FS Analysis.

Selected fx function = Constant (1.0)

SELECTED CONVERGENCE PARAMETERS FOR SPENCER METHOD:
Initial estimate of FS = 1.500
FS tolerance = 0.000001000
Initial estimate of theta(deg) = 15.00
Theta tolerance(radians) = 0.0001000
Minimum theta(deg) = -45.00 ; Maximum theta(deg) = 45.00
Theta convergence Step Factor = 5000.00
Maximum number of iterations = **
Allowable negative side force = -1000.0(lbs)
Maximum force imbalance = 100.000000(lbs)
Maximum moment imbalance = 100.000000 (ft/lbs)

Selected Lambda Coefficient = 1.00

Specified Tension Crack Water Depth Factor = 0.000

Total Number of Trial Surfaces Attempted = 1000

WARNING! The Factor of Safety Calculation for one or More Trial Surfaces
Did Not Converge in ** Iterations.

Excav Effec

Number of Trial Surfaces with Non-Converged FS = 110

Number of Trial Surfaces With Valid FS = 890

Percentage of Trial Surfaces With Non-Converged and/or
Non-Valid FS Solutions of the Total Attempted = 11.0 %

Statistical Data On All Valid FS Values:
FS Max = 9.753 FS Min = 2.672 FS Ave = 5.894
Standard Deviation = 1.626 Coefficient of Variation = 27.59 %

Critical Surface is Sequence Number 427 of Those Analyzed.

*****BEGINNING OF DETAILED GEOSTASE OUTPUT FOR CRITICAL SURFACE FROM A SEARCH*****

BACK-CALCULATED CIRCULAR SURFACE PARAMETERS:

Circle Center At X = 1667.486350(ft) ; Y = 651.581602(ft); and Radius = 196.677198(ft)

Circular Trial Failure Surface Generated With 15 Coordinate Points

Point No.	X-Coord. (ft)	Y-Coord. (ft)
1	1604.78478	465.16692
2	1620.14484	460.68712
3	1635.81821	457.47068
4	1651.70117	455.53888
5	1667.68858	454.90451
6	1683.67466	455.57176
7	1699.55361	457.53622
8	1715.22033	460.78489
9	1730.57115	465.29626
10	1745.50446	471.04049
11	1759.92144	477.97955
12	1773.72669	486.06752
13	1786.82882	495.25088
14	1799.14114	505.46885
15	1800.44880	506.74724

EXCAVATED SLOPE STABILITY – LONG TERM GEOSTASE INPUT PARAMETERS

This analysis evaluates the long term stability of the excavated sideslope after the liner is installed using a circular failure surface. The geometry for the critical section is shown on the following page. The analysis was performed at Analysis Line EX which is the deepest part of the proposed excavation. Effective stress parameters were used to analyze the long term condition for the excavated slope. Material properties for each soil type are tabulated on the following page. The water surface was assumed as the highest recorded groundwater at the site from Appendix D7A and was adjusted for the effect of the dewatering system. The analysis resulted in a factor of safety greater than 1.5, the generally recognized minimum for long term conditions.

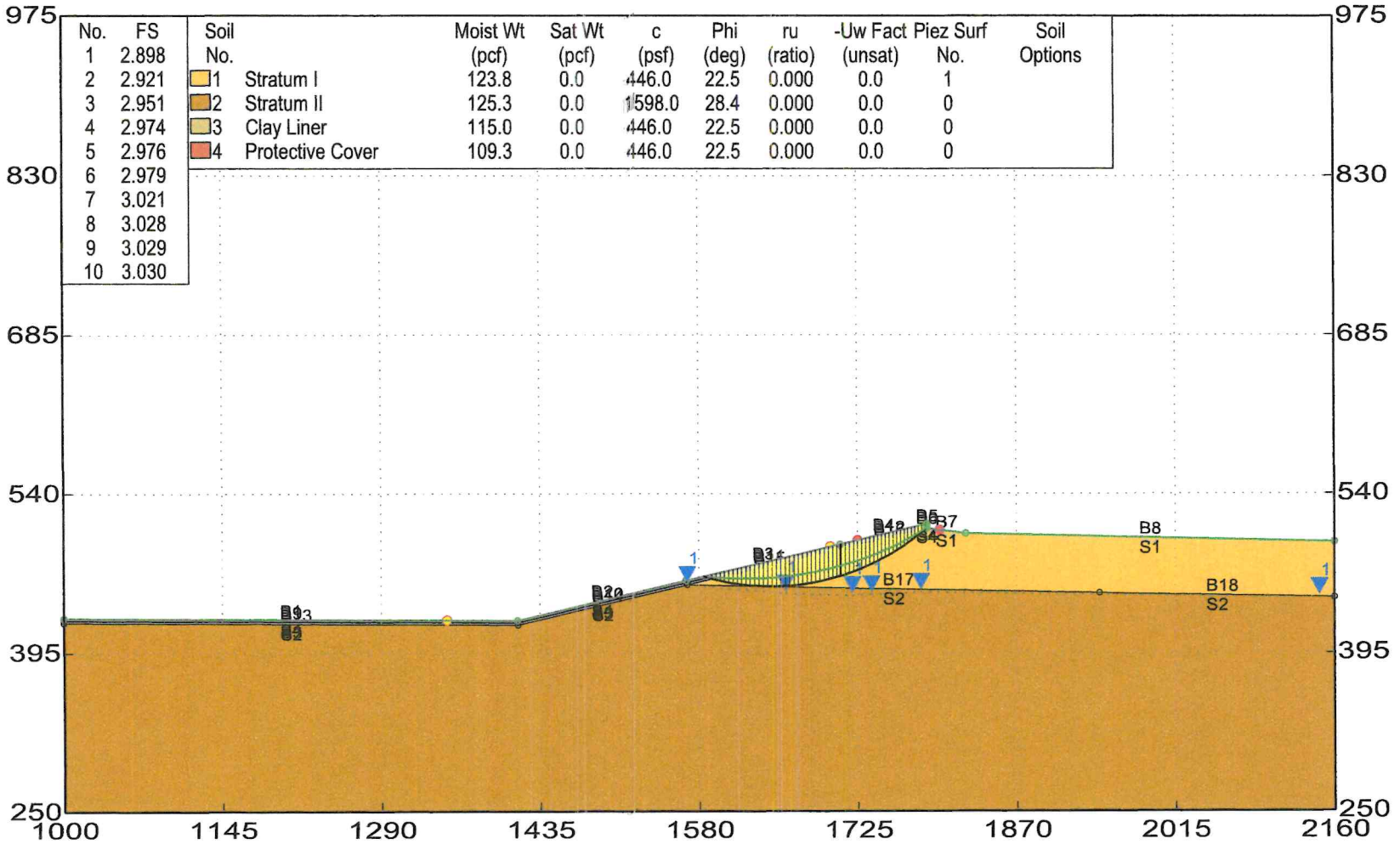
SKYLINE LANDFILL - PERMIT EXPANSION
EXCAVATED SLOPE STABILITY WITH LINER & PROTECTIVE COVER - LONG TERM

BIGGS AND MATHEWS ENVIRONMENTAL - WRC

\Excav Ext Slope EFFEC w LINER-PC.gsd

No.	FS
1	2.898
2	2.921
3	2.951
4	2.974
5	2.976
6	2.979
7	3.021
8	3.028
9	3.029
10	3.030

Soil No.		Moist Wt (pcf)	Sat Wt (pcf)	c (psf)	Phi (deg)	ru (ratio)	-Uw Fact (unsat)	Piez Surf No.	Soil Options
1	Stratum I	123.8	0.0	446.0	22.5	0.000	0.0	1	
2	Stratum II	125.3	0.0	1598.0	28.4	0.000	0.0	0	
3	Clay Liner	115.0	0.0	446.0	22.5	0.000	0.0	0	
4	Protective Cover	109.3	0.0	446.0	22.5	0.000	0.0	0	



GEOSTASE FS = 2.898

Spencer Method

GEOSTASE
Slope Stability
Analysis

Excav Effec

*** GEOSTASE(R) ***

** GEOSTASE(R) (c)Copyright by Garry H. Gregory, Ph.D.,P.E.,S.E.,BC.GE **

** Current Version 4.30.32-Double Precision, Sept 2023 **
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SLOPE STABILITY ANALYSIS SOFTWARE (2D & 3D)
Simplified Bishop, Simplified Janbu, or General Equilibrium (GE) Options.
(Spencer, Morgenstern-Price, USACE, and Lowe & Karafiath)
Including Pier/Pile, Planar Reinf, Nail, Tieback, Line Loads
Applied Forces, Fiber-Reinforced Soil (FRS), Distributed Loads
Nonlinear Undrained Shear Strength, Curved Strength Envelope,
Anisotropic Strengths, Water Surfaces, 3-Stage Rapid Drawdown
2- or 3-Stage Pseudo-Static & Simplified Newmark Seismic Analyses.

****

Analysis Date: 4/ 11/ 2024
Analysis Time: 10 :44 AM
Analysis By: BIGGS AND MATHEWS ENVIRONMENTAL - WRC

Input File Name: O:\Waste Management\Skyline\Solid Waste\2022 - Expansion Permit\PART II (2)\Borings\Stability Analysis\Excavation\Excav Eff\Excav Ext Slope EFFEC w LINER-PC.gsd
Output File Name: O:\Waste Management\Skyline\Solid Waste\2022 - Expansion Permit\PART II (2)\Borings\Stability Analysis\Excavation\Excav Eff\Excav Ext Slope EFFEC w LINER-PC.OUT
Unit System: English

PROJECT: SKYLINE LANDFILL - PERMIT EXPANSION

DESCRIPTION: EXCAVATED SLOPE STABILITY WITH LINER & PROTECTIVE COVER - LONG TERM

PROFILE BOUNDARY DATA

8 Surface Boundaries
18 Total Boundaries

Boundary	X - 1	Y - 1	X - 2	Y - 2	Soil Type

No.	(ft)	(ft)	(ft)	(ft)	Excav Effec Below Bnd
1	1000.000	426.545	1414.186	424.467	4
2	1414.186	424.467	1568.527	460.752	4
3	1568.527	460.752	1709.019	493.781	4
4	1709.019	493.781	1788.205	512.397	4
5	1788.205	512.397	1788.307	510.367	4
6	1788.307	510.367	1788.408	508.336	4
7	1788.408	508.336	1823.687	503.681	1
8	1823.687	503.681	2160.000	496.000	1
9	1000.000	424.546	1414.442	422.473	3
10	1414.442	422.473	1568.984	458.805	3
11	1568.984	458.805	1709.476	491.834	3
12	1709.476	491.834	1788.307	510.367	3
13	1000.000	422.546	1414.697	420.478	2
14	1414.697	420.478	1569.442	456.858	2
15	1569.442	456.858	1709.934	489.887	1
16	1709.934	489.887	1788.408	508.336	1
17	1569.442	456.858	1945.689	449.376	2
18	1945.689	449.376	2160.000	445.386	2

User Specified X-Origin = 1000.000(ft)

User Specified Y-Origin = 250.000(ft)

SURFACE BOUNDARY POINT COORDINATES
(Information Only-Not Used Directly)

Point No.	X-COORD	Y-COORD
1	1000.000	426.545
2	1414.186	424.467
3	1568.527	460.752
4	1709.019	493.781
5	1788.205	512.397
6	1788.307	510.367
7	1788.408	508.336
8	1823.687	503.681
9	2160.000	496.000

SUBSURFACE BOUNDARY POINT COORDINATES
(Information Only-Not Used Directly)

Point No.	X-COORD	Y-COORD
10	1000.000	424.546
11	1414.442	422.473
12	1568.984	458.805
13	1709.476	491.834

Surface boundary point 6 and Subsurface boundary point 14 are duplicate points.

14	1788.307	510.367

		Excav Effec
15	1414.697	420.478
16	1569.442	456.858
17	1709.934	489.887

Surface boundary point 7 and Subsurface boundary point 18 are duplicate points.

18	1788.408	508.336
19	1945.689	449.376
20	2160.000	445.386

PROFILE BOUNDARY SLOPES AND ANGLES

BND No.	Slope	Angle(Deg.)
1	-0.005	-0.287
2	0.235	13.230
3	0.235	13.230
4	0.235	13.230
5	-19.902	-87.124
6	-20.109	-87.153
7	-0.132	-7.517
8	-0.023	-1.308
9	-0.005	-0.287
10	0.235	13.230
11	0.235	13.230
12	0.235	13.230
13	-0.005	-0.286
14	0.235	13.230
15	0.235	13.230
16	0.235	13.230
17	-0.020	-1.139
18	-0.019	-1.067

MOHR-COULOMB SOIL PARAMETERS

4 Type(s) of Soil Defined

Soil Number and Description	Moist Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Ratio(ru)	(-Uw) Fact.	Water Surface No.	Water Option
1 Stratum I	123.8	0.0	446.00	22.50	0.000	0.0	1	0
2 Stratum II	125.3	0.0	1598.00	28.40	0.000	0.0	0	0
3 Clay Liner	115.0	0.0	446.00	22.50	0.000	0.0	0	0
4 Protective Cover	109.3	0.0	446.00	22.50	0.000	0.0	0	0

WATER SURFACE DATA

1 Water Surface(s) Defined

Excav Effec

Unit Weight of Water = 62.400 (pcf)

Water Surface No. 1 Specified by 6 Coordinate Points
Phreatic Adjustment Factor = 0.00

Point No.	X-Water (ft)	Y-Water (ft)
1	1569.44	456.86
2	1659.40	449.00
3	1720.28	447.00
4	1737.72	448.00
5	1782.78	450.00
6	2146.31	445.39

TRIAL FAILURE SURFACE DATA

Circular Trial Failure Surfaces Have Been Generated Using A Random Procedure.

1000 Trial Surfaces Have Been Generated.

1000 Surfaces Generated at Increments of 4.2042(in) Equally Spaced Within the Start Range

Along The Specified Surface Between X =1350.00(ft)
and X =1700.00(ft)

Each Surface ends within a Range Between X =1725.00(ft)
and X =1800.00(ft)

All surfaces are generated left to right for both a left and right sliding slope.

Unless XCLUDE Lines Were Specified, The Minimum Elevation
To Which A Surface Extends Is Y = 250.00(ft)

Specified Maximum Radius = 1000.000(ft)

4.000(ft) Line Segments Were Used For Each Trial Failure Surface.

The Spencer Method Was Selected for FS Analysis.

Selected fx function = Constant (1.0)

SELECTED CONVERGENCE PARAMETERS FOR SPENCER METHOD:
Initial estimate of FS = 1.500
FS tolerance = 0.000001000
Initial estimate of theta(deg) = 15.00
Theta tolerance(radians) = 0.0001000
Minimum theta(deg) = -45.00 ; Maximum theta(deg) = 45.00
Theta convergence Step Factor = 5000.00
Maximum number of iterations = **
Allowable negative side force = -1000.0(lbs)
Maximum force imbalance = 100.000000(lbs)
Maximum moment imbalance = 100.000000 (ft/lbs)

Selected Lambda Coefficient = 1.00

Specified Tension Crack Water Depth Factor = 0.000

Total Number of Trial Surfaces Attempted = 1000

WARNING! The Factor of Safety Calculation for one or More Trial Surfaces
Did Not Converge in ** Iterations.

Number of Trial Surfaces with Non-Converged FS = 53

Number of Trial Surfaces With Valid FS = 947

Percentage of Trial Surfaces With Non-Converged and/or
Non-Valid FS Solutions of the Total Attempted = 5.3 %

Statistical Data On All Valid FS Values:
FS Max = 10.059 FS Min = 2.898 FS Ave = 4.504
Standard Deviation = 0.714 Coefficient of Variation = 15.86 %

Critical Surface is Sequence Number 638 of Those Analyzed.

*****BEGINNING OF DETAILED GEOSTASE OUTPUT FOR CRITICAL SURFACE FROM A SEARCH*****

BACK-CALCULATED CIRCULAR SURFACE PARAMETERS:

Circle Center At X = 1645.884370(ft) ; Y = 672.693224(ft); and Radius =

Excav Effec

217.284419(ft)

Circular Trial Failure Surface Generated With 56 Coordinate Points

Point No.	X-Coord. (ft)	Y-Coord. (ft)
1	1584.03403	464.39763
2	1587.87888	463.29437
3	1591.74338	462.26207
4	1595.62622	461.30108
5	1599.52610	460.41174
6	1603.44169	459.59433
7	1607.37167	458.84914
8	1611.31469	458.17643
9	1615.26944	457.57641
10	1619.23455	457.04929
11	1623.20870	456.59525
12	1627.19053	456.21445
13	1631.17870	455.90701
14	1635.17185	455.67304
15	1639.16863	455.51261
16	1643.16769	455.42579
17	1647.16767	455.41260
18	1651.16721	455.47304
19	1655.16496	455.60709
20	1659.15957	455.81472
21	1663.14968	456.09584
22	1667.13394	456.45036
23	1671.11100	456.87817
24	1675.07950	457.37912
25	1679.03812	457.95304
26	1682.98549	458.59973
27	1686.92030	459.31897
28	1690.84120	460.11053
29	1694.74686	460.97413
30	1698.63596	461.90948
31	1702.50719	462.91626
32	1706.35922	463.99413
33	1710.19077	465.14273
34	1714.00052	466.36167
35	1717.78718	467.65054
36	1721.54948	469.00889
37	1725.28613	470.43626
38	1728.99588	471.93218
39	1732.67746	473.49614
40	1736.32963	475.12761

EXCAVATION SLOPE STABILITY WITH EXISTING MSW SURCHARGE – LONG TERM GEOSTASE INPUT PARAMETERS

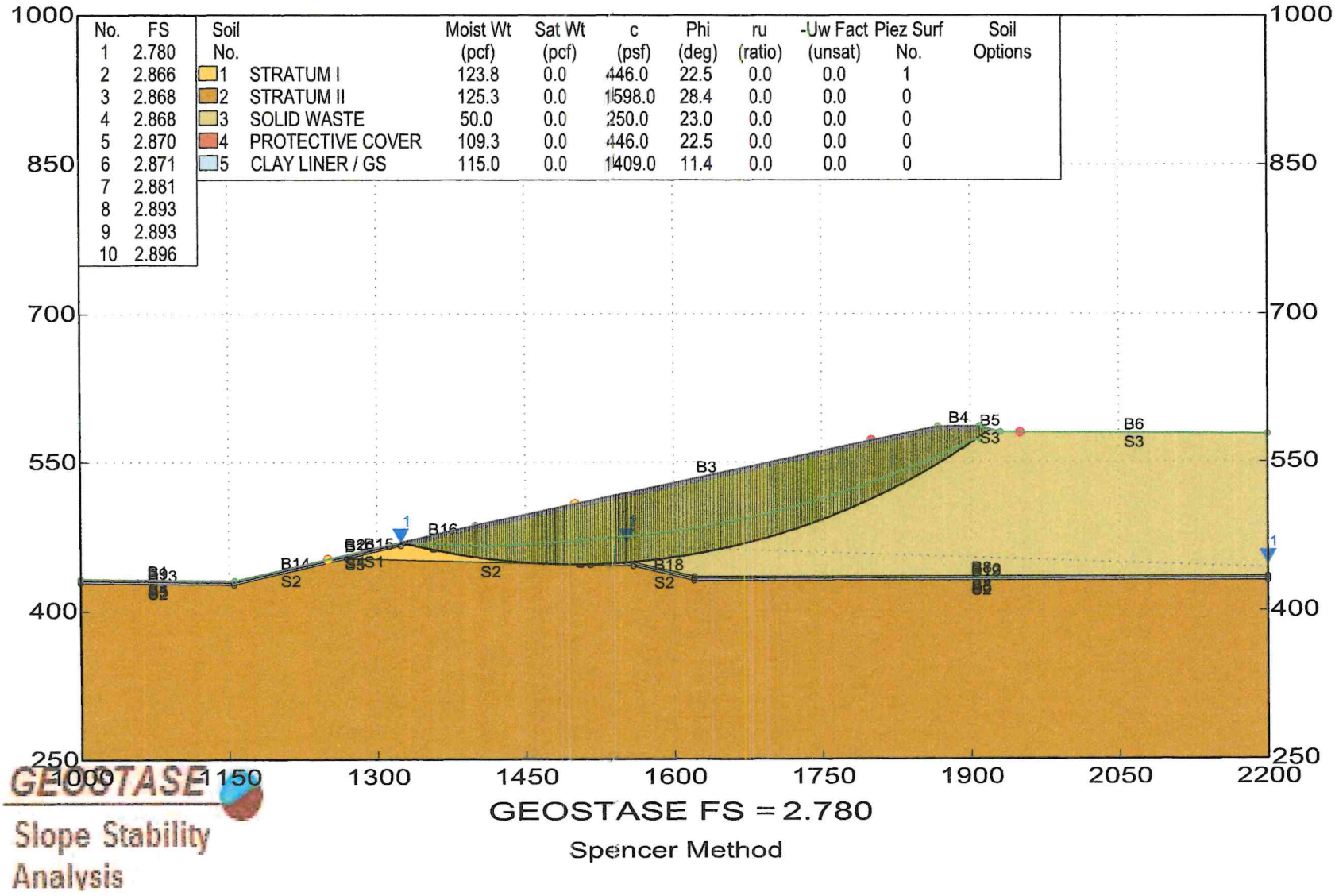
This analysis evaluates the long term stability of the excavation and the 5H:1V existing waste slope using a circular failure surface. The geometry for the critical section is shown on the following page. The analysis was performed at Analysis Line EX S which is the deepest proposed excavation adjacent to the existing waste slope. Effective stress parameters were used to analyze the long term condition for the soil slopes. Material properties for each soil and material type are tabulated on the following page. The water surface was assumed as the highest recorded groundwater at the site from Appendix D7A. The analysis resulted in a factor of safety greater than 1.5, the generally recognized minimum for long term conditions. The analysis demonstrates that the critical failure surface is almost entirely in the waste and has very little effect on the excavation slope.

SKYLINE LANDFILL EXPANSION

EXCAVATION STABILITY W/MSW SURCHARGE - CIRCULAR ANALYSIS - LONG TERM

BIGGS AND MATHEWS ENVIRONMENTAL - WRC

\Exc CIR EFFEC w- Liner w- Srg Chg w-OLD Excav.gsd



Excav Effec

*** GEOSTASE(R) ***

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SLOPE STABILITY ANALYSIS SOFTWARE (2D & 3D)
Simplified Bishop, Simplified Janbu, or General Equilibrium (GE) Options.
(Spencer, Morgenstern-Price, USACE, and Lowe & Karafiath)
Including Pier/Pile, Planar Reinf, Nail, Tieback, Line Loads
Applied Forces, Fiber-Reinforced Soil (FRS), Distributed Loads
Nonlinear Undrained Shear Strength, Curved Strength Envelope,
Anisotropic Strengths, Water Surfaces, 3-Stage Rapid Drawdown
2- or 3-Stage Pseudo-Static & Simplified Newmark Seismic Analyses.
****

Analysis Date: 5/ 7/ 2024
Analysis Time: 10 :22 AM
Analysis By: BIGGS AND MATHEWS ENVIRONMENTAL - WRC

Input File Name: O:\Waste Management\Skyline\Solid Waste\2022 - Expansion Permit\PART II (2)\Borings\Stability Analysis\Excavation\Exc w- Surchg\Effec\Exc CIR EFFEC w- Liner w- Srg Chg w-OLD Excav.gsd
Output File Name: O:\Waste Management\Skyline\Solid Waste\2022 - Expansion Permit\PART II (2)\Borings\Stability Analysis\Excavation\Exc w- Surchg\Effec\Exc CIR EFFEC w- Liner w- Srg Chg w-OLD Excav.OUT
Unit System: English

PROJECT: SKYLINE LANDFILL EXPANSION

DESCRIPTION: EXCAVATION STABILITY W/MSW SURCHARGE - CIRCULAR ANALYSIS - LONG TERM

PROFILE BOUNDARY DATA

6 Surface Boundaries
20 Total Boundaries

Boundary	X - 1	Y - 1	X - 2	Y - 2	Soil Type

No.	(ft)	(ft)	(ft)	(ft)	Excav Effec Below Bnd
1	1000.000	432.000	1155.570	430.000	4
2	1155.570	430.000	1399.110	486.260	4
3	1399.110	486.260	1867.000	586.000	3
4	1867.000	586.000	1909.000	586.000	3
5	1909.000	586.000	1930.000	580.000	3
6	1930.000	580.000	2200.000	578.000	3
7	1399.110	486.260	1620.470	434.000	3
8	1620.470	434.000	2200.000	434.000	3
9	1000.000	430.000	1154.780	428.000	5
10	1154.780	428.000	1399.100	484.210	5
11	1399.100	484.210	1620.230	432.000	5
12	1620.230	432.000	2200.000	432.000	5
13	1000.000	428.000	1155.000	426.000	2
14	1155.000	426.000	1269.435	452.521	2
15	1269.435	452.521	1323.888	465.141	1
16	1323.888	465.141	1399.090	482.160	1
17	1399.090	482.160	1559.116	444.375	1
18	1559.116	444.375	1620.000	430.000	2
19	1620.000	430.000	2200.000	430.000	2
20	1269.435	452.521	1559.116	444.375	2

User Specified X-Origin = 1000.000(ft)

User Specified Y-Origin = 250.000(ft)

SURFACE BOUNDARY POINT COORDINATES
(Information Only-Not Used Directly)

Point No.	X-COORD	Y-COORD
1	1000.000	432.000
2	1155.570	430.000
3	1399.110	486.260
4	1867.000	586.000
5	1909.000	586.000
6	1930.000	580.000
7	2200.000	578.000

SUBSURFACE BOUNDARY POINT COORDINATES
(Information Only-Not Used Directly)

Point No.	X-COORD	Y-COORD
Surface boundary point 3 and Subsurface boundary point 8 are duplicate points.		
8	1399.110	486.260
9	1620.470	434.000
10	2200.000	434.000
11	1154.780	428.000
12	1399.100	484.210

		Excav Effec
13	1620.230	432.000
14	2200.000	432.000
15	1155.000	426.000
16	1269.435	452.521
17	1323.888	465.141
18	1399.090	482.160
19	1559.116	444.375
20	1620.000	430.000
21	2200.000	430.000
22	1559.116	444.375

PROFILE BOUNDARY SLOPES AND ANGLES

BND No.	Slope	Angle(Deg.)
1	-0.013	-0.737
2	0.231	13.008
3	0.213	12.034
4	0.000	0.000
5	-0.286	-15.945
6	-0.007	-0.424
7	-0.236	-13.284
8	0.000	0.000
9	-0.013	-0.740
10	0.230	12.956
11	-0.236	-13.285
12	0.000	0.000
13	-0.013	-0.739
14	0.232	13.048
15	0.232	13.048
16	0.226	12.752
17	-0.236	-13.285
18	-0.236	-13.285
19	0.000	0.000
20	-0.028	-1.611

MOHR-COULOMB SOIL PARAMETERS

5 Type(s) of Soil Defined

Soil Number and Description	Moist Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Ratio(ru)	(-Uw) Fact.	Water Surface No.	Water Option
1 STRATUM I	123.8	0.0	446.00	22.50	0.000	0.0	1	0
2 STRATUM II	125.3	0.0	1598.00	28.40	0.000	0.0	0	0
3 SOLID WASTE	50.0	0.0	250.00	23.00	0.000	0.0	0	0
4 PROTECTIVE COVER	109.3	0.0	446.00	22.50	0.000	0.0	0	0

			Excav	Effec				
5 CLAY LINER / GS	115.0	0.0	1409.00	11.40	0.000	0.0	0	0

WATER SURFACE DATA

1 Water Surface(s) Defined

Unit Weight of Water = 62.400 (pcf)

Water Surface No. 1 Specified by 3 Coordinate Points
Phreatic Adjustment Factor = 0.00

Point No.	X-Water (ft)	Y-Water (ft)
1	1323.89	465.14
2	1552.00	465.00
3	2200.00	443.00

TRIAL FAILURE SURFACE DATA

Circular Trial Failure Surfaces Have Been Generated Using A Random Procedure.

1000 Trial Surfaces Have Been Generated.

1000 Surfaces Generated at Increments of 3.0030(in) Equally Spaced Within the Start Range

Along The Specified Surface Between X =1250.00(ft)
and X =1500.00(ft)

Each Surface ends within a Range Between X =1800.00(ft)
and X =1950.00(ft)

All surfaces are generated left to right for both a left and right sliding slope.

Unless XCLUDE Lines Were Specified, The Minimum Elevation
To Which A Surface Extends Is Y = 250.00(ft)

Specified Maximum Radius = 1300.000(ft)

2.000(ft) Line Segments Were Used For Each Trial Failure Surface.

The Spencer Method Was Selected for FS Analysis.

Selected fx function = Constant (1.0)

SELECTED CONVERGENCE PARAMETERS FOR SPENCER METHOD:
Initial estimate of FS = 1.500
FS tolerance = 0.000001000
Initial estimate of theta(deg) = 15.00
Theta tolerance(radians) = 0.0001000
Minimum theta(deg) = -45.00 ; Maximum theta(deg) = 45.00
Theta convergence Step Factor = 5000.00
Maximum number of iterations = 50
Allowable negative side force = -1000.0(lbs)
Maximum force imbalance = 100.000000(lbs)
Maximum moment imbalance = 100.000000 (ft/lbs)

Selected Lambda Coefficient = 1.00

Specified Tension Crack Water Depth Factor = 0.000

Total Number of Trial Surfaces Attempted = 1000

WARNING! The Factor of Safety Calculation for one or More Trial Surfaces
Did Not Converge in 50 Iterations.

Number of Trial Surfaces with Non-Converged FS = 228

Number of Trial Surfaces With Valid FS = 772

Percentage of Trial Surfaces With Non-Converged and/or
Non-Valid FS Solutions of the Total Attempted = 22.8 %

Statistical Data On All Valid FS Values:
FS Max = 10.995 FS Min = 2.780 FS Ave = 5.176
Standard Deviation = 2.046 Coefficient of Variation = 39.54 %

Critical Surface is Sequence Number 137 of Those Analyzed.

*****BEGINNING OF DETAILED GEOSTASE OUTPUT FOR CRITICAL SURFACE FROM A SEARCH*****

Excav Effec

BACK-CALCULATED CIRCULAR SURFACE PARAMETERS:

Circle Center At X = 1500.571771(ft) ; Y = 1160.729612(ft); and Radius = 714.199257(ft)

Circular Trial Failure Surface Generated With315 Coordinate Points

Point No.	X-Coord. (ft)	Y-Coord. (ft)
1	1323.57357	468.81038
2	1325.51187	468.31744
3	1327.45155	467.82993
4	1329.39258	467.34785
5	1331.33495	466.87121
6	1333.27865	466.40001
7	1335.22366	465.93426
8	1337.16997	465.47395
9	1339.11756	465.01910
10	1341.06642	464.56970
11	1343.01653	464.12576
12	1344.96787	463.68729
13	1346.92043	463.25428
14	1348.87420	462.82673
15	1350.82916	462.40467
16	1352.78529	461.98808
17	1354.74258	461.57696
18	1356.70101	461.17133
19	1358.66058	460.77119
20	1360.62125	460.37654
21	1362.58303	459.98737
22	1364.54588	459.60371
23	1366.50980	459.22554
24	1368.47477	458.85287
25	1370.44078	458.48570
26	1372.40781	458.12405
27	1374.37585	457.76790
28	1376.34487	457.41727
29	1378.31487	457.07215
30	1380.28583	456.73254
31	1382.25773	456.39846
32	1384.23055	456.06991
33	1386.20429	455.74687
34	1388.17893	455.42937
35	1390.15445	455.11740
36	1392.13083	454.81096
37	1394.10807	454.51006

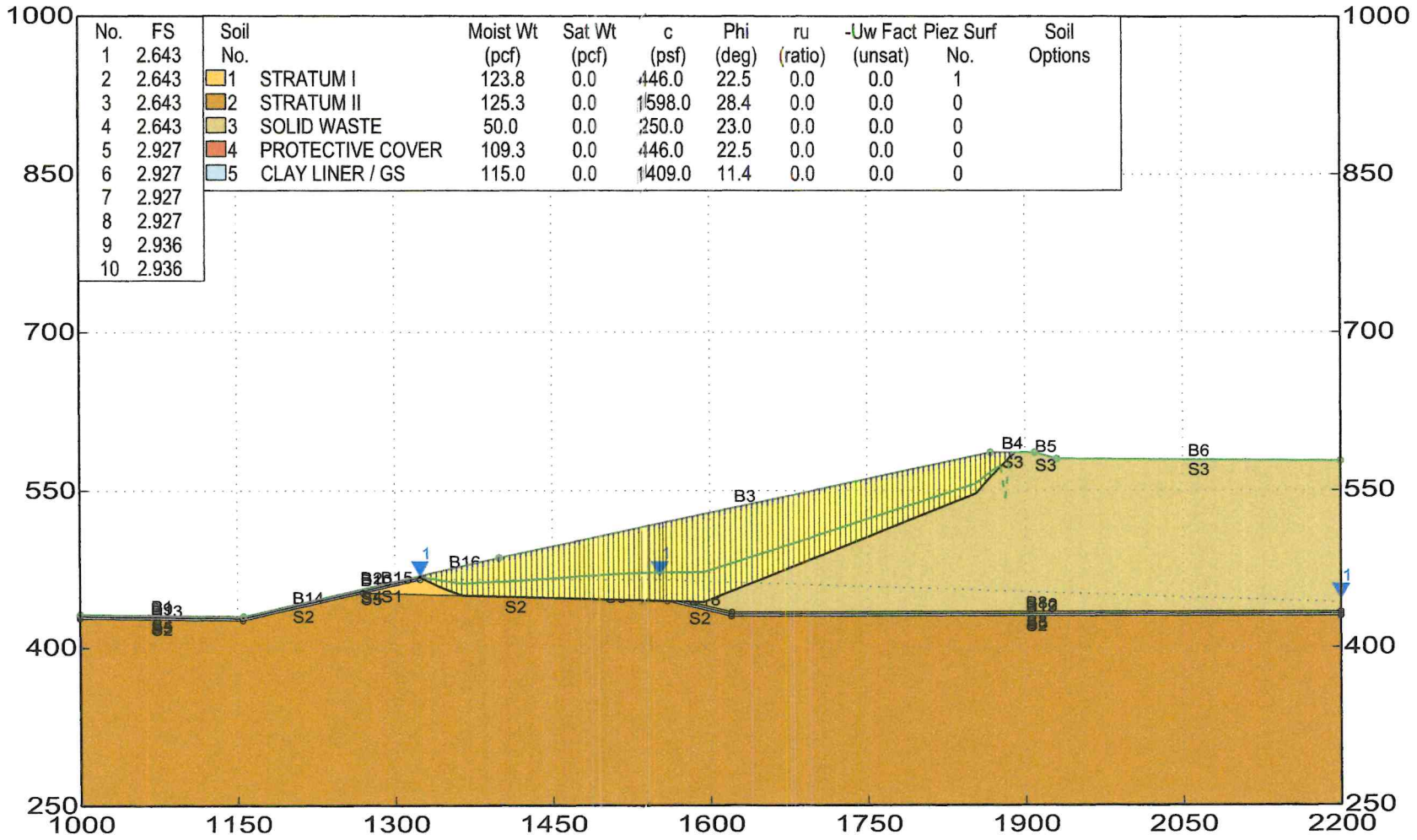
EXCAVATION SLOPE STABILITY WITH EXISTING MSW SURCHARGE – LONG TERM GEOSTASE INPUT PARAMETERS

This analysis evaluates the long term stability of the excavation and the 5H:1V existing waste slope using a circular failure surface. The geometry for the critical section is shown on the following page. The analysis was performed at Analysis Line EX S which is the deepest proposed excavation adjacent to the existing waste slope. Effective stress parameters were used to analyze the long term condition for the soil slopes. Material properties for each soil and material type are tabulated on the following page. The water surface was assumed as the highest recorded groundwater at the site from Appendix D7A. The analysis resulted in a factor of safety greater than 1.5, the generally recognized minimum for long term conditions. The analysis demonstrates that the critical failure surface is almost entirely in the waste and has very little effect on the excavation slope.

SKYLINE LANDFILL EXPANSION
EXCAVATION STABILITY W/MSW SURCHARGE - BLOCK ANALYSIS - LONG TERM

BIGGS AND MATHEWS ENVIRONMENTAL - WRC

\Exc BLK EFFEC w- Liner w- Srg Chg w-OLD Excav.gsd



GEOSTASE FS = 2.643

Spencer Method

GEOSTASE
Slope Stability Analysis

Excav Effec

*** GEOSTASE(R) ***

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SLOPE STABILITY ANALYSIS SOFTWARE (2D & 3D)
Simplified Bishop, Simplified Janbu, or General Equilibrium (GE) Options.
(Spencer, Morgenstern-Price, USACE, and Lowe & Karafiath)
Including Pier/Pile, Planar Reinf, Nail, Tieback, Line Loads
Applied Forces, Fiber-Reinforced Soil (FRS), Distributed Loads
Nonlinear Undrained Shear Strength, Curved Strength Envelope,
Anisotropic Strengths, Water Surfaces, 3-Stage Rapid Drawdown
2- or 3-Stage Pseudo-Static & Simplified Newmark Seismic Analyses.

****

Analysis Date: 5/ 1/ 2024
Analysis Time: 1 :27 PM
Analysis By: BIGGS AND MATHEWS ENVIRONMENTAL - WRC

Input File Name: O:\Waste Management\Skyline\Solid Waste\2022 - Expansion Permit\PART II (2)\Borings\Stability Analysis\Excavation\Exc w- Surchg\Effec\Exc BLK EFFEC w- Liner w- Srg Chg w-OLD Excav.gsd
Output File Name: O:\Waste Management\Skyline\Solid Waste\2022 - Expansion Permit\PART II (2)\Borings\Stability Analysis\Excavation\Exc w- Surchg\Effec\Exc BLK EFFEC w- Liner w- Srg Chg w-OLD Excav.OUT
Unit System: English

PROJECT: SKYLINE LANDFILL EXPANSION

DESCRIPTION: EXCAVATION STABILITY W/MSW SURCHARGE - BLOCK ANALYSIS - LONG TERM

PROFILE BOUNDARY DATA

6 Surface Boundaries
20 Total Boundaries

Boundary	X - 1	Y - 1	X - 2	Y - 2	Soil Type

No.	(ft)	(ft)	(ft)	(ft)	Excav Effec Below Bnd
1	1000.000	432.000	1155.570	430.000	4
2	1155.570	430.000	1399.110	486.260	4
3	1399.110	486.260	1867.000	586.000	3
4	1867.000	586.000	1909.000	586.000	3
5	1909.000	586.000	1930.000	580.000	3
6	1930.000	580.000	2200.000	578.000	3
7	1399.110	486.260	1620.470	434.000	3
8	1620.470	434.000	2200.000	434.000	3
9	1000.000	430.000	1154.780	428.000	5
10	1154.780	428.000	1399.100	484.210	5
11	1399.100	484.210	1620.230	432.000	5
12	1620.230	432.000	2200.000	432.000	5
13	1000.000	428.000	1155.000	426.000	2
14	1155.000	426.000	1269.435	452.521	2
15	1269.435	452.521	1323.888	465.141	1
16	1323.888	465.141	1399.090	482.160	1
17	1399.090	482.160	1559.116	444.375	1
18	1559.116	444.375	1620.000	430.000	2
19	1620.000	430.000	2200.000	430.000	2
20	1269.435	452.521	1559.116	444.375	2

User Specified X-Origin = 1000.000(ft)

User Specified Y-Origin = 250.000(ft)

SURFACE BOUNDARY POINT COORDINATES
(Information Only-Not Used Directly)

Point No.	X-COORD	Y-COORD
1	1000.000	432.000
2	1155.570	430.000
3	1399.110	486.260
4	1867.000	586.000
5	1909.000	586.000
6	1930.000	580.000
7	2200.000	578.000

SUBSURFACE BOUNDARY POINT COORDINATES
(Information Only-Not Used Directly)

Point No.	X-COORD	Y-COORD

Surface boundary point 3 and Subsurface boundary point 8 are duplicate points.

8	1399.110	486.260
9	1620.470	434.000
10	2200.000	434.000
11	1154.780	428.000
12	1399.100	484.210

		Excav Effec
13	1620.230	432.000
14	2200.000	432.000
15	1155.000	426.000
16	1269.435	452.521
17	1323.888	465.141
18	1399.090	482.160
19	1559.116	444.375
20	1620.000	430.000
21	2200.000	430.000
22	1559.116	444.375

PROFILE BOUNDARY SLOPES AND ANGLES

BND No.	Slope	Angle(Deg.)
1	-0.013	-0.737
2	0.231	13.008
3	0.213	12.034
4	0.000	0.000
5	-0.286	-15.945
6	-0.007	-0.424
7	-0.236	-13.284
8	0.000	0.000
9	-0.013	-0.740
10	0.230	12.956
11	-0.236	-13.285
12	0.000	0.000
13	-0.013	-0.739
14	0.232	13.048
15	0.232	13.048
16	0.226	12.752
17	-0.236	-13.285
18	-0.236	-13.285
19	0.000	0.000
20	-0.028	-1.611

MOHR-COULOMB SOIL PARAMETERS

5 Type(s) of Soil Defined

Soil Number and Description	Moist Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Ratio(ru)	(-Uw) Fact.	Water Surface No.	Water Option
1 STRATUM I	123.8	0.0	446.00	22.50	0.000	0.0	1	0
2 STRATUM II	125.3	0.0	1598.00	28.40	0.000	0.0	0	0
3 SOLID WASTE	50.0	0.0	250.00	23.00	0.000	0.0	0	0
4 PROTECTIVE COVER	109.3	0.0	446.00	22.50	0.000	0.0	0	0

				Excav	Effec			
5 CLAY LINER / GS	115.0	0.0	1409.00	11.40	0.000	0.0	0	0

WATER SURFACE DATA

1 Water Surface(s) Defined

Unit Weight of Water = 62.400 (pcf)

Water Surface No. 1 Specified by 3 Coordinate Points
Phreatic Adjustment Factor = 0.00

Point No.	X-Water (ft)	Y-Water (ft)
1	1323.89	465.14
2	1552.00	465.00
3	2200.00	443.00

A Non-Circular Zone Search Has Been Selected For Analysis
Using Random Generation Within Specified Zones.

3 Zones Defined For Generation Of Non-Circular Surfaces

1000 Trial Surfaces Have Been Generated.

Length Of Line Segments For Active And Passive Portions Of
Non-Circular Zone Search = 20.50(ft)

Zone No.	X - 1 (ft)	Y - 1 (ft)	X - 2 (ft)	Y - 2 (ft)	Height (ft)
1	1320.00	450.00	1430.00	450.00	10.00
2	1440.00	445.00	1650.00	445.00	50.00
3	1700.00	450.00	1900.00	550.00	50.00

The Spencer Method Was Selected for FS Analysis.

Selected fx function = Constant (1.0)

SELECTED CONVERGENCE PARAMETERS FOR SPENCER METHOD:
Initial estimate of FS = 1.500
FS tolerance = 0.000001000
Initial estimate of theta(deg) = 15.00
Theta tolerance(radians) = 0.0001000

Excav Effec

Minimum theta(deg) = -45.00 ; Maximum theta(deg) = 45.00
Theta convergence Step Factor = 5000.00
Maximum number of iterations = 50
Allowable negative side force = -1000.0(lbs)
Maximum force imbalance = 100.000000(lbs)
Maximum moment imbalance = 100.000000 (ft/lbs)

Selected Lambda Coefficient = 1.00

Specified Tension Crack Water Depth Factor = 0.000

Total Number of Trial Surfaces Attempted = 1000

WARNING! The Factor of Safety Calculation for one or More Trial Surfaces
Did Not Converge in 50 Iterations.

Number of Trial Surfaces with Non-Converged FS = 128

Number of Trial Surfaces With Valid FS = 872

Percentage of Trial Surfaces With Non-Converged and/or
Non-Valid FS Solutions of the Total Attempted = 12.8 %

Statistical Data On All Valid FS Values:
FS Max = 9.891 FS Min = 2.643 FS Ave = 4.929
Standard Deviation = 1.395 Coefficient of Variation = 28.31 %

Critical Surface is Sequence Number 98 of Those Analyzed.

*****BEGINNING OF DETAILED GEOSTASE OUTPUT FOR CRITICAL SURFACE FROM A SEARCH*****

Iter. No.	Theta (deg) (fx=1.0)	FS (Moment)	FS (Force)	Lambda	Delta FS
1	15.0000	1.945515	2.721670	0.268	0.7761545E+00
2	19.9500	0.000000	2.813096	0.363	0.2813096E+01
3	13.1142	2.274346	2.689960	0.233	0.4156136E+00
4	11.9308	2.440525	2.670787	0.211	0.2302624E+00
5	10.4612	2.613832	2.647681	0.185	0.3384907E-01
6	10.2083	2.640491	2.643778	0.180	0.3287294E-02

INTERIM WASTE SLOPE STABILITY – SHORT TERM GEOSTASE INPUT PARAMETERS

This analysis evaluates short term stability of the waste slope in the proposed expansion area using a circular arc failure surface. The geometry for the critical section is shown on the following page. The analysis was performed at Analysis Line EX which is the deepest part of the proposed excavation. Strata I and II and the solid waste were modeled using total stress parameters. The clay liner and protective cover had geosynthetic components and were modeled using the high pressure interface shear strength parameters. Material properties for each material are tabulated on the following page. The water surface was assumed as the highest recorded groundwater at the site from Appendix D7A. The analysis resulted in a factor of safety greater than 1.3, the generally recognized minimum for short term conditions. The analysis demonstrates that the critical failure surface is entirely in the waste and does not encroach on the underlying soils. Consequently, a long term analysis of the interim waste slope was not performed because the short and long term properties of the waste are the same and the analysis would yield the same results.

SKYLINE LANDFILL - PERMIT EXPANSION

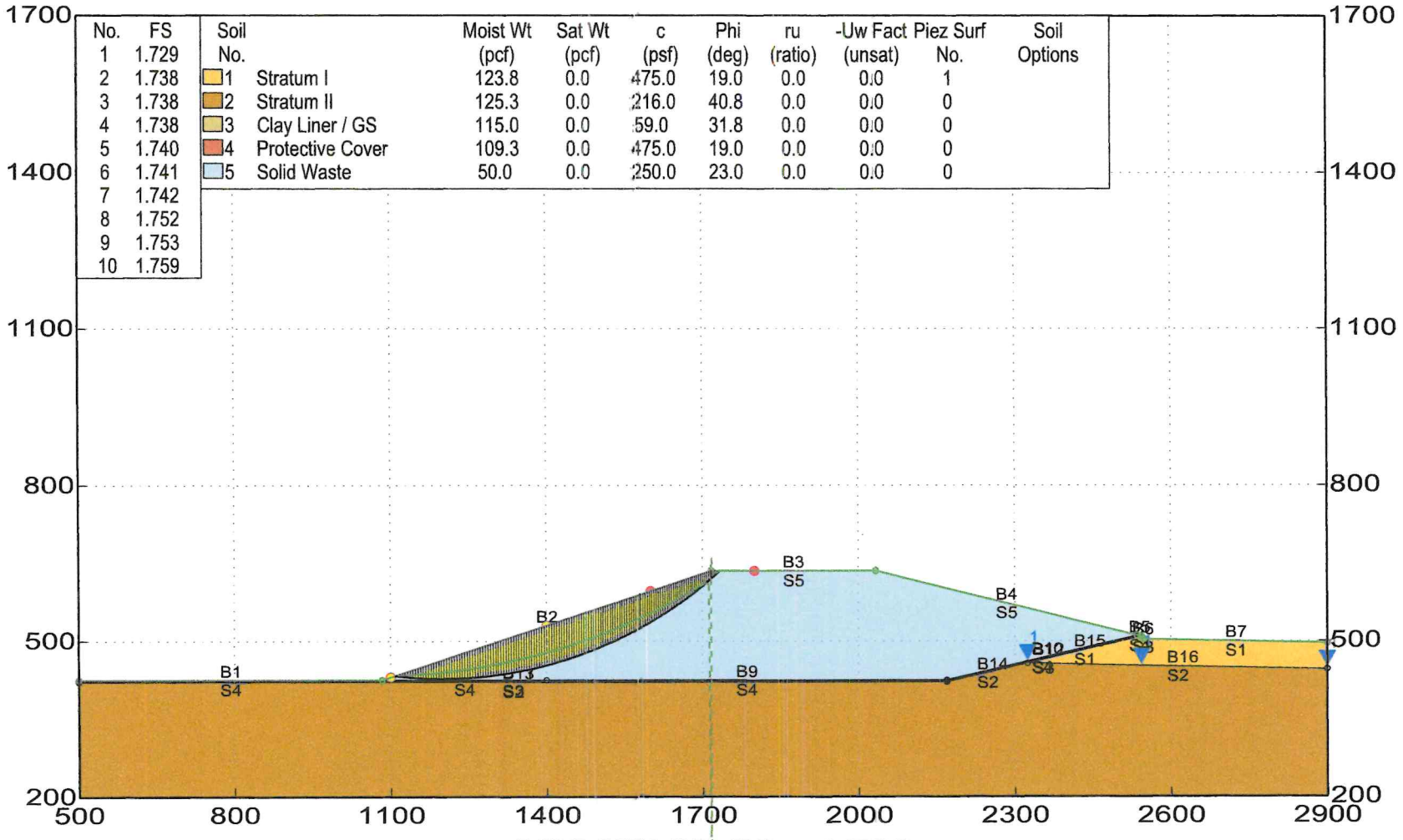
INTERIM WAST SLOPE STABILITY WITH LINER & PROTECTIVE COVER - SHORT TERM

BIGGS AND MATHEWS ENVIRONMENTAL - WRC

\Int MSW Excav Slope CIR TOT w LINER-PC .gsd

No.	FS
1	1.729
2	1.738
3	1.738
4	1.738
5	1.740
6	1.741
7	1.742
8	1.752
9	1.753
10	1.759

Soil No.		Moist Wt (pcf)	Sat Wt (pcf)	c (psf)	Phi (deg)	ru (ratio)	-Uw Fact (unsat)	Piez Surf No.	Soil Options
1	Stratum I	123.8	0.0	475.0	19.0	0.0	0.0	1	
2	Stratum II	125.3	0.0	216.0	40.8	0.0	0.0	0	
3	Clay Liner / GS	115.0	0.0	59.0	31.8	0.0	0.0	0	
4	Protective Cover	109.3	0.0	475.0	19.0	0.0	0.0	0	
5	Solid Waste	50.0	0.0	250.0	23.0	0.0	0.0	0	



GEOSTASE FS = 1.729

Spencer Method

GEOSTASE
Slope Stability
Analysis

Excav Effec

*** GEOSTASE(R) ***

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****
SLOPE STABILITY ANALYSIS SOFTWARE (2D & 3D)
Simplified Bishop, Simplified Janbu, or General Equilibrium (GE) Options.
(Spencer, Morgenstern-Price, USACE, and Lowe & Karafiath)
Including Pier/Pile, Planar Reinf, Nail, Tieback, Line Loads
Applied Forces, Fiber-Reinforced Soil (FRS), Distributed Loads
Nonlinear Undrained Shear Strength, Curved Strength Envelope,
Anisotropic Strengths, Water Surfaces, 3-Stage Rapid Drawdown
2- or 3-Stage Pseudo-Static & Simplified Newmark Seismic Analyses.
****

Analysis Date: 5/ 6/ 2024
Analysis Time: 11 :09 AM
Analysis By: BIGGS AND MATHEWS ENVIRONMENTAL - WRC

Input File Name: O:\Waste Management\Skyline\Solid Waste\2022 - Expansion Permit\PART II (2)\Borings\Stability Analysis\Excavation\Interim Waste\Int MSW Excav Slope CIR TOT w LINER-PC .gsd
Output File Name: O:\Waste Management\Skyline\Solid Waste\2022 - Expansion Permit\PART II (2)\Borings\Stability Analysis\Excavation\Interim Waste\Int MSW Excav Slope CIR TOT w LINER-PC .OUT
Unit System: English

PROJECT: SKYLINE LANDFILL - PERMIT EXPANSION

DESCRIPTION: INTERIM WAST SLOPE STABILITY WITH LINER & PROTECTIVE COVER - SHORT TERM

PROFILE BOUNDARY DATA

7 Surface Boundaries
16 Total Boundaries

Boundary	X - 1	Y - 1	X - 2	Y - 2	Soil Type

No.	(ft)	(ft)	(ft)	(ft)	Excav Effec Below Bnd
1	500.000	425.000	1083.640	424.982	4
2	1083.640	424.982	1717.017	636.107	5
3	1717.017	636.107	2032.783	635.953	5
4	2032.783	635.953	2534.778	510.455	5
5	2534.778	510.455	2543.249	508.337	4
6	2543.249	508.337	2548.523	503.681	3
7	2548.523	503.681	2900.000	496.000	1
8	1083.640	424.982	1399.418	424.832	4
9	1399.418	424.832	2169.023	424.467	4
10	2169.023	424.467	2534.778	510.455	4
11	500.000	423.010	2169.278	422.472	3
12	2169.278	422.472	2539.013	509.396	3
13	500.000	421.000	2169.534	420.478	2
14	2169.534	420.478	2324.279	456.858	2
15	2324.279	456.858	2543.249	508.337	1
16	2324.279	456.858	2900.000	445.386	2

User Specified X-Origin = 500.000(ft)

User Specified Y-Origin = 200.000(ft)

SURFACE BOUNDARY POINT COORDINATES
(Information Only-Not Used Directly)

Point No.	X-COORD	Y-COORD
1	500.000	425.000
2	1083.640	424.982
3	1717.017	636.107
4	2032.783	635.953
5	2534.778	510.455
6	2543.249	508.337
7	2548.523	503.681
8	2900.000	496.000

SUBSURFACE BOUNDARY POINT COORDINATES
(Information Only-Not Used Directly)

Point No.	X-COORD	Y-COORD
Surface boundary point 2 and Subsurface boundary point 9 are duplicate points.		
9	1083.640	424.982
10	1399.418	424.832
11	2169.023	424.467
Surface boundary point 5 and Subsurface boundary point 12 are duplicate points.		
12	2534.778	510.455
13	2169.278	422.472
14	2539.013	509.396
15	2169.534	420.478

		Excav Effec
16	2324.279	456.858

Surface boundary point 6 and Subsurface boundary point 17 are duplicate points.

17	2543.249	508.337
18	2900.000	445.386

PROFILE BOUNDARY SLOPES AND ANGLES

BND No.	Slope	Angle(Deg.)
1	-0.000	-0.002
2	0.333	18.435
3	-0.000	-0.028
4	-0.250	-14.036
5	-0.250	-14.038
6	-0.883	-41.439
7	-0.022	-1.252
8	-0.000	-0.027
9	-0.000	-0.027
10	0.235	13.230
11	-0.000	-0.018
12	0.235	13.230
13	-0.000	-0.018
14	0.235	13.230
15	0.235	13.230
16	-0.020	-1.142

MOHR-COULOMB SOIL PARAMETERS

5 Type(s) of Soil Defined

Soil Number and Description	Moist Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Ratio(ru)	(-Uw) Fact.	Water Surface No.	Water Option
1 Stratum I	123.8	0.0	475.00	19.00	0.000	0.0	1	0
2 Stratum II	125.3	0.0	216.00	40.80	0.000	0.0	0	0
3 Clay Liner / GS	115.0	0.0	59.00	31.80	0.000	0.0	0	0
4 Protective Cover	109.3	0.0	475.00	19.00	0.000	0.0	0	0
5 Solid Waste	50.0	0.0	250.00	23.00	0.000	0.0	0	0

WATER SURFACE DATA

1 Water Surface(s) Defined

Unit Weight of Water = 62.400 (pcf)

Water Surface No. 1 Specified by 3 Coordinate Points

Excav Effec

Phreatic Adjustment Factor = 0.00

Point No.	X-Water (ft)	Y-Water (ft)
1	2324.28	456.86
2	2543.24	450.00
3	2900.00	445.29

TRIAL FAILURE SURFACE DATA

Circular Trial Failure Surfaces Have Been Generated Using A Random Procedure.

1000 Trial Surfaces Have Been Generated.

1000 Surfaces Generated at Increments of 3.6036(in) Equally Spaced Within the Start Range

Along The Specified Surface Between X =1100.00(ft)
and X =1400.00(ft)

Each Surface ends within a Range Between X =1600.00(ft)
and X =1800.00(ft)

All surfaces are generated left to right for both a left and right sliding slope.

Unless XCLUDE Lines Were Specified, The Minimum Elevation
To Which A Surface Extends Is Y = 200.00(ft)

Specified Maximum Radius = 850.000(ft)

5.000(ft) Line Segments Were Used For Each Trial Failure Surface.

The Spencer Method Was Selected for FS Analysis.

Selected fx function = Constant (1.0)

SELECTED CONVERGENCE PARAMETERS FOR SPENCER METHOD:
Initial estimate of FS = 1.500
FS tolerance = 0.000001000
Initial estimate of theta(deg) = 15.00

Excav Effec

Theta tolerance(radians) = 0.0001000
Minimum theta(deg) = -45.00 ; Maximum theta(deg) = 45.00
Theta convergence Step Factor = 5000.00
Maximum number of iterations = **
Allowable negative side force = -1000.0(lbs)
Maximum force imbalance = 100.000000(lbs)
Maximum moment imbalance = 100.000000 (ft/lbs)

Selected Lambda Coefficient = 1.00

Specified Tension Crack Water Depth Factor = 0.000

Total Number of Trial Surfaces Attempted = 1000

WARNING! The Factor of Safety Calculation for one or More Trial Surfaces
Did Not Converge in ** Iterations.

Number of Trial Surfaces with Non-Converged FS = 101

Number of Trial Surfaces With Valid FS = 899

Percentage of Trial Surfaces With Non-Converged and/or
Non-Valid FS Solutions of the Total Attempted = 10.1 %

Statistical Data On All Valid FS Values:
FS Max = 6.917 FS Min = 1.729 FS Ave = 3.214
Standard Deviation = 1.472 Coefficient of Variation = 45.79 %

Critical Surface is Sequence Number 25 of Those Analyzed.

*****BEGINNING OF DETAILED GEOSTASE OUTPUT FOR CRITICAL SURFACE FROM A SEARCH*****

BACK-CALCULATED CIRCULAR SURFACE PARAMETERS:

Circle Center At X = 1199.670103(ft) ; Y = 1217.322734(ft); and Radius = 789.646355(ft)

Circular Trial Failure Surface Generated With137 Coordinate Points

Point No.	X-Coord. (ft)	Y-Coord. (ft)

INTERIM WASTE SLOPE STABILITY – SHORT TERM GEOSTASE INPUT PARAMETERS

This analysis evaluates short term stability of the waste slope in the proposed expansion area using a block type failure surface. The geometry for the critical section is shown on the following page. The analysis was performed at Analysis Line EX which is the deepest part of the proposed excavation. Strata I and II and the solid waste were modeled using total stress parameters. The clay liner and protective cover had geosynthetic components and were modeled using the high pressure interface shear strength parameters. Material properties for each material are tabulated on the following page. The water surface was assumed as the highest recorded groundwater at the site from Appendix D7. The analysis resulted in a factor of safety greater than 1.3, the generally recognized minimum for short term conditions. The analysis demonstrates that the critical failure surface is entirely in the waste and does not encroach on the underlying soils. Consequently, a long term analysis of the interim waste slope was not performed because the short and long term properties of the waste are the same and the analysis would yield the same results.

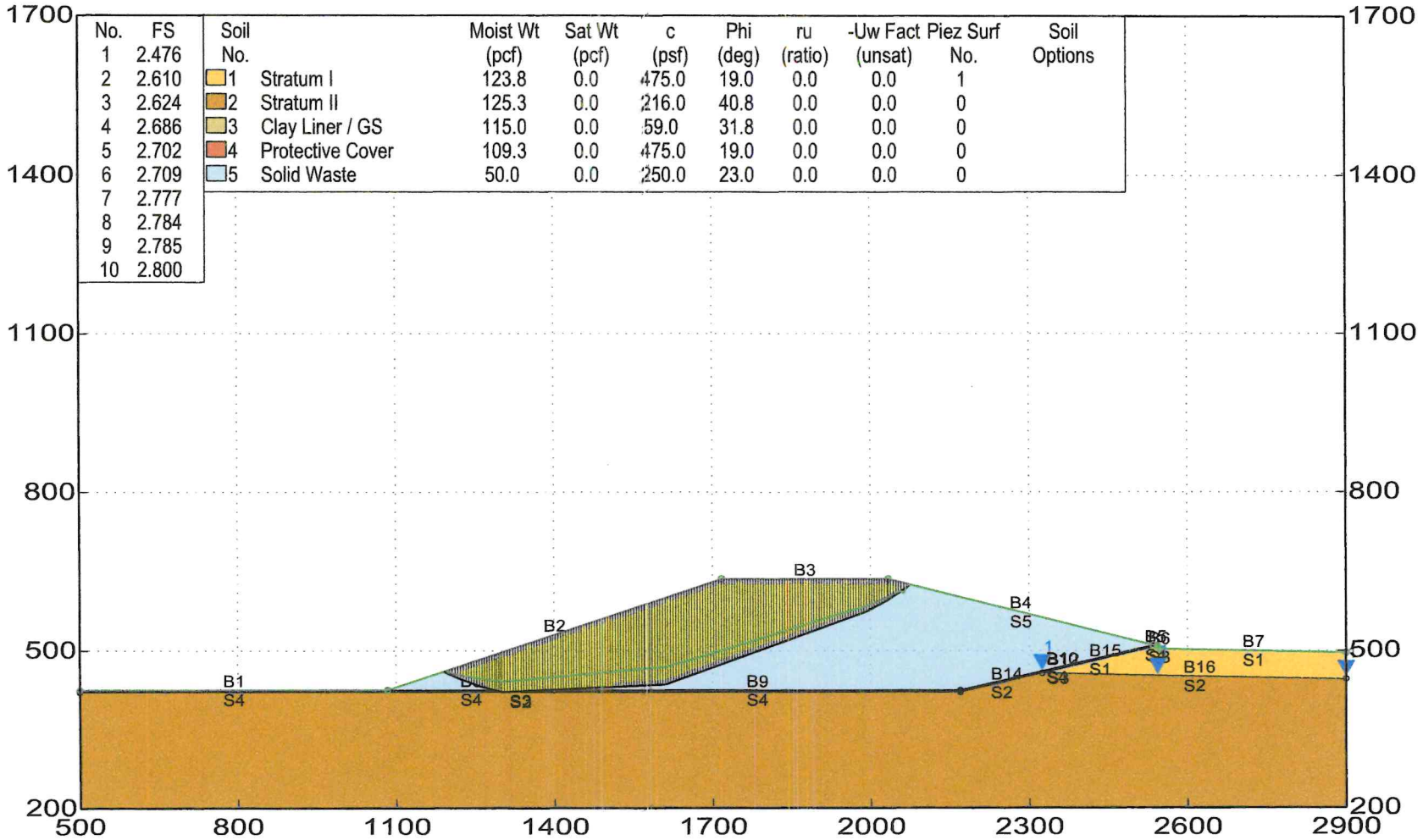
SKYLINE LANDFILL - PERMIT EXPANSION
INTERIM WASTE SLOPE STABILITY - BLOCK - SHORT TERM

BIGGS AND MATHEWS ENVIRONMENTAL - WRC

\Int MSW Excav Slope BLK TOT w LINER-PC .gsd

No.	FS
1	2.476
2	2.610
3	2.624
4	2.686
5	2.702
6	2.709
7	2.777
8	2.784
9	2.785
10	2.800

Soil No.		Moist Wt (pcf)	Sat Wt (pcf)	c (psf)	Phi (deg)	ru (ratio)	-Uw Fact (unsat)	Piez Surf No.	Soil Options
1	Stratum I	123.8	0.0	475.0	19.0	0.0	0.0	1	
2	Stratum II	125.3	0.0	216.0	40.8	0.0	0.0	0	
3	Clay Liner / GS	115.0	0.0	59.0	31.8	0.0	0.0	0	
4	Protective Cover	109.3	0.0	475.0	19.0	0.0	0.0	0	
5	Solid Waste	50.0	0.0	250.0	23.0	0.0	0.0	0	



GEOSTASE FS = 2.476

Spencer Method

GEOSTASE
Slope Stability Analysis

Excav Effec

*** GEOSTASE(R) ***

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SLOPE STABILITY ANALYSIS SOFTWARE (2D & 3D)
Simplified Bishop, Simplified Janbu, or General Equilibrium (GE) Options.
(Spencer, Morgenstern-Price, USACE, and Lowe & Karafiath)
Including Pier/Pile, Planar Reinf, Nail, Tieback, Line Loads
Applied Forces, Fiber-Reinforced Soil (FRS), Distributed Loads
Nonlinear Undrained Shear Strength, Curved Strength Envelope,
Anisotropic Strengths, Water Surfaces, 3-Stage Rapid Drawdown
2- or 3-Stage Pseudo-Static & Simplified Newmark Seismic Analyses.
****

Analysis Date: 5/ 2/ 2024
Analysis Time: 6 :04 PM
Analysis By: BIGGS AND MATHEWS ENVIRONMENTAL - WRC

Input File Name: O:\Waste Management\Skyline\Solid Waste\2022 - Expansion Permit\PART II (2)\Borings\Stability Analysis\Excavation\Interim Waste\Int MSW Excav Slope BLK TOT w LINER-PC .gsd
Output File Name: O:\Waste Management\Skyline\Solid Waste\2022 - Expansion Permit\PART II (2)\Borings\Stability Analysis\Excavation\Interim Waste\Int MSW Excav Slope BLK TOT w LINER-PC .OUT
Unit System: English

PROJECT: SKYLINE LANDFILL - PERMIT EXPANSION

DESCRIPTION: INTERIM WASTE SLOPE STABILITY - BLOCK - SHORT TERM

PROFILE BOUNDARY DATA

7 Surface Boundaries
16 Total Boundaries

Boundary	X - 1	Y - 1	X - 2	Y - 2	Soil Type

No.	(ft)	(ft)	(ft)	(ft)	Excav Effec Below Bnd
1	500.000	425.000	1083.640	424.982	4
2	1083.640	424.982	1717.017	636.107	5
3	1717.017	636.107	2032.783	635.953	5
4	2032.783	635.953	2534.778	510.455	5
5	2534.778	510.455	2543.249	508.337	4
6	2543.249	508.337	2548.523	503.681	3
7	2548.523	503.681	2900.000	496.000	1
8	1083.640	424.982	1399.418	424.832	4
9	1399.418	424.832	2169.023	424.467	4
10	2169.023	424.467	2534.778	510.455	4
11	500.000	423.010	2169.278	422.472	3
12	2169.278	422.472	2539.013	509.396	3
13	500.000	421.000	2169.534	420.478	2
14	2169.534	420.478	2324.279	456.858	2
15	2324.279	456.858	2543.249	508.337	1
16	2324.279	456.858	2900.000	445.386	2

User Specified X-Origin = 500.000(ft)

User Specified Y-Origin = 200.000(ft)

SURFACE BOUNDARY POINT COORDINATES
(Information Only-Not Used Directly)

Point No.	X-COORD	Y-COORD
1	500.000	425.000
2	1083.640	424.982
3	1717.017	636.107
4	2032.783	635.953
5	2534.778	510.455
6	2543.249	508.337
7	2548.523	503.681
8	2900.000	496.000

SUBSURFACE BOUNDARY POINT COORDINATES
(Information Only-Not Used Directly)

Point No.	X-COORD	Y-COORD	
Surface boundary point	2 and Subsurface boundary point	9 are duplicate points.	
9	1083.640	424.982	
10	1399.418	424.832	
11	2169.023	424.467	
Surface boundary point	5 and Subsurface boundary point	12 are duplicate points.	
12	2534.778	510.455	
13	2169.278	422.472	
14	2539.013	509.396	
15	2169.534	420.478	

Excav Effec

16 2324.279 456.858

Surface boundary point 6 and Subsurface boundary point 17 are duplicate points.

17 2543.249 508.337

18 2900.000 445.386

PROFILE BOUNDARY SLOPES AND ANGLES

BND No.	Slope	Angle(Deg.)
1	-0.000	-0.002
2	0.333	18.435
3	-0.000	-0.028
4	-0.250	-14.036
5	-0.250	-14.038
6	-0.883	-41.439
7	-0.022	-1.252
8	-0.000	-0.027
9	-0.000	-0.027
10	0.235	13.230
11	-0.000	-0.018
12	0.235	13.230
13	-0.000	-0.018
14	0.235	13.230
15	0.235	13.230
16	-0.020	-1.142

MOHR-COULOMB SOIL PARAMETERS

5 Type(s) of Soil Defined

Soil Number and Description	Moist Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Ratio(ru)	(-Uw) Fact.	Water Surface No.	Water Option
1 Stratum I	123.8	0.0	475.00	19.00	0.000	0.0	1	0
2 Stratum II	125.3	0.0	216.00	40.80	0.000	0.0	0	0
3 Clay Liner / GS	115.0	0.0	59.00	31.80	0.000	0.0	0	0
4 Protective Cover	109.3	0.0	475.00	19.00	0.000	0.0	0	0
5 Solid Waste	50.0	0.0	250.00	23.00	0.000	0.0	0	0

WATER SURFACE DATA

1 Water Surface(s) Defined

Unit Weight of Water = 62.400 (pcf)

Water Surface No. 1 Specified by 3 Coordinate Points

Excav Effec

Phreatic Adjustment Factor = 0.00

Point No.	X-Water (ft)	Y-Water (ft)
1	2324.28	456.86
2	2543.24	450.00
3	2900.00	445.29

A Non-Circular Zone Search Has Been Selected For Analysis
Using Random Generation Within Specified Zones.

3 Zones Defined For Generation Of Non-Circular Surfaces

1000 Trial Surfaces Have Been Generated.

Length Of Line Segments For Active And Passive Portions Of
Non-Circular Zone Search = 44.00(ft)

Zone No.	X - 1 (ft)	Y - 1 (ft)	X - 2 (ft)	Y - 2 (ft)	Height (ft)
1	1300.00	445.00	1450.00	450.00	100.00
2	1450.01	450.00	1700.00	450.00	100.00
3	1850.00	450.00	2050.00	560.00	100.00

The Spencer Method Was Selected for FS Analysis.

Selected fx function = Constant (1.0)

SELECTED CONVERGENCE PARAMETERS FOR SPENCER METHOD:
Initial estimate of FS = 1.500
FS tolerance = 0.000001000
Initial estimate of theta(deg) = 15.00
Theta tolerance(radians) = 0.0001000
Minimum theta(deg) = -45.00 ; Maximum theta(deg) = 45.00
Theta convergence Step Factor = 5000.00
Maximum number of iterations = **
Allowable negative side force = -1000.0(lbs)
Maximum force imbalance = 100.000000(lbs)
Maximum moment imbalance = 100.000000 (ft/lbs)

Selected Lambda Coefficient = 1.00

Specified Tension Crack Water Depth Factor = 0.000

Excav Effec

Total Number of Trial Surfaces Attempted = 1000

WARNING! The Factor of Safety Calculation for one or More Trial Surfaces
Did Not Converge in ** Iterations.

Number of Trial Surfaces with Non-Converged FS = 645

Number of Trial Surfaces With Valid FS = 355

Percentage of Trial Surfaces With Non-Converged and/or
Non-Valid FS Solutions of the Total Attempted = 64.5 %

Statistical Data On All Valid FS Values:
FS Max = 10.493 FS Min = 2.476 FS Ave = 4.336
Standard Deviation = 1.309 Coefficient of Variation = 30.19 %

Critical Surface is Sequence Number 115 of Those Analyzed.

*****BEGINNING OF DETAILED GEOSTASE OUTPUT FOR CRITICAL SURFACE FROM A SEARCH*****

Iter. No.	Theta (deg) (fx=1.0)	FS (Moment)	FS (Force) Lambda	Delta FS	
1	15.0000	1.672536	2.526124	0.268	0.8535884E+00
2	19.9500	0.000000	2.585469	0.363	0.2585469E+01
3	12.5608	2.178729	2.499583	0.223	0.3208545E+00
4	11.5156	2.328470	2.488662	0.204	0.1601921E+00
5	10.4738	2.451594	2.478021	0.185	0.2642691E-01
6	10.2683	2.473330	2.475949	0.181	0.2619487E-02
7	10.2457	2.475670	2.475722	0.181	0.5245659E-04
8	10.2452	2.475717	2.475717	0.181	0.6196360E-06

Factor Of Safety For The Preceding Specified Surface = 2.476
Theta (fx = 1.0) = 10.25 Deg Lambda = 0.181

The Spencer Method Has Been Selected For Analysis.

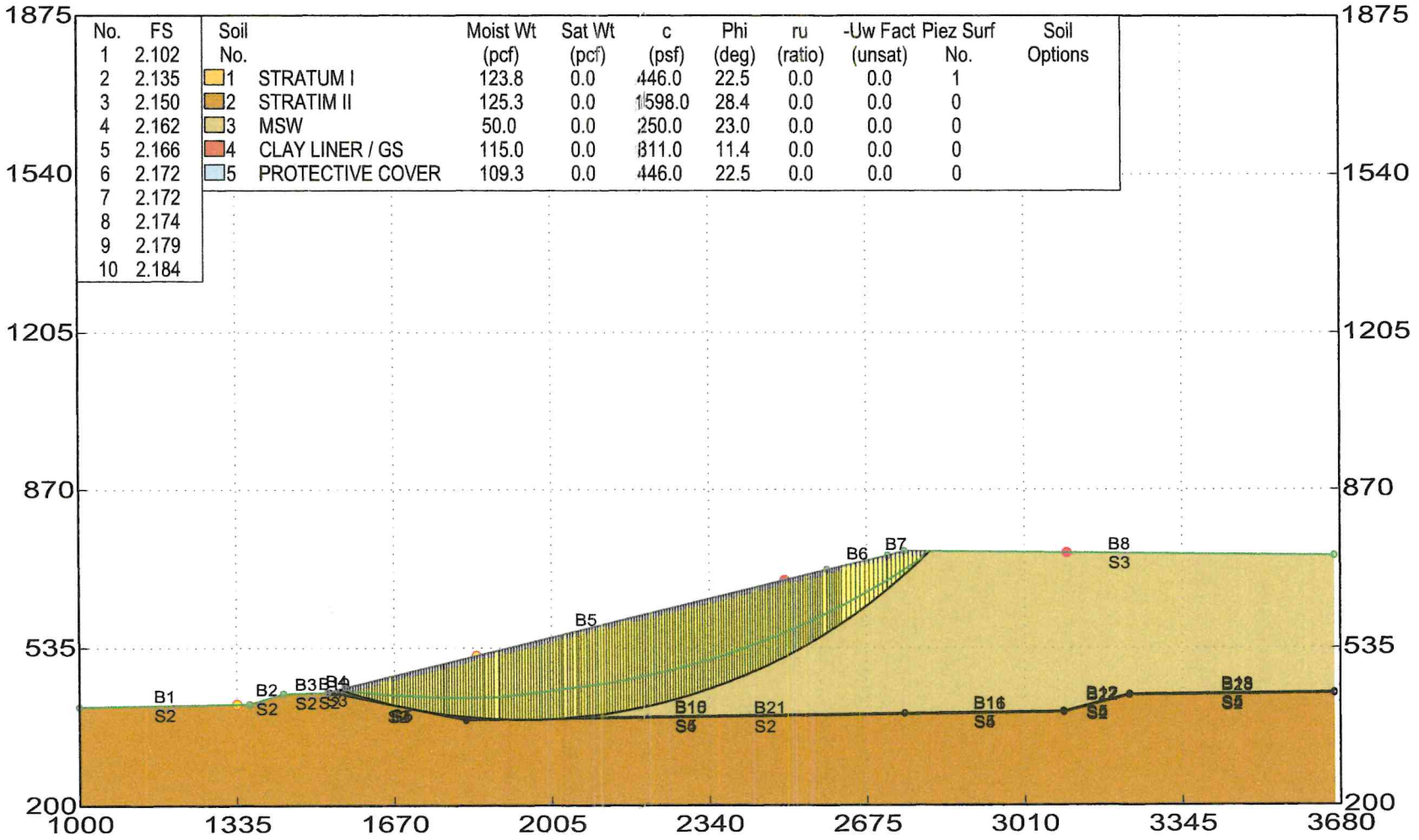
FINAL WASTE SLOPE STABILITY – LONG TERM GEOSTASE INPUT PARAMETERS

This analysis evaluates the long term stability of the final waste using a circular arc failure surface. The stability of the final cover systems was evaluated using the infinite slope method which is appropriate for a veneer system of layers which are not included in this analysis model. The geometry for the critical section is shown on the following page. The analysis was performed at Analysis Line FW which is the highest part of the waste. Effective stress parameters were used to analyze the long term condition for Stratum II and the solid waste. The clay liner and protective cover had geosynthetic components and were modeled using the high pressure interface shear strength parameters. Material properties for each soil and material type are tabulated on the following page. The water surface was assumed as the highest recorded groundwater at the site from Appendix D7A. The analysis resulted in a factor of safety greater than 1.5, the generally recognized minimum for long term conditions. The analysis demonstrates that the critical failure surface is entirely in the waste and does not encroach on the underlying soils. Consequently, a long term analysis of the interim waste slope was not performed because the short and long term properties of the waste are the same and the analysis would yield the same results.

SKYLINE LANDFILL EXPANSION
FINAL WASTE SLOPE STABILITY - CIRCULAR ANALYSIS - LONG TERM

BIGGS AND MATHEWS ENVIRONMENTAL - WRC

\Waste Stab Analysis CIRC Template.gsd



No.	FS
1	2.102
2	2.135
3	2.150
4	2.162
5	2.166
6	2.172
7	2.172
8	2.174
9	2.179
10	2.184

Soil No.		Moist Wt (pcf)	Sat Wt (pcf)	c (psf)	Phi (deg)	ru (ratio)	-Uw Fact (unsat)	Piez Surf No.	Soil Options
1	STRATUM I	123.8	0.0	446.0	22.5	0.0	0.0	1	
2	STRATIM II	125.3	0.0	1598.0	28.4	0.0	0.0	0	
3	MSW	50.0	0.0	250.0	23.0	0.0	0.0	0	
4	CLAY LINER / GS	115.0	0.0	311.0	11.4	0.0	0.0	0	
5	PROTECTIVE COVER	109.3	0.0	446.0	22.5	0.0	0.0	0	

GEOSTASE FS = 2.102

Spencer Method

GEOSTASE Slope Stability Analysis

GEOSTASE® v4.30.32 by GREGORY GEOTECHNICAL SOFTWARE

PLATE C.1

Excav Effec

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SLOPE STABILITY ANALYSIS SOFTWARE (2D & 3D)
Simplified Bishop, Simplified Janbu, or General Equilibrium (GE) Options.
(Spencer, Morgenstern-Price, USACE, and Lowe & Karafiath)
Including Pier/Pile, Planar Reinf, Nail, Tieback, Line Loads
Applied Forces, Fiber-Reinforced Soil (FRS), Distributed Loads
Nonlinear Undrained Shear Strength, Curved Strength Envelope,
Anisotropic Strengths, Water Surfaces, 3-Stage Rapid Drawdown
2- or 3-Stage Pseudo-Static & Simplified Newmark Seismic Analyses.

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Analysis Date: 5/ 2/ 2024
Analysis Time: 12 :17 AM
Analysis By: BIGGS AND MATHEWS ENVIRONMENTAL - WRC

Input File Name: O:\Waste Management\Skyline\Solid Waste\2022 - Expansion Permit\PART II (2)\Borings\Stability Analysis\Waste Slope\Waste Stab Analysis CIRC Template.gsd
Output File Name: O:\Waste Management\Skyline\Solid Waste\2022 - Expansion Permit\PART II (2)\Borings\Stability Analysis\Waste Slope\Waste Stab Analysis CIRC Template.OUT
Unit System: English

PROJECT: SKYLINE LANDFILL EXPANSION

DESCRIPTION: FINAL WASTE SLOPE STABILITY - CIRCULAR ANALYSIS - LONG TERM

PROFILE BOUNDARY DATA

8 Surface Boundaries
23 Total Boundaries

Boundary	X - 1	Y - 1	X - 2	Y - 2	Soil Type

No.	(ft)	(ft)	(ft)	Excav Effec (ft)	Below Bnd
1	1000.000	410.000	1361.600	416.000	2
2	1361.600	416.000	1433.900	438.000	2
3	1433.900	438.000	1528.200	440.000	2
4	1528.200	440.000	1564.300	450.000	3
5	1564.300	450.000	2590.300	700.000	3
6	2590.300	700.000	2719.600	730.000	3
7	2719.600	730.000	2754.400	740.000	3
8	2754.400	740.000	3667.200	730.000	3
9	1548.257	440.885	1821.944	384.626	5
10	1821.944	384.626	2754.384	396.298	5
11	2754.384	396.298	3091.312	400.524	5
12	3091.912	400.524	3232.015	436.896	5
13	3232.015	436.896	3667.215	440.600	5
14	1544.028	439.713	1821.753	382.626	4
15	1821.753	382.626	2754.384	394.298	4
16	2754.384	394.298	3092.180	398.527	4
17	3092.180	398.527	3232.279	434.898	4
18	3232.279	434.898	3667.232	438.600	4
19	1528.200	440.000	1532.700	440.000	2
20	1532.700	440.000	1821.600	380.600	2
21	1821.600	380.600	3092.400	396.500	2
22	3092.400	396.500	3232.500	432.900	2
23	3232.500	432.900	3667.200	436.600	2

User Specified X-Origin = 1000.000(ft)

User Specified Y-Origin = 200.000(ft)

SURFACE BOUNDARY POINT COORDINATES
(Information Only-Not Used Directly)

Point No.	X-COORD	Y-COORD
1	1000.000	410.000
2	1361.600	416.000
3	1433.900	438.000
4	1528.200	440.000
5	1564.300	450.000
6	2590.300	700.000
7	2719.600	730.000
8	2754.400	740.000
9	3667.200	730.000

SUBSURFACE BOUNDARY POINT COORDINATES
(Information Only-Not Used Directly)

Point No.	X-COORD	Y-COORD
10	1548.257	440.885

		Excav Effec
11	1821.944	384.626
12	2754.384	396.298
13	3091.312	400.524
14	3232.015	436.896
15	3667.215	440.600
16	1821.753	382.626
17	2754.384	394.298
18	3092.180	398.527
19	3232.279	434.898
20	3667.232	438.600
21	1532.700	440.000
22	1821.600	380.600
23	3092.400	396.500
24	3232.500	432.900
25	3667.200	436.600

PROFILE BOUNDARY SLOPES AND ANGLES

BND No.	Slope	Angle(Deg.)
1	0.017	0.951
2	0.304	16.924
3	0.021	1.215
4	0.277	15.483
5	0.244	13.694
6	0.232	13.063
7	0.287	16.032
8	-0.011	-0.628
9	-0.206	-11.616
10	0.013	0.717
11	0.013	0.719
12	0.260	14.553
13	0.009	0.488
14	-0.206	-11.615
15	0.013	0.717
16	0.013	0.717
17	0.260	14.553
18	0.009	0.488
19	0.000	0.000
20	-0.206	-11.619
21	0.013	0.717
22	0.260	14.564
23	0.009	0.488

MOHR-COULOMB SOIL PARAMETERS

5 Type(s) of Soil Defined

Soil Number and Description	Moist Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Ratio(ru)	Excav Effec (-Uw) Fact.	Water Surface No.	Water Option
1 STRATUM I	123.8	0.0	446.00	22.50	0.000	0.0	1	0
2 STRATIM II	125.3	0.0	1598.00	28.40	0.000	0.0	0	0
3 MSW	50.0	0.0	250.00	23.00	0.000	0.0	0	0
4 CLAY LINER / GS	115.0	0.0	811.00	11.40	0.000	0.0	0	0
5 PROTECTIVE COVER	109.3	0.0	446.00	22.50	0.000	0.0	0	0

TRIAL FAILURE SURFACE DATA

Circular Trial Failure Surfaces Have Been Generated Using A Random Procedure.

1000 Trial Surfaces Have Been Generated.

1000 Surfaces Generated at Increments of 6.1261(in) Equally Spaced Within the Start Range

Along The Specified Surface Between X =1335.00(ft)
and X =1845.00(ft)

Each Surface ends within a Range Between X =2500.00(ft)
and X =3100.00(ft)

All surfaces are generated left to right for both a left and right sliding slope.

Unless XCLUDE Lines Were Specified, The Minimum Elevation
To Which A Surface Extends Is Y = 200.00(ft)

Specified Maximum Radius = 5000.000(ft)

12.000(ft) Line Segments Were Used For Each Trial Failure Surface.

The Spencer Method Was Selected for FS Analysis.

Selected fx function = Constant (1.0)

SELECTED CONVERGENCE PARAMETERS FOR SPENCER METHOD:
Initial estimate of FS = 1.500
FS tolerance = 0.000001000
Initial estimate of theta(deg) = 15.00

Excav Effec

Theta tolerance(radians) = 0.0001000
Minimum theta(deg) = -45.00 ; Maximum theta(deg) = 45.00
Theta convergence Step Factor = 5000.00
Maximum number of iterations = 50
Allowable negative side force = -1000.0(lbs)
Maximum force imbalance = 100.000000(lbs)
Maximum moment imbalance = 100.000000 (ft/lbs)

Selected Lambda Coefficient = 1.00

Specified Tension Crack Water Depth Factor = 0.000

Total Number of Trial Surfaces Attempted = 1000

WARNING! The Factor of Safety Calculation for one or More Trial Surfaces
Did Not Converge in 50 Iterations.

Number of Trial Surfaces with Non-Converged FS = 118

Number of Trial Surfaces With Valid FS = 882

Percentage of Trial Surfaces With Non-Converged and/or
Non-Valid FS Solutions of the Total Attempted = 11.8 %

Statistical Data On All Valid FS Values:
FS Max = 8.481 FS Min = 2.102 FS Ave = 4.521
Standard Deviation = 1.605 Coefficient of Variation = 35.50 %

Critical Surface is Sequence Number 390 of Those Analyzed.

*****BEGINNING OF DETAILED GEOSTASE OUTPUT FOR CRITICAL SURFACE FROM A SEARCH*****

BACK-CALCULATED CIRCULAR SURFACE PARAMETERS:

Circle Center At X = 1945.148643(ft) ; Y = 1606.303989(ft); and Radius = 1223.962957(ft)

Circular Trial Failure Surface Generated With115 Coordinate Points

Point No.	X-Coord. (ft)	Y-Coord. (ft)

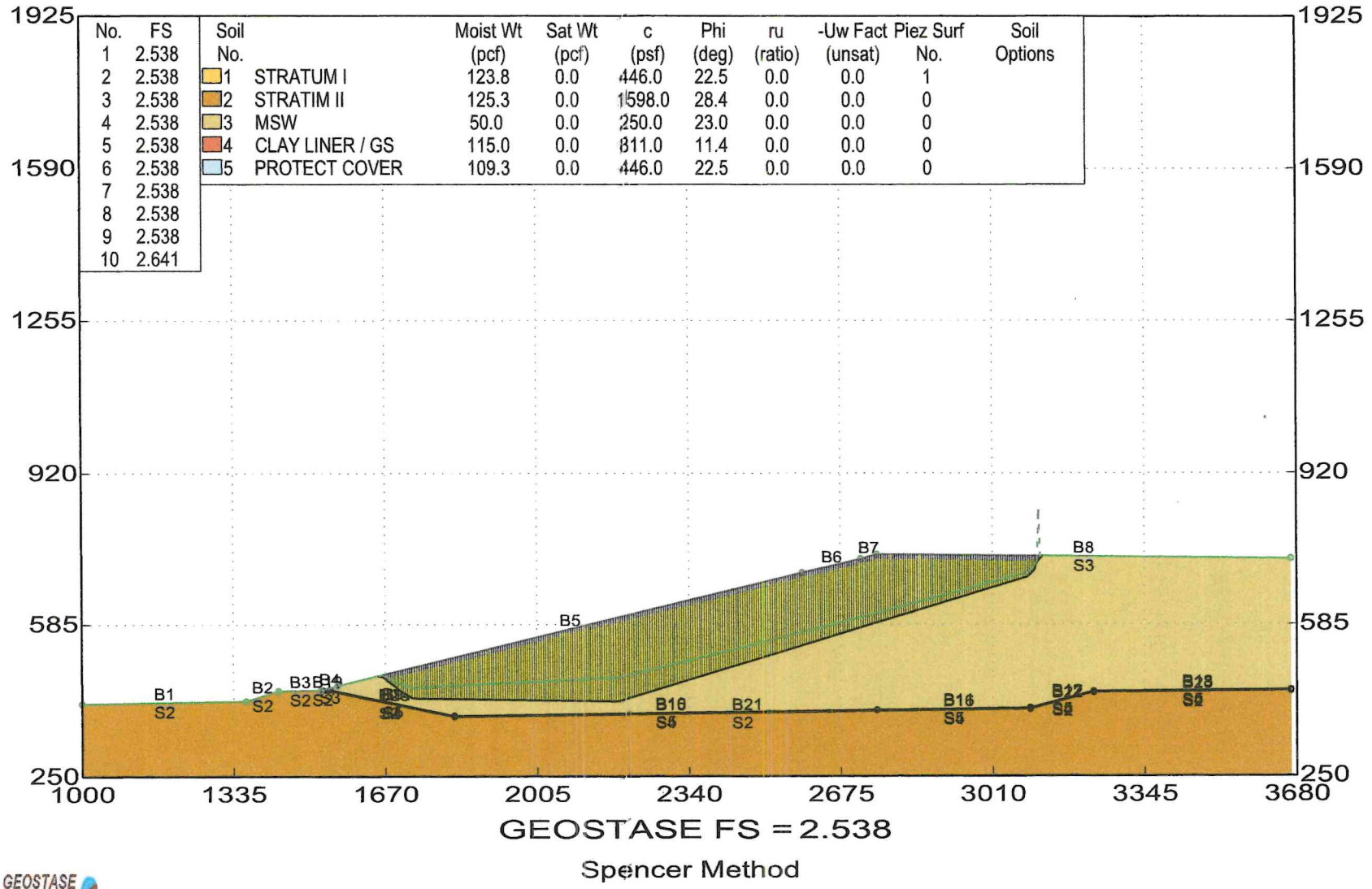
FINAL WASTE SLOPE STABILITY – LONG TERM GEOSTASE INPUT PARAMETERS

This analysis evaluates the long term stability of the final waste slope using a block type failure surface. The stability of the final cover systems was evaluated using the infinite slope method which is appropriate for a veneer system of layers which are not included in this analysis model. The geometry for the critical section is shown on the following page. The analysis was performed at Analysis Line FW which is the highest part of the waste. Effective stress parameters were used to analyze the long term condition for Stratum II and the solid waste. The clay liner and protective cover had geosynthetic components and were modeled using the high pressure interface shear strength parameters. Material properties for each soil and material type are tabulated on the following page. The water surface was assumed as the highest recorded groundwater at the site from Appendix D7A. The analysis resulted in a factor of safety greater than 1.5, the generally recognized minimum for long term conditions. The analysis demonstrates that the critical failure surface is predominantly in the waste which has the same short and long term strength properties. Additionally, the subgrade soils and liner system will have been in place long enough for these soils to reach their long term strength state. Therefore, a short term analysis of the final waste slope was not necessary.

SKYLINE LANDFILL EXPANSION
FINAL WASTE SLOPE STABILITY - BLOCK ANALYSIS - LONG TERM

BIGGS AND MATHEWS ENVIRONMENTAL - WRC

\Waste Stab Analysis BLOCK Tmplate.gsd



GEOSTASE FS = 2.538

Spencer Method

GEOSTASE Slope Stability Analysis

GEOSTASE® v4.30.32 by GREGORY GEOTECHNICAL SOFTWARE

PLATE C.1

Attachment D5, Appendix D5B

Excav Effec

*** GEOSTASE(R) ***

** GEOSTASE(R) (c)Copyright by Garry H. Gregory, Ph.D.,P.E.,S.E.,BC.GE **

** Current Version 4.30.32-Double Precision, Sept 2023 **
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****

SLOPE STABILITY ANALYSIS SOFTWARE (2D & 3D)
Simplified Bishop, Simplified Janbu, or General Equilibrium (GE) Options.
(Spencer, Morgenstern-Price, USACE, and Lowe & Karafiath)
Including Pier/Pile, Planar Reinf, Nail, Tieback, Line Loads
Applied Forces, Fiber-Reinforced Soil (FRS), Distributed Loads
Nonlinear Undrained Shear Strength, Curved Strength Envelope,
Anisotropic Strengths, Water Surfaces, 3-Stage Rapid Drawdown
2- or 3-Stage Pseudo-Static & Simplified Newmark Seismic Analyses.

****

Analysis Date: 5/ 2/ 2024
Analysis Time: 10 :48 AM
Analysis By: BIGGS AND MATHEWS ENVIRONMENTAL - WRC

Input File Name: O:\Waste Management\Skyline\Solid Waste\2022 - Expansion Permit\PART II (2)\Borings\Stability Analysis\Waste Slope\Waste Stab Analysis BLOCK Tmplate.gsd
Output File Name: O:\Waste Management\Skyline\Solid Waste\2022 - Expansion Permit\PART II (2)\Borings\Stability Analysis\Waste Slope\Waste Stab Analysis BLOCK Tmplate.OUT
Unit System: English

PROJECT: SKYLINE LANDFILL EXPANSION

DESCRIPTION: FINAL WASTE SLOPE STABILITY - BLOCK ANALYSIS - LONG TERM

PROFILE BOUNDARY DATA

8 Surface Boundaries
23 Total Boundaries

Boundary	X - 1	Y - 1	X - 2	Y - 2	Soil Type

No.	(ft)	(ft)	(ft)	(ft)	Excav Effec Below Bnd
1	1000.000	410.000	1361.600	416.000	2
2	1361.600	416.000	1433.900	438.000	2
3	1433.900	438.000	1528.200	440.000	2
4	1528.200	440.000	1564.300	450.000	3
5	1564.300	450.000	2590.300	700.000	3
6	2590.300	700.000	2719.600	730.000	3
7	2719.600	730.000	2754.400	740.000	3
8	2754.400	740.000	3667.200	730.000	3
9	1548.257	440.885	1821.944	384.626	5
10	1821.944	384.626	2754.384	396.298	5
11	2754.384	396.298	3091.312	400.524	5
12	3091.912	400.524	3232.015	436.896	5
13	3232.015	436.896	3667.215	440.600	5
14	1544.028	439.713	1821.753	382.626	4
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16	2754.384	394.298	3092.180	398.527	4
17	3092.180	398.527	3232.279	434.898	4
18	3232.279	434.898	3667.232	438.600	4
19	1528.200	440.000	1532.700	440.000	2
20	1532.700	440.000	1821.600	380.600	2
21	1821.600	380.600	3092.400	396.500	2
22	3092.400	396.500	3232.500	432.900	2
23	3232.500	432.900	3667.200	436.600	2

User Specified X-Origin = 1000.000(ft)

User Specified Y-Origin = 250.000(ft)

SURFACE BOUNDARY POINT COORDINATES
(Information Only-Not Used Directly)

Point No.	X-COORD	Y-COORD
1	1000.000	410.000
2	1361.600	416.000
3	1433.900	438.000
4	1528.200	440.000
5	1564.300	450.000
6	2590.300	700.000
7	2719.600	730.000
8	2754.400	740.000
9	3667.200	730.000

SUBSURFACE BOUNDARY POINT COORDINATES
(Information Only-Not Used Directly)

Point No.	X-COORD	Y-COORD
10	1548.257	440.885

		Excav Effec
11	1821.944	384.626
12	2754.384	396.298
13	3091.312	400.524
14	3232.015	436.896
15	3667.215	440.600
16	1821.753	382.626
17	2754.384	394.298
18	3092.180	398.527
19	3232.279	434.898
20	3667.232	438.600
21	1532.700	440.000
22	1821.600	380.600
23	3092.400	396.500
24	3232.500	432.900
25	3667.200	436.600

PROFILE BOUNDARY SLOPES AND ANGLES

BND No.	Slope	Angle(Deg.)
1	0.017	0.951
2	0.304	16.924
3	0.021	1.215
4	0.277	15.483
5	0.244	13.694
6	0.232	13.063
7	0.287	16.032
8	-0.011	-0.628
9	-0.206	-11.616
10	0.013	0.717
11	0.013	0.719
12	0.260	14.553
13	0.009	0.488
14	-0.206	-11.615
15	0.013	0.717
16	0.013	0.717
17	0.260	14.553
18	0.009	0.488
19	0.000	0.000
20	-0.206	-11.619
21	0.013	0.717
22	0.260	14.564
23	0.009	0.488

MOHR-COULOMB SOIL PARAMETERS

5 Type(s) of Soil Defined

Soil Number and Description	Moist Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Ratio(ru)	Excav Effec (-Uw) Fact.	Water Surface No.	Water Option
1 STRATUM I	123.8	0.0	446.00	22.50	0.000	0.0	1	0
2 STRATIM II	125.3	0.0	1598.00	28.40	0.000	0.0	0	0
3 MSW	50.0	0.0	250.00	23.00	0.000	0.0	0	0
4 CLAY LINER / GS	115.0	0.0	811.00	11.40	0.000	0.0	0	0
5 PROTECT COVER	109.3	0.0	446.00	22.50	0.000	0.0	0	0

A Non-Circular Zone Search Has Been Selected For Analysis
Using Random Generation Within Specified Zones.

3 Zones Defined For Generation Of Non-Circular Surfaces

1000 Trial Surfaces Have Been Generated.

Length Of Line Segments For Active And Passive Portions Of
Non-Circular Zone Search = 11.25(ft)

Zone No.	X - 1 (ft)	Y - 1 (ft)	X - 2 (ft)	Y - 2 (ft)	Height (ft)
1	1580.00	420.00	1820.00	420.00	30.00
2	1820.01	410.00	2700.00	410.00	66.00
3	2700.01	410.00	3100.00	650.00	100.00

The Spencer Method Was Selected for FS Analysis.

Selected fx function = Constant (1.0)

SELECTED CONVERGENCE PARAMETERS FOR SPENCER METHOD:
Initial estimate of FS = 1.500
FS tolerance = 0.000001000
Initial estimate of theta(deg) = 15.00
Theta tolerance(radians) = 0.0001000
Minimum theta(deg) = -45.00 ; Maximum theta(deg) = 45.00
Theta convergence Step Factor = 5000.00
Maximum number of iterations = 50
Allowable negative side force = -1000.0(lbs)
Maximum force imbalance = 100.000000(lbs)
Maximum moment imbalance = 100.000000 (ft/lbs)

Selected Lambda Coefficient = 1.00

Specified Tension Crack Water Depth Factor = 0.000

Excav Effec

Total Number of Trial Surfaces Attempted = 1000

WARNING! The Factor of Safety Calculation for one or More Trial Surfaces Did Not Converge in 50 Iterations.

Number of Trial Surfaces with Non-Converged FS = 100

Number of Trial Surfaces With Valid FS = 900

Percentage of Trial Surfaces With Non-Converged and/or Non-Valid FS Solutions of the Total Attempted = 10.0 %

Statistical Data On All Valid FS Values:
FS Max = 5.626 FS Min = 2.538 FS Ave = 3.085
Standard Deviation = 0.335 Coefficient of Variation = 10.86 %

Critical Surface is Sequence Number 66 of Those Analyzed.

*****BEGINNING OF DETAILED GEOSTASE OUTPUT FOR CRITICAL SURFACE FROM A SEARCH*****

Iter. No.	Theta (deg) (fx=1.0)	FS (Moment)	FS (Force) Lambda		Delta FS
1	15.0000	1.393443	2.600407	0.268	0.1206964E+01
2	19.9500	0.000000	2.676043	0.363	0.2676043E+01
3	10.9340	2.398630	2.550293	0.193	0.1516638E+00
4	10.3942	2.468720	2.544219	0.183	0.7549944E-01
5	9.8594	2.530600	2.538313	0.174	0.7713172E-02
6	9.7987	2.537199	2.537650	0.173	0.4509324E-03
7	9.7949	2.537604	2.537609	0.173	0.4322676E-05
8	9.7949	2.537608	2.537608	0.173	0.1022654E-06

Factor Of Safety For The Preceding Specified Surface = 2.538
Theta (fx = 1.0) = 9.79 Deg Lambda = 0.173

The Spencer Method Has Been Selected For Analysis.

SKYLINE LANDFILL

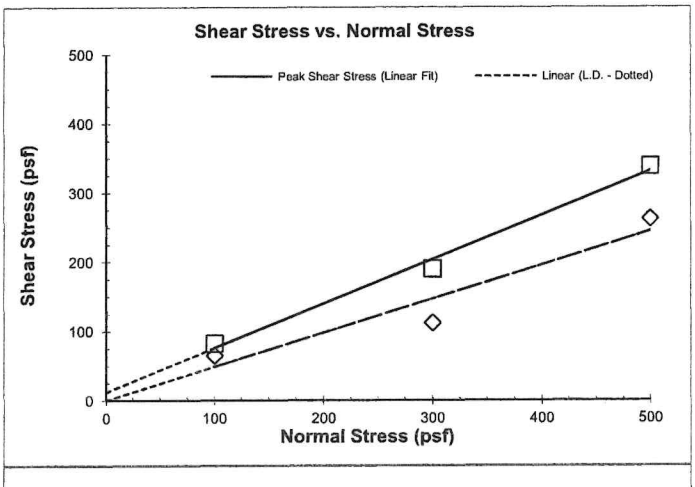
APPENDIX D5C
INTERFACE FRICTION TEST RESULTS

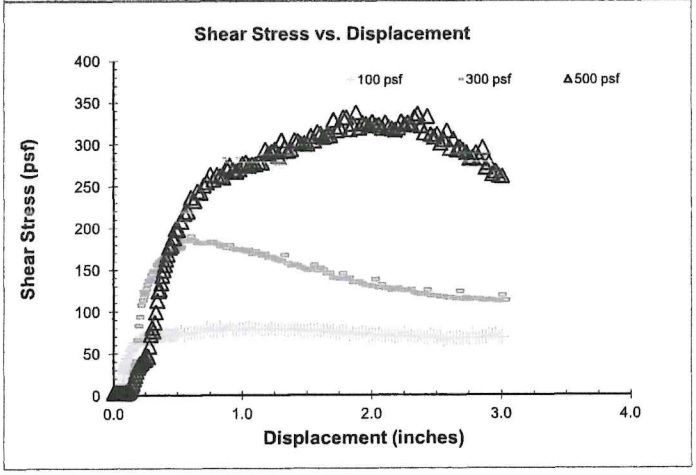
TRI/ENVIRONMENTAL, INC.
A Texas Research International Company

BME Liner Testing

Interface Friction Test Report

Client: **Biggs & Mathews Environmental, Inc.** TRI Log#: E2357-55-06 John M. Allen, P.E., 10/04/2011
Project: Tested Interface: Soil Liner vs. GSE Double-sided Geocomposite Test Method: ASTM D 5321 Quality Review/Date
Test Date: 09/30/11-10/03/11





Test Results		
	Peak	**Large Displacement (@ 3.0 in.)**
Friction Angle (degrees):	**32.6**	**26.1**
Y-intercept or Adhesion (psf):	**12**	**0**

Shearing occurred at the interface under all loads. The large displacement friction angle regression analysis was adjusted to fit a zero y-intercept.

Test Conditions

Upper Box & Subtitle D Liner Soil remolded to 81.6 pcf at 27.0% moisture content

Lower Box GSE double-sided geocomposite

Box Dimensions: 12"x12"x4"

Interface Conditioning: Interface soaked and loading applied for a minimum of 1 hour prior to shear.

Test Condition: Wet

Shearing Rate: 0.04 inches/minute

Test Data

Specimen No.	1	2	3
Bearing Slide Resistance (lbs)	3	3	3
Normal Stress (psf)	100	300	500
Corrected Peak Shear Stress (psf)	83	190	338
Corrected Large Displacement Shear Stress (psf)	65	112	262
Peak Secant Angle (degrees)	39.6	32.4	34.1
Large Displacement Secant Angle (degrees)	33.0	20.5	27.7

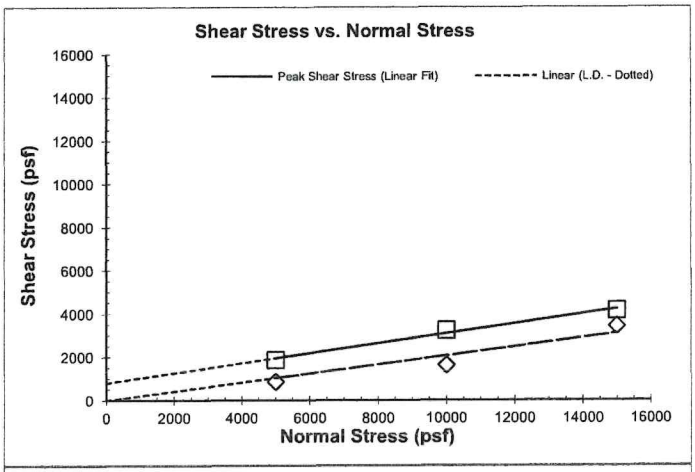
The testing herein is based upon accepted industry practice as well as the test method listed. Test results reported herein do not apply to samples other than those tested. TRI neither accepts responsibility for nor makes claim as to the final use and purpose of the material. TRI observes and maintains client confidentiality. TRI limits reproduction of this report, except in full, without prior approval of TRI.

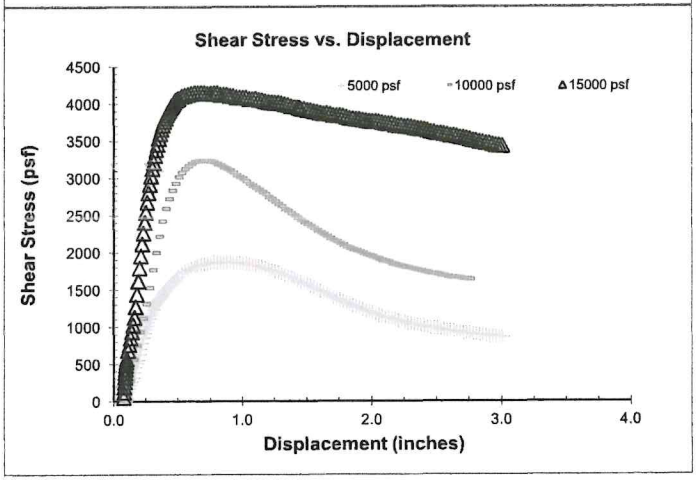
9063 Bee Caves Road □ Austin, TX 78733-6201 □ (512) 263-2101 □ (512) 263-2558 □ 1-800-880-TEST

BME Liner Testing

Interface Friction Test Report

Client: **Biggs & Mathews Environmental, Inc.** TRI Log#: E2357-55-06 John M. Allen, P.E., 10/04/2011
Project: Tested Interface: Soil Liner vs. GSE Double-sided Geocomposite Test Method: ASTM D 5321 Quality Review/Date
Test Date: 09/28/11-09/29/11





Test Results

	Peak	Large Displacement (@ 3.0 in.)
Friction Angle (degrees):	12.8	11.7
Y-intercept or Adhesion (psf):	811	0

Shearing occurred at the interface under the 5000 and 10000 psf loads. Plowing of the soil was noted under the 15000 psf load. The large displacement friction angle regression analysis was adjusted to fit a zero y-intercept.

Test Conditions

Upper Box & Subtitle D Liner Soil remolded to 81.6 pcf at 27.0% moisture content

Lower Box GSE double-sided geocomposite

Box Dimensions: 12"x12"x4"

Interface Conditioning: Interface soaked and loading applied for a minimum of 1 hour prior to shear.

Test Condition: Wet

Shearing Rate: 0.04 inches/minute

Test Data

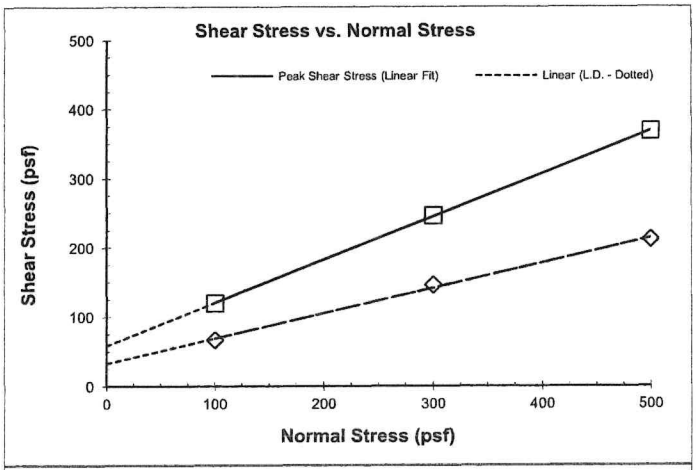
Specimen No.	1	2	3
Bearing Slide Resistance (lbs)	56	103	151
Normal Stress (psf)	5000	10000	15000
Corrected Peak Shear Stress (psf)	1875	3237	4153
Corrected Large Displacement Shear Stress (psf)	858	1639	3434
Peak Secant Angle (degrees)	20.6	17.9	15.5
Large Displacement Secant Angle (degrees)	9.7	9.3	12.9

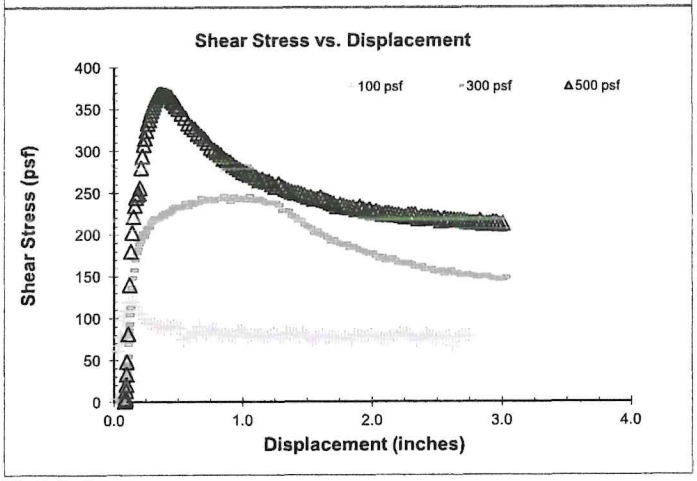
The testing herein is based upon accepted industry practice as well as the test method listed. Test results reported herein do not apply to samples other than those tested. TRI neither accepts responsibility for nor makes claim as to the final use and purpose of the material. TRI observes and maintains client confidentiality. TRI limits reproduction of this report, except in full, without prior approval of TRI.

BME Liner Testing

Interface Friction Test Report

Client: Bio-Mediterranean Environmental, Inc. TRI Proj. #: 62-1671-1506 Geomembrane vs. GSE
Project: Tested Interface: Soil Liner vs. GSE 60 mil HDPE Textured Geomembrane vs. GSE Double-sided Geocomposite Quality Review/Date
Test Date: 09/27/11-10/13/11 Tested in accordance with ASTM D 5321





Test Results		
	Peak	**Large Displacement (@ 3.0 in.)**
Friction Angle (degrees):	**31.8**	**19.9**
Y-intercept or Adhesion (psf):	**59**	**33**

Shearing occurred at the soil/geomembrane interface under all loads.

Test Conditions	
Upper Box &	Subtitle D Liner Soil remolded to 86.2 pcf at 29.0% moisture content
Floating	GSE 60 mil HDPE textured geomembrane
Lower Box	GSE double-sided geocomposite
Box Dimensions: 12"x12"x4"	
Interface Conditioning:	Interface soaked and loading applied for a minimum of 16 hours prior to shear.
Test Condition: Wet	
Shearing Rate: 0.04 inches/minute	

Test Data			
Specimen No.	1	2	3
Bearing Slide Resistance (lbs)	9	11	13
Normal Stress (psf)	100	300	500
Corrected Peak Shear Stress (psf)	120	246	368
Corrected Large Displacement Shear Stress (psf)	67	146	212
Peak Secant Angle (degrees)	50.2	39.4	36.4
Large Displacement Secant Angle (degrees)	33.8	26.0	23.0
Asperity (mils), side to soil	22.2	22.2	20.2
Asperity (mils), side to geocomposite	19.6	19.4	19.8

The testing herein is based upon accepted industry practice as well as the test method listed. Test results reported herein do not apply to samples other than those tested. TRI neither accepts responsibility for nor makes claim as to the final use and purpose of the material. TRI observes and maintains client confidentiality. TRI limits reproduction of this report, except in full, without prior approval of TRI.

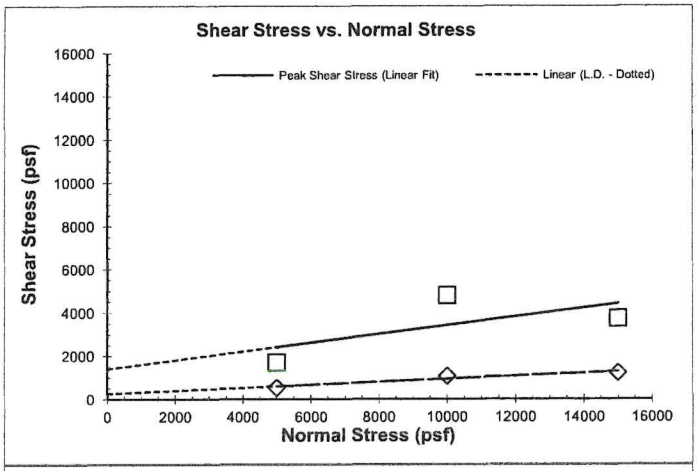
BME Liner Testing

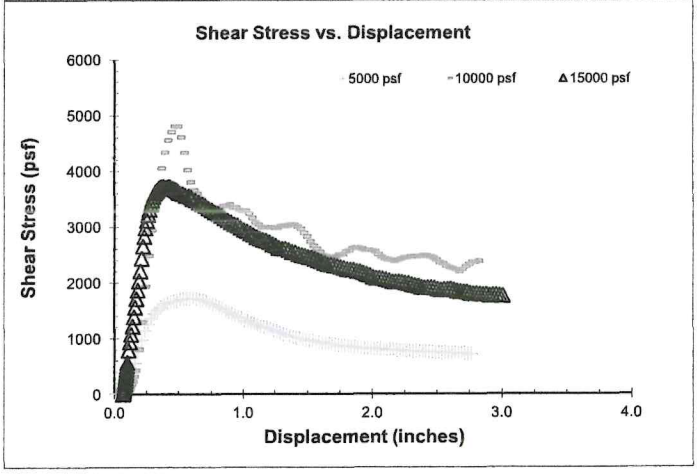
Interface Friction Test Report

Client: Biggs & Mathews Environmental, Inc.
Project: Test Interface: Soil Liner vs. GSE 60 mil HDPE Textured Geomembrane vs. GSE Double-sided Geocomposite
Test Date: 09/25/11-09/26/11

TRI Job #: 23757.5100
Technician: SWD 5321

Geomembrane Lot #: 0401
Quality Review/Date





Test Results

	Peak	Large Displacement (@ 3.0 in.)
Friction Angle (degrees):	**11.4**	**3.9**
Y-intercept or Adhesion (psf):	**1409**	**262**

Shearing occurred at the soil/geomembrane interface under the 5000 and 10000 psf loads. Shearing occurred at the doulbe-sided geocomposite/geomembrane under the 10000 psf load.

Test Conditions

Upper Box &	Subtitle D Liner Soil remolded to 86.2 pcf at 29.0% moisture content
Floating	GSE 60 mil HDPE textured geomembrane
Lower Box	GSE double-sided geocomposite
Box Dimensions: 12"x12"x4"	
Interface Conditioning:	Interface soaked and loading applied for a minimum of 16 hours prior to shear.
Test Condition: Wet	
Shearing Rate: 0.04 inches/minute	

Test Data

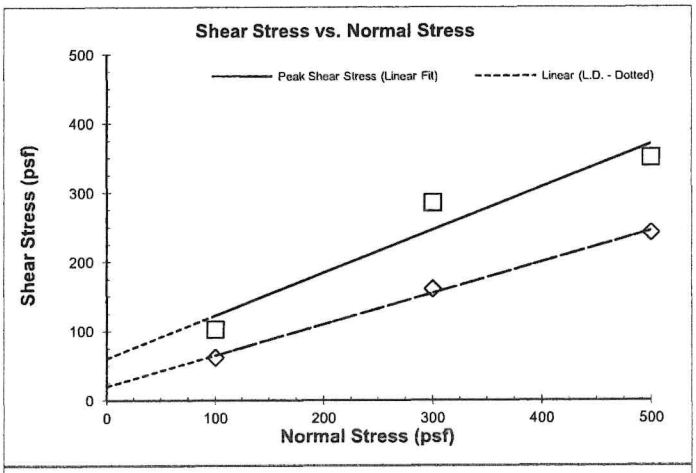
Specimen No.	1	2	3
Bearing Slide Resistance (lbs)	56	103	151
Normal Stress (psf)	5000	10000	15000
Corrected Peak Shear Stress (psf)	1718	4809	3726
Corrected Large Displacement Shear Stress (psf)	540	1075	1224
Peak Secant Angle (degrees)	19.0	25.7	14.0
Large Displacement Secant Angle (degrees)	6.2	6.1	4.7
Asperity (mils), side to soil	26.2	25.8	26.8
Asperity (mils), side to geocomposite	22.6	21.8	22.6

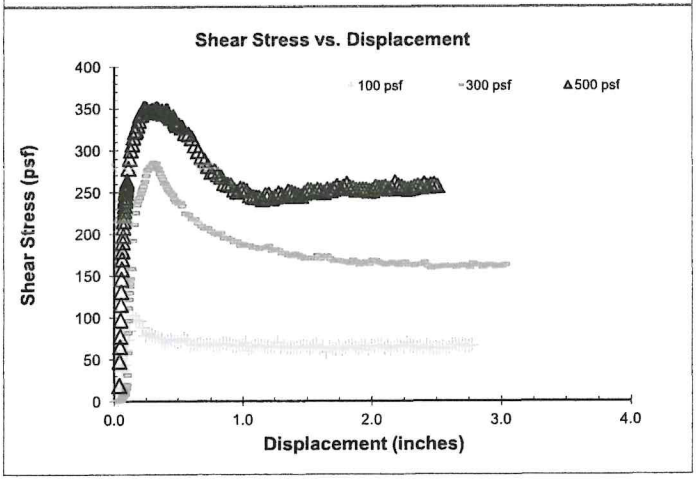
The testing herein is based upon accepted industry practice as well as the test method listed. Test results reported herein do not apply to samples other than those tested. TRI neither accepts responsibility for nor makes claim as to the final use and purpose of the material. TRI observes and maintains client confidentiality. TRI limits reproduction of this report, except in full, without prior approval of TRI.

BME Liner Testing

Interface Friction Test Report

Client: **Biggs & Mathews Environmental, Inc.** TRI Log#: E2357-55-06 John M. Allen, P.E., 10/04/2011
Project: Tested Interface: Soil Liner vs. GSE 60 mil HDPE Textured Geomembrane
Test Method: ASTM D 5321 Quality Review/Date
Test Date: 09/27/11-09/28/11





Test Results		
	Peak	**Large Displacement (@ 3.0 in.)**
Friction Angle (degrees):	**31.8**	**24.2**
Y-intercept or Adhesion (psf):	**60**	**20**

Shearing occurred at the interface.

Test Conditions

Upper Box & Lower Box: Subtitle D Liner Soil remolded to 86.2 pcf at 29.0% moisture content; GSE 60 mil HDPE textured geomembrane

Box Dimensions: 12"x12"x4"

Interface Conditioning: Interface soaked and loading applied for a minimum of 16 hours prior to shear.

Test Condition: Wet

Shearing Rate: 0.04 inches/minute

Test Data

Specimen No.	1	2	3
Bearing Slide Resistance (lbs)	9	11	13
Normal Stress (psf)	100	300	500
Corrected Peak Shear Stress (psf)	103	285	350
Corrected Large Displacement Shear Stress (psf)	62	161	242
Peak Secant Angle (degrees)	45.8	43.6	35.0
Large Displacement Secant Angle (degrees)	31.8	28.2	25.8
Asperity (mils)	20.6	20.0	23.2

The testing herein is based upon accepted industry practice as well as the test method listed. Test results reported herein do not apply to samples other than those tested. TRI neither accepts responsibility for nor makes claim as to the final use and purpose of the material. TRI observes and maintains client confidentiality. TRI limits reproduction of this report, except in full, without prior approval of TRI.

9063 Bee Caves Road □ Austin, TX 78733-6201 □ (512) 263-2101 □ (512) 263-2558 □ 1-800-880-TEST

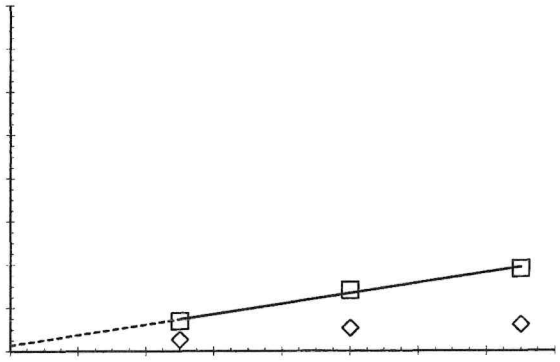
BME Liner Testing

Interface Friction Test Report

Client: **Biggs & Mathews Environmental, Inc.** TRI Log#: E2357-55-06 John M. Allen, P.E. 10/04/2011
Project: **WMI-Skyline BME Subtitle D Liner** Test Method: ASTM D 5321 Quality Review/Date
Test Date: 09/25/11-09/26/11

Tested Interface: Soil Liner vs. GSE 60 mil HDPE Textured Geomembrane

Tested Interface: Subtitle D Liner Soil vs. GSE 60 mil HDPE Textured Geomembrane



Test Results		
	Peak	Large Displacement (@ 3.0 in.)
Friction Angle (degrees):	13.5	3.9
Y-intercept or Adhesion (psf):	273	262

Shearing occurred at the interface.

Test Conditions

WASTE MANAGEMENT SKYLINE LANDFILL
DALLAS AND ELLIS COUNTIES, TEXAS
PERMIT AMENDMENT APPLICATION NO. MSW 42E

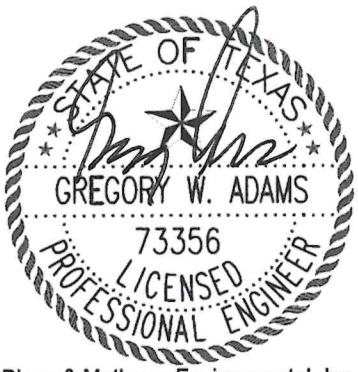
PART III – FACILITY INVESTIGATION AND DESIGN

ATTACHMENT D6
LEACHATE AND CONTAMINATED WATER MANAGEMENT PLAN

Prepared for

WASTE MANAGEMENT OF TEXAS, INC.

March 2026



Biggs & Mathews Environmental, Inc.
Firm Registration No. F-256
3/31/2026

Prepared by

BIGGS & MATHEWS ENVIRONMENTAL
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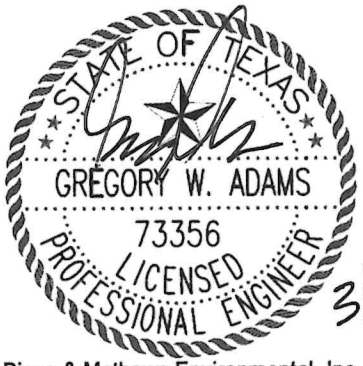
FIRM REGISTRATION NO. 50222



3/31/2026

Biggs & Mathews Environmental, Inc.
Firm Registration No. F-256

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APPENDIX D6B – LEACHATE GENERATION MODEL

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APPENDIX D6D – SECONDARY CONTAINMENT VOLUME CALCULATIONS

1 INTRODUCTION

30 TAC §§330.65(c), 330.177, 330.207, 330.227, 330.331(a)(2), 330.333, 330.337(d)

1.1 Purpose

This Leachate and Contaminated Water Management Plan has been prepared for the Skyline Landfill consistent with 30 TAC §§330.65(c), 330.177, 330.207, 330.227, 330.331(a)(2), 330.333, and 330.337(d). This plan provides the details of the collection, storage, treatment, and disposal of contaminated water, leachate, and gas condensate from the leachate collection system, gas collection and control system, and site operations.

1.2 Definitions

Leachate is defined in §330.3(81) as a liquid that has passed through or emerged from solid waste and contains soluble, suspended, or miscible materials removed from such waste.

Contaminated water is defined in §330.3(37) as leachate, gas condensate, or water that has come into contact with waste.

Gas condensate is defined in §330.3(59) as the liquid generated as a result of any gas recovery process at a municipal solid waste facility.

2 LEACHATE MANAGEMENT

30 TAC §§330.65(b),330.177, 330.227, 330.331(a)(2), 330.333, 330.337(d)

2.1 Leachate Generation

Leachate is generated as water infiltrates and percolates through layers of solid waste. The quantity of leachate that is generated depends upon rainfall, site topography, type of cover, operating procedures, and waste characteristics. The Hydrologic Evaluation of Landfill Performance (HELP) model was used to predict the quantity of leachate that will be generated at the Skyline Landfill. The HELP model is a water balance model that uses climate, soil, and landfill design data to perform a solution technique that accounts for the effects of surface storage, runoff, infiltration, percolation, soil moisture storage, evapotranspiration, and lateral drainage. Leachate generation was evaluated for both active and closed landfill conditions. An explanation and results of the HELP model are included in Appendix D6B.

2.2 Leachate Collection

The Skyline Landfill will accept Type I waste and will have leachate collection systems in accordance with 30 TAC §330.333. All leachate collection systems in The existing footprint have been constructed and approved under MSW Permit No. 42D. Details of the existing leachate collection system are documented in the Geomembrane Liner Evaluation Reports (GLERs).

2.2.1 Leachate Collection System Design

The leachate collection system (LCS) will consist of the following:

- A geocomposite leachate collection layer.
- The leachate collection trenches and piping.
- Leachate collection pipe risers.
- The leachate collection sumps and pumps.

Each cell will have the configuration described below:

- Leachate collection pipes will have a nominal spacing of 300 feet.
- Leachate collection trenches will have a minimum slope of 1 percent.
- Cross-slopes into the leachate collection trench will be a minimum of 2 percent.

The LCS plan and details are provided in Attachment D3.

The LCS has been designed to:

- Maintain less than 30 cm (approximately 12 inches) depth of leachate over the liner.
- Be constructed of materials that are chemically resistant to the leachate expected to be generated. The components of the leachate collection system have been designed with materials that are inert to leachates typically produced by municipal solid waste facilities. Drainage nets and pipes will be high density polyethylene (HDPE). Aggregates will be resistant to carbonate loss. Geotextiles have been designed with factors of safety for biological and chemical clogging.
- Be constructed of materials that have sufficient strength and thickness to prevent collapse under the pressures exerted by overlying wastes, waste cover materials, and by any equipment used at the landfill.
- Function through the scheduled closure and postclosure care period of the landfill considering:
  - Estimated rate of leachate removal.
  - Capacity of sumps.
  - Pipe material and strength.
  - Pipe network spacing and grading.
  - Collection sump materials and strength.
  - Drainage media specifications and performance.
  - Demonstration that pipes and perforations will be resistant to clogging and can be cleaned.

The LCS has been designed to handle both the leachate generated and the groundwater inflow from materials beneath and lateral to the liner system.

2.2.2 Leachate Collection Layer

The leachate collection layer consists of geocomposite drainage net installed above the geomembrane. Double-sided geocomposite (nonwoven geotextile bonded to the top and bottom of HDPE drainage net) will be installed on both the sidewalls and the floor of the expansion area. Leachate collection layer design calculations are presented in Appendix D6A. The geocomposite properties are provided in Attachment D7.

2.2.3 Geotextile

The drainage aggregate will be covered by a geotextile to prevent migration of the protective cover soil into the LCS. The geotextile will be inert to commonly encountered chemicals, hydrocarbons, and mildew, and will be rot resistant. Geotextile design

calculations are presented in Appendix D6A. The geotextile properties are provided in Attachment D7.

2.2.4 Leachate Aggregate

Leachate aggregate will be placed in the collection trenches and in the sumps. The aggregate shall consist of manufactured or natural materials having the properties listed in Attachment D7.

In addition, aggregates must meet the following criteria:

For circular pipe perforations, the ratio:

$$\frac{\text{85 Percent Size of Aggregate}}{\text{Perforation Hole Diameter}} > 1.7$$

For slotted pipe perforations, the ratio:

$$\frac{\text{85 Percent of Aggregate Material}}{\text{Perforation Slot Width}} > 2.0$$

Chimney drains will be installed above the leachate collection pipes and will extend through the protective cover. The chimney drains will be constructed from the same drainage aggregate described above. Details illustrating the construction of the chimney drains are included in Attachment D3.

2.2.5 Leachate Collection Trenches and Piping

The leachate collection layer will slope toward the leachate collection trenches. The leachate piping includes perforated collection trench pipes and the solid sidewall riser pipes. Sidewall risers will extend to the top of the perimeter berm to provide access for cleaning the leachate collection pipes and sump risers. The leachate piping shall meet the criteria listed in Attachment D7.

Each collection trench will contain a 6-inch-diameter perforated leachate collection pipe surrounded by drainage aggregate. The leachate collection trench will convey the leachate to sumps located along the toe of the side slopes. The leachate collection pipes have been designed for the critical loading condition expected at the site. Both the overburden load (due to the weight of the waste and soil layers over the pipe) and the construction load (due to the weight of equipment and operations layers) were considered. Leachate collection system details are provided in Attachment D3. Leachate collection pipe design calculations are provided in Appendix D6A.

2.2.6 Leachate Sumps

The leachate sumps will consist of a 3-foot-deep square area. The sumps will have a minimum dimension of 40 by 40 feet at the landfill floor and 16 by 16 feet at the sump

base. Details of the leachate sumps are provided in Attachment D3. Each sump will be backfilled with leachate drainage aggregate. Sump capacity and strength calculations are presented in Appendix D6A. Leachate will be transferred from the sumps by submersible pumps, as discussed in Section 2.4. The submersible pumps will be equipped with internal pressure transducers to measure the depth of the leachate in the sumps and a leachate level readout will be provided in the pump control panel. The pumps will be operated by an automatic start switch to limit the leachate level to the top of the sump. The allowable maximum leachate head is 30 cm (approximately 12 inches) on the liner (or 48 inches in the sump). If needed, vertical supplemental sumps may be installed after waste has been placed to provide enhanced leachate removal. Details of vertical sumps are provided in Attachment 3. Leachate sump material requirements are provided in Attachment D7.

2.3 Leachate Storage

Primary leachate storage will be provided by the leachate sumps, which are located within each landfill cell. Leachate will be pumped from the sumps through a leachate forcemain to the leachate storage tank facility. The tanks are located in the existing leachate storage facility shown in Attachment D3 near the maintenance facility. The storage facility currently consists of one (1) 24,500-gallon storage tank and one (1) 17,000-gallon storage tank. The calculations in Appendix D6D demonstrate that the secondary containment provides containment, with 6 inches of freeboard, for the leachate storage tanks and precipitation from the 25-year, 24-hour storm event.

2.4 Leachate Disposal

Leachate will be pumped directly from the sumps or onsite leachate storage facility to a publicly owned treatment works (POTW) via a direct connection. Leachate sampling and analysis will be limited to that facility's requirements. The results of any monitoring required by the disposal facility will be placed in the site operating record. Leachate passing through the existing storage tanks provides temporary leachate storage, and the storage tanks will be emptied into tanker trucks in the event that the direct connection to the POTW is not functional.

Leachate may be recirculated into an on-site landfill unit that is designed and constructed with a leachate collection system and a composite liner in accordance with §330.177. Leachate may also be recirculated by transferring into a tanker and spraying on the active area. Leachate will not be recirculated to the active area during rainy or wet periods. The automated leachate pumps will prevent leachate depth greater than 30 cm from accumulating over the liner and will be in operation during leachate recirculation activities. The application of leachate will not cause accumulation, ponding, or other operational problems. The Skyline Landfill will ensure that recirculating will not result in vectors, odor, or other nuisance conditions.

3 CONTAMINATED WATER MANAGEMENT

30 TAC §330.207

3.1 Contaminated Water Generation

Water that comes into contact with waste, leachate, or gas condensate is considered to be contaminated water. Best management practices will be used to minimize contaminated water generation. Temporary diversion berms will be constructed around areas of exposed waste to minimize the amount of surface water that comes into contact with waste. Design calculations and typical details for temporary diversion berms are presented in Appendix D6C. Daily cover and intermediate cover will be placed over filled areas to minimize the area of exposed waste. Procedures for verifying the adequacy of daily and intermediate cover placement are provided in Part IV. If waste is exposed in areas where daily or intermediate cover has been previously placed, runoff from these areas will be considered to be contaminated water. Secondary containment will be provided around the leachate storage facility to contain leachate in case of a spill or leak. Gas condensate will be collected and segregated from surface water as described in Section 4.

3.2 Contaminated Water Collection and Containment

Temporary containment berms will be constructed around the active face to collect and contain surface water that has come into contact with waste. In addition to the planned containment berms around the active face, temporary containment berms will be constructed wherever needed to collect contaminated water. The design calculations and typical details for containment berms for a 25-year, 24-hour storm event are provided in Appendix D6C. The calculations show the dimensions for typical conditions, but additional storage capacity will be provided as site operating conditions dictate.

3.3 Contaminated Water Storage

Primary contaminated water storage will be provided by the containment berms, which will provide storage for the 25-year, 24-hour storm event.

3.4 Contaminated Water Disposal

Contaminated water will not be allowed to discharge into waters of the United States or discharged offsite without prior written approval. Contaminated water may be conveyed or transported to a POTW for treatment and disposal in accordance with §330.207(f). Sampling and analysis will be limited to the POTW's requirements. The results of any monitoring required by the disposal facility will be placed in the site operating record.

4 GAS CONDENSATE MANAGEMENT

30 TAC §330.207

4.1 Gas Condensate Generation

Gas condensate is the liquid generated during the gas recovery process at a municipal solid waste facility.

4.2 Gas Condensate Collection, Storage, and Disposal

Gas condensate will be collected in the gas collection and control system (GCCS) as described in Attachment G. The gas condensate will be conveyed from the GCCS to the on-site leachate storage facility or discharged directly into leachate sumps through the leachate cleanout risers. Gas condensate will be recirculated with leachate or disposed of per Section 2.4.

APPENDIX D6A
LEACHATE COLLECTION SYSTEM
DESIGN CALCULATIONS

Leachate Collection System Flow Rates

Required: Determine the design flowrates for the following components of the leachate system.
1) Chimney, Collection Pipe, and Sump
2) Geotextile

References: 1) Appendix D6B HELP Model Analyses.

Approach: 1) The largest contributing area to a sump occurs in Cell 19, which is approximately 36.3

2) The maximum flowrate for the collection pipe and sump will occur in Cell 19 due to its largest contributing area. The flowrates are calculated from the areas within Cell 19 that correspond to each case.
3) The maximum flowrate for the geotextile will occur in Cell 19 due to its combination of leachate pipe length and contributing area. The flowrates are calculated from the areas within Cell 19 that correspond to each case.

Solution: 1) Case 1, Active face with 20 feet of waste = 0.9 acres
Case 2, Daily cover over 50 feet of waste = 11.8 acres
Case 3, Daily cover over 100 feet of waste = 11.8 acres
Case 4, Intermediate cover over 200 feet of waste = 11.8 acres

Calculate the leachate generation rate for the critical configuration.

CONDITION	AREA acres	AVERAGE RATE cf/yr/ac	AVERAGE cfs	PEAK RATE cf/day/ac	PEAK cfs
Case 1	0.9	17,544.3	0.001	601.8	0.006
Case 2	11.8	16,611.3	0.006	590.3	0.081
Case 3	11.8	14,721.4	0.006	577.9	0.079
Case 4	11.8	15,562.7	0.006	579.9	0.079
TOTAL	36.3		0.018		0.245

Leachate Collection System Design

Required: Size the following elements of the leachate collection system:

1) Leachate Chimney
2) Leachate Collection Pipe
3) Leachate Sump

Assumptions:

1) The leachate chimney will extend the length of the collection trench.
2) Minimum leachate aggregate permeability shall be 0.01 cm/sec.
3) The leachate chimney should be sized to convey the peak flow rate to the sumps.
4) The collection pipe should be sized to convey the peak flow rate.
5) The leachate sump should be sized to store the average flow rate for 12 hours.

Solution:

1) ***Leachate Chimney***

Use Darcy's Equation to determine the width of the leachate chimney.

$$Q = KiA$$

where:	Q = design flowrate =	0.245	cfs
	K = hydraulic conductivity of aggregate =	0.01	cm/sec
	=	3.28E-04	fps
	i = hydraulic gradient = $\Delta h/\ell$		
	for vertical flow $\Delta h = \ell$	1	ft/ft
	L = length of trench =	1,533	ft
	A = cross section area = L x W		
Substitute and solve for W =		0.5	ft
Width provided =		**3.0**	**ft**

2) ***Leachate Collection Pipe***

Use Manning's Equation to size the leachate collection pipe.

$$Q = (1.486/n)AR^{2/3}S^{1/2}$$

where:	Q = design flowrate =	0.245	cfs
	n = Manning's number =	0.009	
	A = cross section area of pipe =	$\pi dia^2/4$	sf
	R = hydraulic radius of pipe =	dia/4	ft
	S = slope of pipe =	0.01	ft/ft
Substitute and solve for diameter =		0.32	ft
	=	3.8	in
Diameter provided =		**6.0**	**in**

Determine the inflow capacity of the perforated leachate collection pipe using the following equation:

$$Q = Ca(2g\Delta h)^2$$

where:	C = coefficient of discharge =	0.61
	g = acceleration of gravity =	32.2 ft/sec^2
	Δh = maximum head on leachate pipe (ft) =	1.0 ft
	p = perforations per linear foot of pipe =	5 /ft
	d = diameter of perforations =	3/8 in
	a = orifice area (p x π (d/12)^2/4) =	0.004 sf/ft
	q = inflow capacity per linear foot of pipe =	0.019 cfs/ft
	L = linear feet of collection pipe =	1,533 ft
Q = design flowrate =		0.25 cfs
Inflow capacity provided by perforated leachate pipe= q x L =		**28.8 cfs**

3) ***Leachate Collection Sump***

Size a square 3-foot deep sump with 3:1 side slopes from the following equation.

$$V = 1/3(L_t^2 h_t) - 1/3(L_b^2 h_b)$$

where:
V = required sump volume (cf)
L_t = length of top side (ft)
L_b = length of bottom side (ft)
h_t = height of 3:1 pyramid with length L_t (ft)
h_b = height of 3:1 pyramid with length L_b (ft)

Q = average flowrate to the sump =	0.018 cfs
P = porosity of aggregate =	0.350
$V = Q$ x 12 hr / P =	2,228 cf

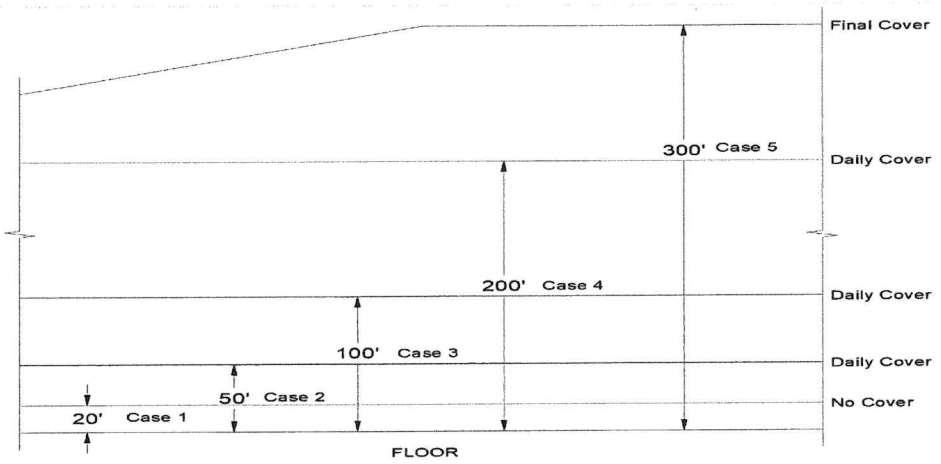
Substitute and solve for L_t =	35.7 ft
Length provided =	**40.0 ft**

Geocomposite Design

Required: Determine the minimum hydraulic conductivity for the geocomposite.

References: 1) *Designing with Geosynthetics,* Sixth Edition Vol. 1; Robert M. Koerner.

Solution: 1) Develop cases to represent the Geocomposite Conditions.



Case	Waste Depth ft	Cover Type
Floor LCS		
1	20	no cover
2	50	daily cover
3	100	daily cover
4	200	daily cover
5	300	final cover
Final Cover Geocomposite		
5	0	final cover

Geocomposite Design

2) Adjust the thickness of the geonet for the overburden of each case. Typical compressibility of geonet is 50% @ 20,000 psf. Assume linear compression between 0 and 20,000 psf.

Geonet Thickness 0.25 inch

Case	Layer	Depth ft	Unit Wt pcf	Load psf	t inch
1	protective cover	2.0	110.0	220.0	
	waste/daily cover	20.0	44.0	880.0	
		22.0		1,100.0	0.243
2	protective cover	2.0	110.0	220.0	
	waste/daily cover	50.0	44.0	2,200.0	
		52.0		2,420.0	0.235
3	protective cover	2.0	110.0	220.0	
	waste/daily cover	100.0	44.0	4,400.0	
		102.0		4,620.0	0.221
4	protective cover	2.0	110.0	220.0	
	waste/daily cover	200.0	44.0	8,800.0	
		202.0		9,020.0	0.194
5	protective cover	2.0	110.0	220.0	
	waste/daily cover	300.0	44.0	13,200.0	
	final cover	3.0	115.0	345.0	
		305.0		13,765.0	0.164
Final Cover Geocomposite					
5	final cover	3.0	115.0	345.0	
		3.0		345.0	0.248

3) Specify the ultimate transmissivity for the geonet.

Transmissivity, m^2/sec
3.00E-03

4) Calculate the allowable transmissivity of the geocomposite from Reference 1, Equation 4.5a and Table 4.1.

$T_{all} = T_{ult} (1 / RF_{CR} \times RF_{IN} \times RF_{CC} \times RF_{BC})$

RF_{CR} = creep reduction factor

RF_{IN} = intrusion reduction factor

RF_{CC} = chemical clogging reduction factor

RF_{BC} = biological clogging reduction factor

Case	RF_{CR}	RF_{IN}	RF_{CC}	RF_{BC}	T_{all} m^2/sec
LCS					
1	1.0	1.0	1.0	1.1	2.73E-03
2	1.0	1.2	1.2	1.2	1.74E-03
3	1.5	1.5	1.5	1.5	5.93E-04
4	1.7	1.7	1.7	1.7	3.59E-04
5	2.0	2.0	2.0	2.0	1.88E-04
Final Cover Geocomposite					
5	2.0	1.1	1.0	1.5	9.09E-04

5) Calculate the allowable hydraulic conductivity of the geocomposite from Reference 1, Equation 4.2.

$k_{all} = T_{all} / t$

Case	t inch	T_{all} m^2/sec	k_{all} cm/sec
LCS			
1	0.24	2.73E-03	44.16
2	0.23	1.74E-03	29.10
3	0.22	5.93E-04	10.55
4	0.19	3.59E-04	7.30
5	0.16	1.88E-04	4.50
Final Cover Geocomposite			
5	0.25	9.09E-04	14.44

Geotextile Design

Required: Determine the minimum properties for:
1) Geotextile around leachate trench aggregate.
2) Geotextile component of geocomposite.

References: 1) *Designing with Geosynthetics, Six* th Edition Vol. 1; Robert M. Koerner.

Assumptions: 1) The protective cover will have at least 50% finer than the No. 200 sieve.
2) The leachate aggregate will be subangular, open graded stone.

Solution: 1) ***Leachate trench geotextile***
Calculate the allowable permittivity from the equation:

$$\Psi_{all} = q / \Delta h A$$

where: Ψ_{all} = *allowable* permittivity

q = peak inflow rate for leachate trench geotextile =	0.245	cfs
Δh = maximum allowable head =	1.0	ft
L = trench length =	1,500.0	ft
W = trench width =	5.0	ft
A = inflow area =	7500.0	sf

Substitute and solve for allowable permittivity = 3.3E-05 sec^{-1}

1a) Calculate the ultimate permittivity from Reference 1, Equation 2.25a.

$$\Psi_{all} = \Psi_{ult} (1 / RF_{SCB} \times RF_{CR} \times RF_{IN} \times RF_{CC} \times RF_{BC})$$

where:

RF_{SCB} = soil clogging/binding reduction factor =	3.0	(Ref. 1, Table 2.8b)
RF_{CR} = creep reduction factor =	1.5	(Ref. 1, Table 2.8b)
RF_{IN} = intrusion reduction factor =	1.2	(Ref. 1, Table 2.8b)
RF_{CC} = chemical clogging reduction factor =	1.5	(Ref. 1, Table 2.8b)
RF_{BC} = biological clogging reduction factor =	7.0	(Ref. 1, Table 2.8b)

Substitute and solve for ultimate permittivity = 1.9E-03 sec^{-1}

Determine the appropriate soil retention criteria from Reference 1, Figure 2.4a.

The AOS must be less than 0.22 mm for fine-grained, non-dispersive soils.

Leachate trench geotextile:	**calculated minimum permittivity =**	**1.9E-03 sec^{-1}**
	required permittivity =	**0.10 sec^{-1}**
	maximum AOS =	**0.22 mm**

2) ***Geocomposite geotextile***
Calculate the allowable permittivity from the equation:

$$\Psi_{all} = q / \Delta h A$$

where: Ψ_{all} = *allowable* permittivity

q = peak inflow rate for critical condition =	0.245	cfs
Δh = maximum allowable head =	1.0	ft
A = area =	845,064	sf

Substitute and solve for allowable permittivity = 2.899E-07 sec^{-1}

Calculate the ultimate permittivity from Reference 1, Equation 2.25a.

$$\Psi_{all} = \Psi_{ult} (1 / RF_{SCB} \times RF_{CR} \times RF_{IN} \times RF_{CC} \times RF_{BC})$$

where:

RF_{SCB} = soil clogging/binding reduction factor =	3.0	(Ref. 1, Table 2.8b)
RF_{CR} = creep reduction factor =	1.5	(Ref. 1, Table 2.8b)
RF_{IN} = intrusion reduction factor =	1.2	(Ref. 1, Table 2.8b)
RF_{CC} = chemical clogging reduction factor =	1.5	(Ref. 1, Table 2.8b)
RF_{BC} = biological clogging reduction factor =	7.0	(Ref. 1, Table 2.8b)

Substitute and solve for ultimate permittivity = 1.6E-05 sec^{-1}

Determine the appropriate soil retention criteria from Reference 1, Figure 2.4a.

The AOS must be less than 0.22 mm for fine-grained, non-dispersive soils.

Geocomposite geotextile:	**minimum permittivity =**	**1.6E-05 sec^{-1}**
	required permittivity =	**0.10 sec^{-1}**
	maximum AOS =	**0.22 mm**

Groundwater Infiltration

Groundwater Infiltration

Required: Demonstrate the adequacy of the LCS to handle additional flow from groundwater infiltration.

References: 1) *Hydrologic Evaluation of Landfill Performance (HELP),* Engineering Documentation.

Approach: 1) Maximum groundwater infiltration will occur in Cell 20 due to highest groundwater elevation.

Solution: For good liner contact, soil leakage will occur from pinholes and installation defects.

Radius of leakage

Pinholes $R = 0.174h^{0.45}K^{-0.13}$ Ref. 1, Equation 163

where: R = radius of wetted area around pinhole (in)
h = hydraulic head beneath liner = 45 ft
K = hydraulic conductivity of clay liner = 1.00E-07 cm/sec, 0.0034 in/day

R = 6.18 in

Defects $R = 0.222h^{0.45}K^{-0.13}$ Ref. 1, Equation 164

where: R = radius of wetted area around defect (in)
h = hydraulic head beneath liner = 45 ft
K = hydraulic conductivity of clay liner = 1.00E-07 cm/sec, 0.0034 in/day

R = 7.89 in

Average hydraulic gradient

$i = 1 + [h / (2T\ln(R / r))]$ Ref. 1, Equation 152

where: i = average hydraulic gradient (in)
h = hydraulic head beneath liner = 45 ft
T = thickness of controlling layer = 24 in
R = radius of wetted area (in)
r = radius of flaw (in)

Pinholes	R =	6.18 in
	r =	0.02 in
	i =	2.96 in/in
Defects	R =	7.89 in
	r =	0.22 in
	i =	4.14 in/in

Leakage rate

$q = 0.877[(Kin\pi R^2) / 6{,}276{,}640]$ Ref. 1, Equation 151

where: q = leakage rate (in/day)
i = average hydraulic gradient (in)
n = density of flaws (no./ac)
T = thickness of controlling layer = 24 in
R = radius of wetted area (in)
K = hydraulic conductivity of clay liner = 0.0034 in/day

Groundwater Infiltration

Pinholes	n =	0.5	holes/ac
	i =	2.96	in/in
	R =	6.18	in
	q_p =	8.447E-08	in/day/ac
Defects	n =	1	holes/ac
	i =	4.14	in/in
	R =	7.89	in
	q_d =	3.84651E-07	in/day/ac

Vapor diffusion

$q = K_m\ [(h + T) / T]$ Ref. 1, Equation 141

where: q = leakage rate (in/day)

T = thickness of geomembrane =	0.06	in
h = hydraulic head beneath liner =	45	ft
K_m = hydraulic conductivity of geomembrane =	6.8E-09	in/day

q = 6.12068E-05 in/day/ac

Inflow rate $Q = q + q_p + q_d$ =

6.2E-05	in/day/ac
2.2E-01	cf/day/ac
2.6E-06	cfs/ac

Inflow will occur after the ballast is in place and the temporary dewatering system is turned off.

Cell 20 contributing area	0	ac
Cell 20 peak leachate rate =	0.000	cfs
Groundwater inflow rate/ac =	2.6E-06	cfs/ac
Cell 20 groundwater inflow rate =	0.0E+00	cfs
Total required inflow capacity = peak leachate + groundwater inflow =	**0.00**	**cfs**
q = inflow capacity per linear foot of pipe =	0.019	cfs/ft
L = Sector 14 linear feet of collection pipe =	1,533	ft
Provided inflow capacity = q x L =	**28.8**	**cfs**

Since the leachate collection pipe for Cell 20 provides for an inflow capacity of 28.8 cfs, the pipe has sufficient capacity to handle the peak leachate rate and groundwater inflow after the temporary dewatering system is turned off.

Leachate Collection Pipe Design

Required: Analyze the structural stability of the leachate collection and header pipes.

References:
1) *Essentials of Soil Mechanics and Foundations,* Second Edition; McCarthy, David F.; Reston Publishing Company, Inc.
2) *Handbook of PE Pipe, Second Edition;* Plastics Pipe Institue (PPI).

Assumptions:
1) The leachate collection pipe size of 6-inch (HDPE material) will be evaluated in this calculation.
2) Heaviest construction load will be a CAT 836H compactor.
3) Maximum overburden load will occur after final closure.

Solution: ***Construction Load***

Critical construction load occurs from drum load of CAT 836H compactor driving over leachate collection trench.

$F = W/n$ and $p = F/\pi r^2$

where:	F = force per drum (lbs)	30,650 lbs
	W = equipment weight =	122,600 lbs
	n = number of drums =	4
	p = contact pressure =	46 psi
	r = radius of contact (in)	

Substitute and solve for r = 14.6 inches

Determine the construction load from: $P_c = P_o + 1.5P_L$

where: P_c = total construction load (psi)
P_o = overburden load (psi)
P_L = live load (psi)

Determine the overburden load from: $P_o = z\gamma$

where:	z = backfill depth =	24.0 in
	γ = backfill unit weight =	125.0 pcf

Substitute and solve for P_o = 1.7 psi

Determine the live load from Boussinesq equation for uniform circular loads.

$$P_L = p(1 - (1 + (r/z)^2)^{-3/2})$$

Substitute and solve for P_L = 17.3 psi

Substitute and solve for P_c = 27.6 psi

Critical construction load = 27.6 psi

Overburden Load

Critical overburden load occurs at the center of landfill after final cover has been constructed. Since the pipe is a flexible positive projecting conduit, use Martson's theory to estimate the overburden load.

$$W_c = \gamma B_c^{\,2} C_c \qquad \text{(Ref. 1, Equation 17-4a)}$$

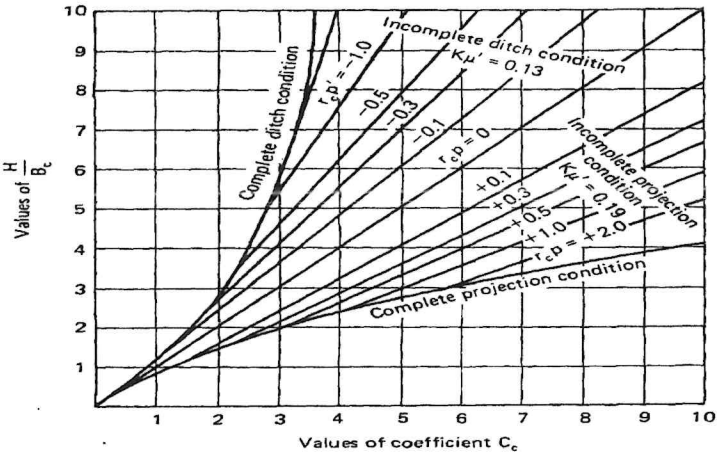
where: W_c = overburden load per ft of pipe (plf)

γ = unit weight of overburden (pcf)

Layer	Thickness (ft)	γ (pcf)	Load (psf)
cover	4.5	105	472.5
solid waste	300	44	13,200.0
aggregate	2	125	250.0
Total	306.5	274	13,922.5
Average γ		45	

B_c = pipe OD = 0.548 ft

Estimate C_c from Reference 1, Figure 17-8.



Leachate Collection Pipe Design

where:	r_c = settlement ratio (Ref. 1, Table 17-1) =	-0.2
	ρB_c = height of conduit above ground	
	ρ =	1
	$r_c \rho$ =	-0.2
	H = height of embankment =	306.5 ft
	H/B_c =	559.3
From Fig. 17-8, $H/B_c = mC_c + b$		
	m =	1.29
	b =	0
	C_c =	434
Substitute and solve for W_c =		5,914 plf
Overburden load = W_c / Dia =		74.9 psi

Critical overburden load =	**74.9 psi**

The overburden load shall be used for the design stress. Adjust the design stress to account for loss of strength due to perforations using the following equation.

$$P_D = 12P/(12 - l_p)$$

where:	P_D = design stress	
	P = critical stress =	74.9 psi
	l_p = cumulative length of perforations per foot of pipe	
	perforation diameter =	3/8 in
	number of holes per foot =	5
Substitute and solve for l_p =		1.9 in/ft
Substitute and solve for P_D =		88.8 psi

Leachate pipe design stress =	**88.8 psi**

Structural Stability

Assume a standard dimension ratio of 17 for the analysis and predict the factor of safety for 1) wall crushing, 2) wall buckling, and 3) ring deflection.

1) Estimate the factor of safety against wall crushing from the following equation.

$FS = S_Y/S_A$

where: S_Y = compressive yield strength of pipe = 1,500 psi

and $S_A = P_D(SDR - 1)/2$

P_D = 88.8 psi

SDR = 17

Substitute and solve for S_A = 710.6 psi

Factor of safety against wall crushing = 2.1

2) Estimate the factor of safety against wall buckling from the following equation.

$FS = P_{cb}/P_D$

where: P_{cb} = critical buckling pressure

$P_{cb}^2 = 0.64(E')(P_c)$

and P_c = *critical collapse pressure*

$P_c = 2.32E/(SDR)^3$

E = modulus of elasticity = 20,000 psi (typical for HDPE)

E' = backfill modulus = 3,000 psi (typical for crushed stone)

Substitute and solve for: P_c = 9.4 psi

P_{cb} = 134.7 psi

Factor of safety against wall buckling = 1.5

3) Estimate the factor of safety against ring deflection from the following equation.

$FS = RD_{allow}/RD_{actual}$

where: RD_{allow} for SDR 17 pipe = 6 % (Ref. 2)

and RD_{actual} = soil strain around the pipe = ε_s

$\varepsilon_s = P_D/E'(100\%)$ = 3.0 %

Factor of safety against ring deflection = 2.0

Leachate Riser Pipe Design

Required: Analyze the structural stability for the riser pipe.

References:
1) *Essentials of Soil Mechanics and Foundations,* Second Edition; McCarthy, David F.; Reston Publishing Company, Inc.
2) *Handbook of PE Pipe, Second Edition;* Plastics Pipe Institue (PPI).

Assumptions:
1) The riser pipe will be 18-inch HDPE.
2) Heaviest construction load will be a CAT 836H compactor.
3) Maximum overburden load will occur after final closure.

Solution: ***Construction Load***

Critical construction load occurs from drum load of CAT 836H compactor driving over the riser pipe on the 5H:1V sidewall slope.

β = sidewall slope = 11.3 deg

The equipment forces acting on the 5H:1V sidewall are:

W_V = vertical equipment weight
W_N = normal equipment weight

$F = W_N/n$ and $p = F/\pi r^2$

where:
F = force per drum (lbs)
W_V = 122,600 lbs
$W_N = W_V \cos\beta$ = 120,223 lbs
n = number of drums = 4
p = contact pressure = 48.5 psi
r = radius of contact (in)

Substitute and solve for r = 14.0 inches

Determine the construction load from: $P_c = P_o + 1.5P_L$

where:
P_c = total construction load (psi)
P_o = overburden load (psi)
P_L = live load (psi)

Leachate Riser Pipe Design

Determine the overburden load from: $P_o = z\gamma$

where: z = backfill depth = 24.0 in
γ = backfill unit weight = 125.0 pcf

Substitute and solve for P_o = 1.7 psi

Determine the live load from Boussinesq equation for uniform circular loads.

$$P_L = p(1 - (1 + (r/z)^2)^{-3/2})$$

Substitute and solve for P_L = 17.3 psi

Substitute and solve for P_c = 27.7 psi

Critical construction load =	**27.7 psi**

Normal Load

Since the riser pipe is placed on the 4H:1V sidewall slope, the design load will be normal to the riser pipe (L_N) and is calculated based on the vertical overburden load (L_V).

Critical overburden load occurs at toe of the slope after final cover has been constructed. Since the pipe is a flexible positive projecting conduit, use Martson's theory to estimate the overburden load.

$$W_c = \gamma B_c^2 C_c \qquad \text{(Ref. 1, Equation 17-4a)}$$

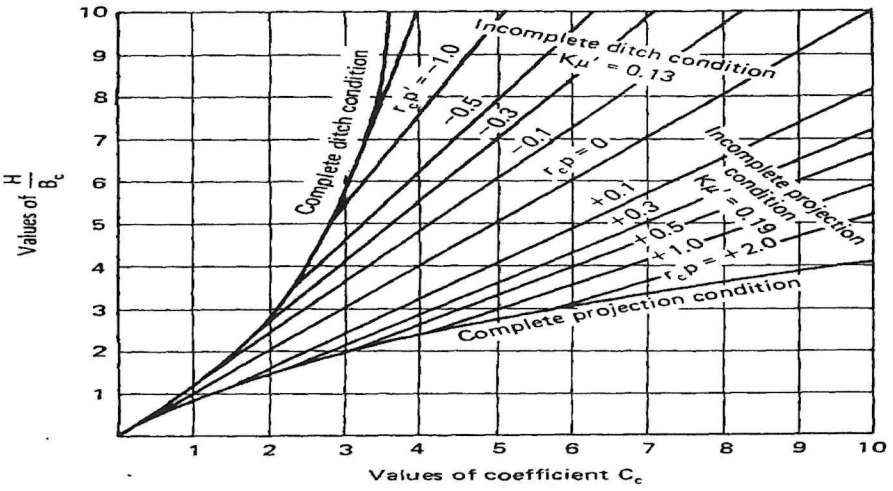
where: W_c = overburden load per ft of pipe (plf)
γ = unit weight of overburden (pcf)

Layer	Thickness (ft)	γ (pcf)	Load (psf)
cover	3.5	105	367.5
solid waste	250	44	11,000.0
clay	1	125	125.0
Total	254.5	274	11,492.5
Average γ		45	

B_c = pipe OD = 1.48 ft

Leachate Riser Pipe Design

Estimate C_c from Figure 17-8.



where:	r_c = settlement ratio (Ref. 1, Table 17-1) =	-0.2
	pB_c = height of conduit above ground	
	p =	1
	$r_c p$ =	-0.2
	H = height of embankment =	254.5 ft
	H/B_c =	172.0
From Fig. 17-1, $H/B_c = mC_c + b$		
	m =	1.29
	b =	0
	C_c =	133
Substitute and solve for W_c =		13,185 plf
Overburden load = W_c / Dia =		61.9 psi
	β = sidewall slope =	11.3 deg

L_V =	61.9 psi
$L_N = L_V \cos\beta$ =	60.7 psi

Critical normal load =	**60.7 psi**

Leachate Riser Pipe Design

Structural Stability

Assume a standard dimension ratio of 11 for the analysis and predict the factor of safety for 1) wall crushing, 2) wall buckling, and 3) ring deflection.

1) Estimate the factor of safety against wall crushing from the following equation.

$$FS = S_Y/S_A$$

where: S_Y = compressive yield strength of pipe = 1,500 psi

and $S_A = P(SDR - 1)/2$

P = *critical stress* = 60.7 psi

SDR = 11

Substitute and solve for SA = 303.3 psi

Factor of safety against wall crushing = 4.9

2) Estimate the factor of safety against wall buckling from the following equation.

$$FS = P_{cb}/P_D$$

where: P_{cb} = critical buckling pressure

$P_{cb}^2 = 0.64(E')(P_c)$

and P_c = *critical collapse pressure*

$P_c = 2.32E/(SDR)^3$

E = modulus of elasticity = 20,000 psi (typ. for HDPE)

E' = backfill modulus = 1,500 psi (typ. for fine grained soils)

Substitute and solve for: P_c = 34.9 psi

P_{cb} = 182.9 psi

Factor of safety against wall buckling = 3.0

3) Estimate the factor of safety against ring deflection from the following equation.

$$FS = RD_{allow}/RD_{actual}$$

where: RD_{allow} for SDR 11 pipe = 5 % (Ref 2)

and RD_{actual} = soil strain around the pipe = ε_s

$\varepsilon_s = P_D/E'(100\%)$ = 4.0 %

Factor of safety against ring deflection = 1.2

APPENDIX D6B
LEACHATE GENERATION MODEL

LEACHATE GENERATION MODEL

HELP MODEL

The Hydrologic Evaluation of Landfill Performance (HELP) Model, Version 4.0, was used to predict the amount of runoff, evapotranspiration, drainage, leachate collection, and percolation through the liner. The HELP Model is a water balance model that uses climate, soil, and landfill design data to perform a solution technique that accounts for the effects of surface storage, runoff, recirculation, infiltration, percolation, soil moisture storage, evapotranspiration, and lateral drainage.

The following stages of landfill development were modeled:

Case 1 – Active face with 20 feet of exposed waste; 1 years
Case 2 – Daily cover with over 50 feet of waste; 2 years
Case 3 – Intermediate cover over 100 feet of waste; 3 years
Case 4 – Intermediate cover over 200 feet of waste; 10 years
Case 5 – Alternative Final cover over 300 feet of waste; 30 years

INPUT PARAMETERS

The HELP model input parameters for each case are summarized on page D6B.4. The selection of each parameter is briefly described below.

Evapotranspiration Data

Default evapotranspiration data for the Ferris, Texas area were used in the model. The minimum evaporative zone depth was selected for Cases 1 and 2 and the medium evaporative zone depth was selected for Cases 3, 4 and 5.

Climate Data

The climate data used for the HELP model was synthetically generated using climate coefficients for the Ferris, Texas area.

Runoff Curve Number

Default curve numbers were chosen based on the soil data, ground cover, surface slope, and slope length of the selected case.

Erosion Layer

The erosion layer consists of a 24-inch-thick layer of soils that are capable of sustaining vegetation. Geotechnical information provided in Attachment D5 indicates that CH and CL soils will be available for use as erosion layer.

Drainage Layer

The drainage layer will consist of a geocomposite. Since the sideslopes will not yield as much infiltration into the cover as the topslopes, the topslope was modeled.

Flexible Membrane Cover

The flexible membrane cover consists of a 40-mil LLDPE geomembrane. The cover will be installed and tested in accordance with the requirements of Attachment D8; therefore, the cover was modeled for good installation quality, one defect per acre, and a pinhole density of one-half hole per acre.

Infiltration Layer

The infiltration layer consists of an 12-inch-thick layer of compacted clay with hydraulic conductivity of 1×10^{-7} cm/sec or less.

Intermediate Cover

The intermediate cover consists of a 12-inch-thick layer of soils. Geotechnical information provided in Attachment D5 indicates that CH and CL soils will be available for use as daily and intermediate cover.

Waste Layers

Waste layers of 20, 50, 100, 200, and 300 feet were used to represent the stages of landfill development. The bottom two feet of solid waste was modeled as a lateral drainage layer to account for leachate movement across the top of the protective cover layer.

Protective Cover

The protective cover consists of a 24-inch-thick layer of on-site soils. Geotechnical information provided in Attachment D5 indicates that CH and CL soils will be available for use as protective cover. The top two inches of protective cover was modeled as a barrier soil layer to force the model to calculate leachate movement across the top of the protective cover.

Leachate Collection Layer

The leachate collection layer consists of a double-sided geocomposite. The thickness and hydraulic conductivity calculations are provided in appendix D6A. The critical slope and drainage distance for the leachate collection system were determined from details included in Attachment D3.

Flexible Membrane Liner

The flexible membrane liner consists of a 60-mil HDPE geomembrane. The liner will be installed and tested in accordance with the requirements of Attachment D7; therefore, the liner was modeled for excellent installation quality, one defect per acre, and a pinhole density of one-half hole per acre.

Compacted Soil Liner

The compacted soil layer consists of a 24-inch-thick layer of compacted soil with a hydraulic conductivity of 1 x 10^{-7} cm/sec or less.

HELP MODEL OUTPUT

Output files for the HELP model are provided on pages D6B.5 through D6B.34. The output for each case is summarized on page D6B.4.

HELP SUMMARY

Case No.	*1*	*2*	*3*	*4*	*5*
Cover	None	Daily	Daily	Daily	Final Cover
Waste Thickness (ft)	20	50	100	200	300
Years	1	2	3	10	30
Vegetative Cover	Bare	Bare	Bare	Bare	Good
Model Area (acre)	1	1	1	1	1
Runoff Area (%)	0	100	100	100	100
Maximum Leaf Area Index	0	0	0	0	4.5
Evaporative Zone Depth (in)	6	12	12	12	24
Erosion Layer					
Layer No.					1
Type					vertical percolation
Thickness (ft)					2.0
Geocomposite					
Layer No.					2
Type					lateral drainage
Thickness (in)					0.25
Slope (%)					2.0
Flow Distance (ft)					500
Hydraulic Conductivity (cm/sec)					14.44
Geomembrane					
Layer No.					3
Type					40 mil LLdPE
Thickness (in)					0.04
Infiltration Layer					
Layer No.					4
Type					barrier soil
Thickness (ft)					1.0
Interim/Daily Cover					
Layer No.		1	1	1	5
Type		vertical percolation	vertical percolation	vertical percolation	vertical percolation
Thickness (ft)		0.5	0.5	0.5	1.0
Solid Waste					
Layer No.	1	2	2	2	6
Type	vertical percolation	vertical percolation	vertical percolation	vertical percolation	vertical percolation
Thickness (ft)	18.0	48.0	98.0	198.0	297.0
Solid Waste					
Layer No.	2	3	3	3	7
Type	lateral drainage	lateral drainage	lateral drainage	lateral drainage	lateral drainage
Thickness (ft)	2.0	2.0	2.0	2.0	2.0
Slope (%)	3.0	3.0	3.0	3.0	3.0
Flow Distance (ft)	225	225	225	225	225
Protective Cover					
Layer No.	3	4	4	4	8
Type	barrier soil	barrier soil	barrier soil	barrier soil	barrier soil
Thickness (ft)	0.17	0.17	0.17	0.17	0.17
Protective Cover					
Layer No.	4	5	5	5	9
Type	vertical percolation	vertical percolation	vertical percolation	vertical percolation	vertical percolation
Thickness (ft)	1.83	1.83	1.83	1.83	1.83
LCS					
Layer No.	5	6	6	6	10
Type	lateral drainage	lateral drainage	lateral drainage	lateral drainage	lateral drainage
Thickness (in)	0.24	0.23	0.22	0.19	0.16
Slope (%)	3.0	3.0	3.0	3.0	3.0
Flow Distance (ft)	225	225	225	225	225
Hydraulic Conductivity (cm/sec)	44.16	29.10	10.55	7.30	4.50
Geomembrane					
Layer No.	6	7	7	7	11
Type	geomembrane	geomembrane	geomembrane	geomembrane	geomembrane
Thickness (in)	0.06	0.06	0.06	0.06	0.06
Clay Liner					
Layer No.	7	8	8	8	12
Type	barrier soil	barrier soil	barrier soil	barrier soil	barrier soil
Thickness (ft)	2.0	2.0	2.0	2.0	2.0
Average Lateral Drainage (cf/yr)	17,544.3	16,611.3	14,721.4	15,562.7	0.0
Peak Lateral Drainage (cf/day)	601.8	590.3	577.9	579.9	0.0
Average Daily Head on Liner(in)	0.0053	0.0140	0.0140	0.0013	0.0000

HELP MODEL
CASE 1

HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE
HELP MODEL VERSION 4.0 BETA (2018)
DEVELOPED BY USEPA NATIONAL RISK MANAGEMENT RESEARCH LABORATORY

Title: Skyline Landfill **Simulated On:** 7/25/2025 14:33

Layer 1

Type 1 - Vertical Percolation Layer (Cover Soil)
Municipal Solid Waste (MSW) (900 pcy)
Material Texture Number 18

Thickness	=	216 inches
Porosity	=	0.671 vol/vol
Field Capacity	=	0.292 vol/vol
Wilting Point	=	0.077 vol/vol
Initial Soil Water Content	=	0.2886 vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E-03 cm/sec

Layer 2

Type 2 - Lateral Drainage Layer
MSW
Material Texture Number 83

Thickness	=	24 inches
Porosity	=	0.671 vol/vol
Field Capacity	=	0.292 vol/vol
Wilting Point	=	0.077 vol/vol
Initial Soil Water Content	=	0.292 vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E-03 cm/sec
Slope	=	3 %
Drainage Length	=	225 ft

Layer 3

Type 3 - Barrier Soil Liner
C - Clay (Low Density)
Material Texture Number 15

Thickness	=	2 inches
Porosity	=	0.475 vol/vol
Field Capacity	=	0.378 vol/vol
Wilting Point	=	0.265 vol/vol
Initial Soil Water Content	=	0.475 vol/vol
Effective Sat. Hyd. Conductivity	=	1.70E-05 cm/sec

Layer 4

Type 1 - Vertical Percolation Layer

C - Clay (Low Density)

Material Texture Number 15

Thickness	=	22 inches
Porosity	=	0.475 vol/vol
Field Capacity	=	0.378 vol/vol
Wilting Point	=	0.265 vol/vol
Initial Soil Water Content	=	0.378 vol/vol
Effective Sat. Hyd. Conductivity	=	1.70E-05 cm/sec

Layer 5

Type 2 - Lateral Drainage Layer

Geocomposite Bottom

Material Texture Number 125

Thickness	=	0.164 inches
Porosity	=	0.85 vol/vol
Field Capacity	=	0.1 vol/vol
Wilting Point	=	0.005 vol/vol
Initial Soil Water Content	=	0.1 vol/vol
Effective Sat. Hyd. Conductivity	=	4.50E+01 cm/sec
Slope	=	3 %
Drainage Length	=	225 ft

Layer 6

Type 4 - Flexible Membrane Liner

HDPE Membrane

Material Texture Number 35

Thickness	=	0.06 inches
Effective Sat. Hyd. Conductivity	=	2.00E-13 cm/sec
FML Pinhole Density	=	0.5 Holes/Acre
FML Installation Defects	=	1 Holes/Acre
FML Placement Quality	=	2 Excellent

Layer 7

Type 3 - Barrier Soil Liner

Liner Soil (High)

Material Texture Number 16

Thickness	=	24 inches
Porosity	=	0.427 vol/vol
Field Capacity	=	0.418 vol/vol

Wilting Point	=	0.367 vol/vol
Initial Soil Water Content	=	0.427 vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E-07 cm/sec

Note: Initial moisture content of the layers and snow water were computed as nearly steady-state values by HELP.

General Design and Evaporative Zone Data

SCS Runoff Curve Number	=	80.5
Fraction of Area Allowing Runoff	=	0 %
Area projected on a horizontal plane	=	1 acres
Evaporative Zone Depth	=	6 inches
Initial Water in Evaporative Zone	=	1.012 inches
Upper Limit of Evaporative Storage	=	4.026 inches
Lower Limit of Evaporative Storage	=	0.462 inches
Initial Snow Water	=	0 inches
Initial Water in Layer Materials	=	88.871 inches
Total Initial Water	=	88.871 inches
Total Subsurface Inflow	=	0 inches/year

Note: SCS Runoff Curve Number was User-Specified.

Evapotranspiration and Weather Data

Station Latitude	=	32.54 Degrees
Maximum Leaf Area Index	=	0
Start of Growing Season (Julian Date)	=	70 days
End of Growing Season (Julian Date)	=	314 days
Average Wind Speed	=	15 mph
Average 1st Quarter Relative Humidity	=	71 %
Average 2nd Quarter Relative Humidity	=	74 %
Average 3rd Quarter Relative Humidity	=	63 %
Average 4th Quarter Relative Humidity	=	68 %

Note: Evapotranspiration data was obtained for Ferris, Texas

Normal Mean Monthly Precipitation (inches)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
2.616586	1.944726	3.711607	3.359808	4.240706	3.770842
2.198988	1.872116	2.607895	3.789102	2.796116	3.385224

Note: Precipitation was simulated based on HELP V4 weather simulation for:
Lat/Long: 32.54/-96.62

Normal Mean Monthly Temperature (Degrees Fahrenheit)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
55.7	56	61.6	74.2	84.3	89.4
94.4	91.5	84	74.5	64.9	58.9

Note: Temperature was simulated based on HELP V4 weather simulation for:
Lat/Long: 32.54/-96.62
Solar radiation was simulated based on HELP V4 weather simulation for:
Lat/Long: 32.54/-96.62

Average Annual Totals Summary

Title: Skyline Landfill
Simulated on: 7/25/2025 14:33

	Average Annual Totals for Years 1 - 1*			
	(inches)	[std dev]	(cubic feet)	(percent)
Precipitation	30.27	[0]	109,886.8	100.00
Runoff	0.000	[0]	0.0000	0.00
Evapotranspiration	25.324	[0]	91,924.4	83.65
Subprofile1				
Lateral drainage collected from Layer 2	0.0004	[0]	1.4925	0.00
Percolation/leakage through Layer 3	4.832732	[0]	17,542.8	15.96
Average Head on Top of Layer 3	0.0044		---	---
Subprofile2				
Lateral drainage collected from Layer 5	4.8327	[0]	17,542.8	15.96
Percolation/leakage through Layer 7	0.000000	[0]	0.0016	0.00
Average Head on Top of Layer 6	0.0009		---	---
Water storage				
Change in water storage	0.1152		418.0	0.38

* Note: Average inches are converted to volume based on the user-specified area.

Peak Values Summary

Title: Skyline Landfill
Simulated on: 7/25/2025 14:33

	Peak Values for Years 1 - 1*		
	(inches)		(cubic feet)
Precipitation	1.94		7,030.1
Runoff	0.000		0.0000
Subprofile1			
Drainage collected from Layer 2	0.0000		0.1140
Percolation/leakage through Layer 3	0.190910		693.0
Average head on Layer 3	0.0665		---
Maximum head on Layer 3	0.0827		---
Location of maximum head in Layer 2	1.16	(feet from drain)	
Subprofile2			
Drainage collected from Layer 5	0.1658		601.8
Percolation/leakage through Layer 7	0.000000		0.0000
Average head on Layer 6	0.0114		---
Maximum head on Layer 6	0.0097		---
Location of maximum head in Layer 5	0.02	(feet from drain)	
Other Parameters			
Snow water	0.3433		1,246.1
Maximum vegetation soil water	0.4364	(vol/vol)	
Minimum vegetation soil water	0.0770	(vol/vol)	

Final Water Storage in Landfill Profile at End of Simulation Period

Title: Skyline Landfill
Simulated on: 7/25/2025 14:33
Simulation period: 1 years

	Final Water Storage	
Layer	(inches)	(vol/vol)
1	62.4475	0.2891
2	7.0080	0.2920
3	0.9500	0.4750
4	8.3160	0.3780
5	0.0164	0.1000
6	0.0000	0.0000
7	10.2480	0.4270
Snow water	0.0000	---

HELP MODEL
CASE 2

HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE
HELP MODEL VERSION 4.0 BETA (2018)
DEVELOPED BY USEPA NATIONAL RISK MANAGEMENT RESEARCH LABORATORY

Title: Skyline Landfill **Simulated On:** 6/11/2025 15:27

Layer 1

Type 1 - Vertical Percolation Layer (Cover Soil)

Daily Cover

Material Texture Number 44

Thickness	=	6 inches
Porosity	=	0.475 vol/vol
Field Capacity	=	0.378 vol/vol
Wilting Point	=	0.265 vol/vol
Initial Soil Water Content	=	0.3518 vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E-04 cm/sec

Layer 2

Type 1 - Vertical Percolation Layer (Waste)

Municipal Solid Waste (MSW) (900 pcy)

Material Texture Number 18

Thickness	=	576 inches
Porosity	=	0.671 vol/vol
Field Capacity	=	0.292 vol/vol
Wilting Point	=	0.077 vol/vol
Initial Soil Water Content	=	0.29 vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E-03 cm/sec

Layer 3

Type 2 - Lateral Drainage Layer

MSW

Material Texture Number 83

Thickness	=	24 inches
Porosity	=	0.671 vol/vol
Field Capacity	=	0.292 vol/vol
Wilting Point	=	0.077 vol/vol
Initial Soil Water Content	=	0.292 vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E-03 cm/sec
Slope	=	3 %
Drainage Length	=	225 ft

Layer 4

Type 3 - Barrier Soil Liner

C - Clay (Low Density)

Material Texture Number 15

Thickness	=	2 inches
Porosity	=	0.475 vol/vol
Field Capacity	=	0.378 vol/vol
Wilting Point	=	0.265 vol/vol
Initial Soil Water Content	=	0.475 vol/vol
Effective Sat. Hyd. Conductivity	=	1.70E-05 cm/sec

Layer 5

Type 1 - Vertical Percolation Layer

C - Clay (Low Density)

Material Texture Number 15

Thickness	=	22 inches
Porosity	=	0.475 vol/vol
Field Capacity	=	0.378 vol/vol
Wilting Point	=	0.265 vol/vol
Initial Soil Water Content	=	0.378 vol/vol
Effective Sat. Hyd. Conductivity	=	1.70E-05 cm/sec

Layer 6

Type 2 - Lateral Drainage Layer

Geocomposite Bottom

Material Texture Number 125

Thickness	=	0.235 inches
Porosity	=	0.85 vol/vol
Field Capacity	=	0.1 vol/vol
Wilting Point	=	0.005 vol/vol
Initial Soil Water Content	=	0.1 vol/vol
Effective Sat. Hyd. Conductivity	=	2.91E+02 cm/sec
Slope	=	3 %
Drainage Length	=	225 ft

Layer 7

Type 4 - Flexible Membrane Liner

HDPE Membrane

Material Texture Number 35

Thickness	=	0.06 inches
Effective Sat. Hyd. Conductivity	=	2.00E-13 cm/sec

FML Pinhole Density	=	0.5 Holes/Acre
FML Installation Defects	=	1 Holes/Acre
FML Placement Quality	=	2 Excellent

Layer 8

Type 3 - Barrier Soil Liner

Liner Soil (High)

Material Texture Number 16

Thickness	=	24 inches
Porosity	=	0.427 vol/vol
Field Capacity	=	0.418 vol/vol
Wilting Point	=	0.367 vol/vol
Initial Soil Water Content	=	0.427 vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E-07 cm/sec

Note: Initial moisture content of the layers and snow water were computed as nearly steady-state values by HELP.

General Design and Evaporative Zone Data

SCS Runoff Curve Number	=	77
Fraction of Area Allowing Runoff	=	100 %
Area projected on a horizontal plane	=	1 acres
Evaporative Zone Depth	=	12 inches
Initial Water in Evaporative Zone	=	2.684 inches
Upper Limit of Evaporative Storage	=	6.876 inches
Lower Limit of Evaporative Storage	=	2.052 inches
Initial Snow Water	=	0 inches
Initial Water in Layer Materials	=	195.67 inches
Total Initial Water	=	195.67 inches
Total Subsurface Inflow	=	0 inches/year

Note: SCS Runoff Curve Number was User-Specified.

Evapotranspiration and Weather Data

Station Latitude	=	32.54 Degrees
Maximum Leaf Area Index	=	0
Start of Growing Season (Julian Date)	=	70 days
End of Growing Season (Julian Date)	=	314 days
Average Wind Speed	=	15 mph
Average 1st Quarter Relative Humidity	=	71 %

Average 2nd Quarter Relative Humidity	=	74 %
Average 3rd Quarter Relative Humidity	=	63 %
Average 4th Quarter Relative Humidity	=	68 %

Note: Evapotranspiration data was obtained for Ferris, Texas

Normal Mean Monthly Precipitation (inches)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
2.616586	1.944726	3.711607	3.359808	4.240706	3.770842
2.198988	1.872116	2.607895	3.789102	2.796116	3.385224

Note: Precipitation was simulated based on HELP V4 weather simulation for:
Lat/Long: 32.54/-96.62

Normal Mean Monthly Temperature (Degrees Fahrenheit)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
55.7	56	61.6	74.2	84.3	89.4
94.4	91.5	84	74.5	64.9	58.9

Note: Temperature was simulated based on HELP V4 weather simulation for:
Lat/Long: 32.54/-96.62
Solar radiation was simulated based on HELP V4 weather simulation for:
Lat/Long: 32.54/-96.62

Average Annual Totals Summary

Title: Skyline Landfill
Simulated on: 6/11/2025 15:27

	Average Annual Totals for Years 1 - 2*			
	(inches)	[std dev]	(cubic feet)	(percent)
Precipitation	34.77	[6.36]	126,208.0	100.00
Runoff	0.057	[0.023]	205.8	0.16
Evapotranspiration	29.797	[3.207]	108,164.3	85.70
Subprofile1				
Lateral drainage collected from Layer 3	0.0004	[0.0002]	1.3657	0.00
Percolation/leakage through Layer 4	4.998606	[3.307756]	18,144.9	14.38
Average Head on Top of Layer 4	0.0046	[0.003]	---	---
Subprofile2				
Lateral drainage collected from Layer 6	4.5757	[2.7097]	16,609.9	13.16
Percolation/leakage through Layer 8	0.000000	[0]	0.0003	0.00
Average Head on Top of Layer 7	0.0010	[0.0006]	---	---
Water storage				
Change in water storage	0.3379	[0.4188]	1,226.6	0.97

* Note: Average inches are converted to volume based on the user-specified area.

Peak Values Summary

Title: Skyline Landfill
Simulated on: 6/11/2025 15:27

	Peak Values for Years 1 - 2*		
	(inches)		(cubic feet)
Precipitation	1.94		7,030.1
Runoff	0.046		168.4
Subprofile1			
Drainage collected from Layer 3	0.0000		0.0899
Percolation/leakage through Layer 4	0.170236		618.0
Average head on Layer 4	0.0575		---
Maximum head on Layer 4	0.0653		---
Location of maximum head in Layer 3	0.91	(feet from drain)	
Subprofile2			
Drainage collected from Layer 6	0.1626		590.2
Percolation/leakage through Layer 8	0.000000		0.0000
Average head on Layer 7	0.0135		---
Maximum head on Layer 7	0.0015		---
Location of maximum head in Layer 6	0.00	(feet from drain)	
Other Parameters			
Snow water	2.4374		8,847.6
Maximum vegetation soil water	0.4006	(vol/vol)	
Minimum vegetation soil water	0.1710	(vol/vol)	

Final Water Storage in Landfill Profile at End of Simulation Period

Title: Skyline Landfill
Simulated on: 6/11/2025 15:28
Simulation period: 2 years

	Final Water Storage	
Layer	(inches)	(vol/vol)
1	1.8750	0.3125
2	167.0794	0.2901
3	7.0080	0.2920
4	0.9500	0.4750
5	9.1618	0.4164
6	0.0235	0.1000
7	0.0000	0.0000
8	10.2480	0.4270
Snow water	0.0000	---

HELP MODEL
CASE 3

HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE
HELP MODEL VERSION 4.0 BETA (2018)
DEVELOPED BY USEPA NATIONAL RISK MANAGEMENT RESEARCH LABORATORY

Title: Skyline Landfill **Simulated On:** 6/11/2025 15:20

Layer 1

Type 1 - Vertical Percolation Layer (Cover Soil)
Daily Cover
Material Texture Number 44

Thickness	=	6 inches
Porosity	=	0.475 vol/vol
Field Capacity	=	0.378 vol/vol
Wilting Point	=	0.265 vol/vol
Initial Soil Water Content	=	0.3518 vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E-04 cm/sec

Layer 2

Type 1 - Vertical Percolation Layer (Waste)
Municipal Solid Waste (MSW) (900 pcy)
Material Texture Number 18

Thickness	=	1176 inches
Porosity	=	0.671 vol/vol
Field Capacity	=	0.292 vol/vol
Wilting Point	=	0.077 vol/vol
Initial Soil Water Content	=	0.291 vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E-03 cm/sec

Layer 3

Type 2 - Lateral Drainage Layer
MSW
Material Texture Number 83

Thickness	=	24 inches
Porosity	=	0.671 vol/vol
Field Capacity	=	0.292 vol/vol
Wilting Point	=	0.077 vol/vol
Initial Soil Water Content	=	0.292 vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E-03 cm/sec
Slope	=	3 %
Drainage Length	=	225 ft

Layer 4

Type 3 - Barrier Soil Liner

C - Clay (Low Density)

Material Texture Number 15

Thickness	=	2 inches
Porosity	=	0.475 vol/vol
Field Capacity	=	0.378 vol/vol
Wilting Point	=	0.265 vol/vol
Initial Soil Water Content	=	0.475 vol/vol
Effective Sat. Hyd. Conductivity	=	1.70E-05 cm/sec

Layer 5

Type 1 - Vertical Percolation Layer

C - Clay (Low Density)

Material Texture Number 15

Thickness	=	22 inches
Porosity	=	0.475 vol/vol
Field Capacity	=	0.378 vol/vol
Wilting Point	=	0.265 vol/vol
Initial Soil Water Content	=	0.378 vol/vol
Effective Sat. Hyd. Conductivity	=	1.70E-05 cm/sec

Layer 6

Type 2 - Lateral Drainage Layer

Geocomposite Bottom

Material Texture Number 125

Thickness	=	0.221 inches
Porosity	=	0.85 vol/vol
Field Capacity	=	0.1 vol/vol
Wilting Point	=	0.005 vol/vol
Initial Soil Water Content	=	0.1 vol/vol
Effective Sat. Hyd. Conductivity	=	1.06E+02 cm/sec
Slope	=	3 %
Drainage Length	=	225 ft

Layer 7

Type 4 - Flexible Membrane Liner

HDPE Membrane

Material Texture Number 35

Thickness	=	0.06 inches
Effective Sat. Hyd. Conductivity	=	2.00E-13 cm/sec

FML Pinhole Density	=	0.5 Holes/Acre
FML Installation Defects	=	1 Holes/Acre
FML Placement Quality	=	2 Excellent

Layer 8

Type 3 - Barrier Soil Liner

Liner Soil (High)

Material Texture Number 16

Thickness	=	24 inches
Porosity	=	0.427 vol/vol
Field Capacity	=	0.418 vol/vol
Wilting Point	=	0.367 vol/vol
Initial Soil Water Content	=	0.427 vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E-07 cm/sec

Note: Initial moisture content of the layers and snow water were computed as nearly steady-state values by HELP.

General Design and Evaporative Zone Data

SCS Runoff Curve Number	=	77
Fraction of Area Allowing Runoff	=	100 %
Area projected on a horizontal plane	=	1 acres
Evaporative Zone Depth	=	12 inches
Initial Water in Evaporative Zone	=	2.684 inches
Upper Limit of Evaporative Storage	=	6.876 inches
Lower Limit of Evaporative Storage	=	2.052 inches
Initial Snow Water	=	0 inches
Initial Water in Layer Materials	=	370.868 inches
Total Initial Water	=	370.868 inches
Total Subsurface Inflow	=	0 inches/year

Note: SCS Runoff Curve Number was User-Specified.

Evapotranspiration and Weather Data

Station Latitude	=	32.54 Degrees
Maximum Leaf Area Index	=	0
Start of Growing Season (Julian Date)	=	70 days
End of Growing Season (Julian Date)	=	314 days
Average Wind Speed	=	15 mph
Average 1st Quarter Relative Humidity	=	71 %

Average 2nd Quarter Relative Humidity	=	74 %
Average 3rd Quarter Relative Humidity	=	63 %
Average 4th Quarter Relative Humidity	=	68 %

Note: Evapotranspiration data was obtained for Ferris, Texas

Normal Mean Monthly Precipitation (inches)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
2.616586	1.944726	3.711607	3.359808	4.240706	3.770842
2.198988	1.872116	2.607895	3.789102	2.796116	3.385224

Note: Precipitation was simulated based on HELP V4 weather simulation for:
Lat/Long: 32.54/-96.62

Normal Mean Monthly Temperature (Degrees Fahrenheit)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
55.7	56	61.6	74.2	84.3	89.4
94.4	91.5	84	74.5	64.9	58.9

Note: Temperature was simulated based on HELP V4 weather simulation for:
Lat/Long: 32.54/-96.62
Solar radiation was simulated based on HELP V4 weather simulation for:
Lat/Long: 32.54/-96.62

Average Annual Totals Summary

Title: Skyline Landfill
Simulated on: 6/11/2025 15:20

	Average Annual Totals for Years 1 - 3*			
	(inches)	[std dev]	(cubic feet)	(percent)
Precipitation	35.46	[4.65]	128,712.8	100.00
Runoff	0.107	[0.089]	389.4	0.30
Evapotranspiration	29.601	[2.293]	107,451.5	83.48
Subprofile1				
Lateral drainage collected from Layer 3	0.0003	[0.0002]	1.0805	0.00
Percolation/leakage through Layer 4	4.099635	[2.809828]	14,881.7	11.56
Average Head on Top of Layer 4	0.0037	[0.0025]	---	---
Subprofile2				
Lateral drainage collected from Layer 6	4.0552	[2.1119]	14,720.3	11.44
Percolation/leakage through Layer 8	0.000000	[0]	0.0005	0.00
Average Head on Top of Layer 7	0.0009	[0.0005]	---	---
Water storage				
Change in water storage	1.6944	[2.3625]	6,150.6	4.78

* Note: Average inches are converted to volume based on the user-specified area.

Peak Values Summary

Title: Skyline Landfill
Simulated on: 6/11/2025 15:21

	Peak Values for Years 1 - 3*		
	(inches)		(cubic feet)
Precipitation	2.46		8,943.7
Runoff	0.104		375.9
Subprofile1			
Drainage collected from Layer 3	0.0000		0.1068
Percolation/leakage through Layer 4	0.185054		671.7
Average head on Layer 4	0.0642		---
Maximum head on Layer 4	0.0775		---
Location of maximum head in Layer 3	1.09	(feet from drain)	
Subprofile2			
Drainage collected from Layer 6	0.1592		577.8
Percolation/leakage through Layer 8	0.000000		0.0000
Average head on Layer 7	0.0135		---
Maximum head on Layer 7	0.0040		---
Location of maximum head in Layer 6	0.00	(feet from drain)	
Other Parameters			
Snow water	2.4374		8,847.6
Maximum vegetation soil water	0.4103	(vol/vol)	
Minimum vegetation soil water	0.1710	(vol/vol)	

Final Water Storage in Landfill Profile at End of Simulation Period

Title: Skyline Landfill
Simulated on: 6/11/2025 15:21
Simulation period: 3 years

	Final Water Storage	
Layer	(inches)	(vol/vol)
1	2.2035	0.3672
2	347.0706	0.2951
3	7.0080	0.2920
4	0.9500	0.4750
5	8.4494	0.3841
6	0.0221	0.1000
7	0.0000	0.0000
8	10.2480	0.4270
Snow water	0.0000	---

HELP MODEL
CASE 4

HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE
HELP MODEL VERSION 4.0 BETA (2018)
DEVELOPED BY USEPA NATIONAL RISK MANAGEMENT RESEARCH LABORATORY

Title: Skyline Landfill **Simulated On:** 6/11/2025 14:58

Layer 1

Type 1 - Vertical Percolation Layer (Cover Soil)
Daily Cover
Material Texture Number 44

Thickness	=	6 inches
Porosity	=	0.475 vol/vol
Field Capacity	=	0.378 vol/vol
Wilting Point	=	0.265 vol/vol
Initial Soil Water Content	=	0.3518 vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E-04 cm/sec

Layer 2

Type 1 - Vertical Percolation Layer (Waste)
Municipal Solid Waste (MSW) (900 pcy)
Material Texture Number 18

Thickness	=	2376 inches
Porosity	=	0.671 vol/vol
Field Capacity	=	0.292 vol/vol
Wilting Point	=	0.077 vol/vol
Initial Soil Water Content	=	0.2915 vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E-03 cm/sec

Layer 3

Type 2 - Lateral Drainage Layer
MSW
Material Texture Number 83

Thickness	=	24 inches
Porosity	=	0.671 vol/vol
Field Capacity	=	0.292 vol/vol
Wilting Point	=	0.077 vol/vol
Initial Soil Water Content	=	0.292 vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E-03 cm/sec
Slope	=	3 %
Drainage Length	=	225 ft

Layer 4

Type 3 - Barrier Soil Liner

C - Clay (Low Density)

Material Texture Number 15

Thickness	=	2 inches
Porosity	=	0.475 vol/vol
Field Capacity	=	0.378 vol/vol
Wilting Point	=	0.265 vol/vol
Initial Soil Water Content	=	0.475 vol/vol
Effective Sat. Hyd. Conductivity	=	1.70E-05 cm/sec

Layer 5

Type 1 - Vertical Percolation Layer

C - Clay (Low Density)

Material Texture Number 15

Thickness	=	22 inches
Porosity	=	0.475 vol/vol
Field Capacity	=	0.378 vol/vol
Wilting Point	=	0.265 vol/vol
Initial Soil Water Content	=	0.378 vol/vol
Effective Sat. Hyd. Conductivity	=	1.70E-05 cm/sec

Layer 6

Type 2 - Lateral Drainage Layer

Geocomposite Bottom

Material Texture Number 125

Thickness	=	0.194 inches
Porosity	=	0.85 vol/vol
Field Capacity	=	0.1 vol/vol
Wilting Point	=	0.005 vol/vol
Initial Soil Water Content	=	0.1 vol/vol
Effective Sat. Hyd. Conductivity	=	7.30E+01 cm/sec
Slope	=	3 %
Drainage Length	=	225 ft

Layer 7

Type 4 - Flexible Membrane Liner

HDPE Membrane

Material Texture Number 35

Thickness	=	0.06 inches
Effective Sat. Hyd. Conductivity	=	2.00E-13 cm/sec

FML Pinhole Density	=	0.5 Holes/Acre
FML Installation Defects	=	1 Holes/Acre
FML Placement Quality	=	2 Excellent

Layer 8

Type 3 - Barrier Soil Liner

Liner Soil (High)

Material Texture Number 16

Thickness	=	24 inches
Porosity	=	0.427 vol/vol
Field Capacity	=	0.418 vol/vol
Wilting Point	=	0.367 vol/vol
Initial Soil Water Content	=	0.427 vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E-07 cm/sec

Note: Initial moisture content of the layers and snow water were computed as nearly steady-state values by HELP.

General Design and Evaporative Zone Data

SCS Runoff Curve Number	=	77
Fraction of Area Allowing Runoff	=	100 %
Area projected on a horizontal plane	=	1 acres
Evaporative Zone Depth	=	12 inches
Initial Water in Evaporative Zone	=	2.684 inches
Upper Limit of Evaporative Storage	=	6.876 inches
Lower Limit of Evaporative Storage	=	2.052 inches
Initial Snow Water	=	0 inches
Initial Water in Layer Materials	=	721.266 inches
Total Initial Water	=	721.266 inches
Total Subsurface Inflow	=	0 inches/year

Note: SCS Runoff Curve Number was User-Specified.

Evapotranspiration and Weather Data

Station Latitude	=	32.54 Degrees
Maximum Leaf Area Index	=	0
Start of Growing Season (Julian Date)	=	70 days
End of Growing Season (Julian Date)	=	314 days
Average Wind Speed	=	15 mph
Average 1st Quarter Relative Humidity	=	71 %

Average 2nd Quarter Relative Humidity	=	74 %
Average 3rd Quarter Relative Humidity	=	63 %
Average 4th Quarter Relative Humidity	=	68 %

Note: Evapotranspiration data was obtained for Ferris, Texas

Normal Mean Monthly Precipitation (inches)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
2.616586	1.944726	3.711607	3.359808	4.240706	3.770842
2.198988	1.872116	2.607895	3.789102	2.796116	3.385224

Note: Precipitation was simulated based on HELP V4 weather simulation for:
Lat/Long: 32.54/-96.62

Normal Mean Monthly Temperature (Degrees Fahrenheit)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
55.7	56	61.6	74.2	84.3	89.4
94.4	91.5	84	74.5	64.9	58.9

Note: Temperature was simulated based on HELP V4 weather simulation for:
Lat/Long: 32.54/-96.62
Solar radiation was simulated based on HELP V4 weather simulation for:
Lat/Long: 32.54/-96.62

Average Annual Totals Summary

Title: Skyline Landfill
Simulated on: 6/11/2025 14:59

	Average Annual Totals for Years 1 - 10*			
	(inches)	[std dev]	(cubic feet)	(percent)
Precipitation	34.30	[3.54]	124,520.5	100.00
Runoff	0.118	[0.068]	428.7	0.34
Evapotranspiration	29.768	[2.561]	108,057.5	86.78
Subprofile1				
Lateral drainage collected from Layer 3	0.0003	[0.0002]	1.1536	0.00
Percolation/leakage through Layer 4	4.329439	[2.807288]	15,715.9	12.62
Average Head on Top of Layer 4	0.0040	[0.0025]	---	---
Subprofile2				
Lateral drainage collected from Layer 6	4.2869	[2.7271]	15,561.5	12.50
Percolation/leakage through Layer 8	0.000000	[0]	0.0007	0.00
Average Head on Top of Layer 7	0.0010	[0.0006]	---	---
Water storage				
Change in water storage	0.1300	[2.654]	471.8	0.38

* Note: Average inches are converted to volume based on the user-specified area.

Peak Values Summary

Title: Skyline Landfill
Simulated on: 6/11/2025 14:59

	Peak Values for Years 1 - 10*		
	(inches)		(cubic feet)
Precipitation	2.70		9,791.8
Runoff	0.151		547.6
Subprofile1			
Drainage collected from Layer 3	0.0000		0.1071
Percolation/leakage through Layer 4	0.186787		678.0
Average head on Layer 4	0.0639		---
Maximum head on Layer 4	0.0777		---
Location of maximum head in Layer 3	1.09	(feet from drain)	
Subprofile2			
Drainage collected from Layer 6	0.1597		579.8
Percolation/leakage through Layer 8	0.000000		0.0000
Average head on Layer 7	0.0134		---
Maximum head on Layer 7	0.0058		---
Location of maximum head in Layer 6	0.00	(feet from drain)	
Other Parameters			
Snow water	2.4862		9,024.9
Maximum vegetation soil water	0.4184	(vol/vol)	
Minimum vegetation soil water	0.1710	(vol/vol)	

Final Water Storage in Landfill Profile at End of Simulation Period

Title: Skyline Landfill
Simulated on: 6/11/2025 14:59
Simulation period: 10 years

	Final Water Storage	
Layer	(inches)	(vol/vol)
1	1.5900	0.2650
2	693.8346	0.2920
3	7.1820	0.2993
4	0.9500	0.4750
5	8.7414	0.3973
6	0.0194	0.1000
7	0.0000	0.0000
8	10.2480	0.4270
Snow water	0.0000	---

HELP MODEL
CASE 5

HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE
HELP MODEL VERSION 4.0 BETA (2018)
DEVELOPED BY USEPA NATIONAL RISK MANAGEMENT RESEARCH LABORATORY

Title: Skyline Landfill **Simulated On:** 8/22/2025 13:13

Layer 1

Type 1 - Vertical Percolation Layer (Cover Soil)
SiCL - Silty Clay Loam
Material Texture Number 12

Thickness	=	24 inches
Porosity	=	0.471 vol/vol
Field Capacity	=	0.342 vol/vol
Wilting Point	=	0.21 vol/vol
Initial Soil Water Content	=	0.2458 vol/vol
Effective Sat. Hyd. Conductivity	=	4.20E-05 cm/sec

Layer 2

Type 2 - Lateral Drainage Layer
Geocomposite
Material Texture Number 123

Thickness	=	0.248 inches
Porosity	=	0.85 vol/vol
Field Capacity	=	0.1 vol/vol
Wilting Point	=	0.005 vol/vol
Initial Soil Water Content	=	0.0999 vol/vol
Effective Sat. Hyd. Conductivity	=	1.44E+02 cm/sec
Slope	=	2 %
Drainage Length	=	500 ft

Layer 3

Type 4 - Flexible Membrane Liner
LDPE Membrane
Material Texture Number 36

Thickness	=	0.04 inches
Effective Sat. Hyd. Conductivity	=	4.00E-13 cm/sec
FML Pinhole Density	=	2 Holes/Acre
FML Installation Defects	=	3 Holes/Acre
FML Placement Quality	=	3 Good

Layer 4

Type 3 - Barrier Soil Liner

Liner Soil (High)

Material Texture Number 16

Thickness	=	12 inches
Porosity	=	0.427 vol/vol
Field Capacity	=	0.418 vol/vol
Wilting Point	=	0.367 vol/vol
Initial Soil Water Content	=	0.427 vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E-07 cm/sec

Layer 5

Type 1 - Vertical Percolation Layer

Intermediate Cover

Material Texture Number 44

Thickness	=	12 inches
Porosity	=	0.475 vol/vol
Field Capacity	=	0.378 vol/vol
Wilting Point	=	0.265 vol/vol
Initial Soil Water Content	=	0.378 vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E-04 cm/sec

Layer 6

Type 1 - Vertical Percolation Layer (Waste)

Municipal Solid Waste (MSW) (900 pcy)

Material Texture Number 18

Thickness	=	3576 inches
Porosity	=	0.671 vol/vol
Field Capacity	=	0.292 vol/vol
Wilting Point	=	0.077 vol/vol
Initial Soil Water Content	=	0.292 vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E-03 cm/sec

Layer 7

Type 2 - Lateral Drainage Layer

MSW

Material Texture Number 83

Thickness	=	24 inches
Porosity	=	0.671 vol/vol
Field Capacity	=	0.292 vol/vol
Wilting Point	=	0.077 vol/vol
Initial Soil Water Content	=	0.292 vol/vol

Effective Sat. Hyd. Conductivity	=	1.00E-03 cm/sec
Slope	=	3 %
Drainage Length	=	225 ft

Layer 8

Type 3 - Barrier Soil Liner

C - Clay (Low Density)

Material Texture Number 15

Thickness	=	2 inches
Porosity	=	0.475 vol/vol
Field Capacity	=	0.378 vol/vol
Wilting Point	=	0.265 vol/vol
Initial Soil Water Content	=	0.475 vol/vol
Effective Sat. Hyd. Conductivity	=	1.70E-05 cm/sec

Layer 9

Type 1 - Vertical Percolation Layer

C - Clay (Low Density)

Material Texture Number 15

Thickness	=	22 inches
Porosity	=	0.475 vol/vol
Field Capacity	=	0.378 vol/vol
Wilting Point	=	0.265 vol/vol
Initial Soil Water Content	=	0.378 vol/vol
Effective Sat. Hyd. Conductivity	=	1.70E-05 cm/sec

Layer 10

Type 2 - Lateral Drainage Layer

Geocomposite Bottom

Material Texture Number 125

Thickness	=	0.164 inches
Porosity	=	0.85 vol/vol
Field Capacity	=	0.1 vol/vol
Wilting Point	=	0.005 vol/vol
Initial Soil Water Content	=	0.1 vol/vol
Effective Sat. Hyd. Conductivity	=	4.50E+01 cm/sec
Slope	=	3 %
Drainage Length	=	225 ft

Layer 11

Type 4 - Flexible Membrane Liner

HDPE Membrane

Material Texture Number 35

Thickness	=	0.06	inches
Effective Sat. Hyd. Conductivity	=	2.00E-13	cm/sec
FML Pinhole Density	=	0.5	Holes/Acre
FML Installation Defects	=	1	Holes/Acre
FML Placement Quality	=	2	Excellent

Layer 12

Type 3 - Barrier Soil Liner

Liner Soil (High)

Material Texture Number 16

Thickness	=	24	inches
Porosity	=	0.427	vol/vol
Field Capacity	=	0.418	vol/vol
Wilting Point	=	0.367	vol/vol
Initial Soil Water Content	=	0.427	vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E-07	cm/sec

Note: Initial moisture content of the layers and snow water were computed as nearly steady-state values by HELP.

General Design and Evaporative Zone Data

SCS Runoff Curve Number	=	93.2	
Fraction of Area Allowing Runoff	=	100	%
Area projected on a horizontal plane	=	1	acres
Evaporative Zone Depth	=	24	inches
Initial Water in Evaporative Zone	=	5.898	inches
Upper Limit of Evaporative Storage	=	11.304	inches
Lower Limit of Evaporative Storage	=	5.04	inches
Initial Snow Water	=	0	inches
Initial Water in Layer Materials	=	1086.313	inches
Total Initial Water	=	1086.313	inches
Total Subsurface Inflow	=	0	inches/year

Note: SCS Runoff Curve Number was User-Specified.

Evapotranspiration and Weather Data

Station Latitude	=	32.54	Degrees
Maximum Leaf Area Index	=	4.5	
Start of Growing Season (Julian Date)	=	70	days

End of Growing Season (Julian Date)	=	314 days
Average Wind Speed	=	15 mph
Average 1st Quarter Relative Humidity	=	71 %
Average 2nd Quarter Relative Humidity	=	74 %
Average 3rd Quarter Relative Humidity	=	63 %
Average 4th Quarter Relative Humidity	=	68 %

Note: Evapotranspiration data was obtained for Ferris, Texas

Normal Mean Monthly Precipitation (inches)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
2.616586	1.944726	3.711607	3.359808	4.240706	3.770842
2.198988	1.872116	2.607895	3.789102	2.796116	3.385224

Note: Precipitation was simulated based on HELP V4 weather simulation for:
Lat/Long: 32.54/-96.62

Normal Mean Monthly Temperature (Degrees Fahrenheit)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
55.7	56	61.6	74.2	84.3	89.4
94.4	91.5	84	74.5	64.9	58.9

Note: Temperature was simulated based on HELP V4 weather simulation for:
Lat/Long: 32.54/-96.62
Solar radiation was simulated based on HELP V4 weather simulation for:
Lat/Long: 32.54/-96.62

Average Annual Totals Summary

Title: Skyline Landfill
Simulated on: 8/22/2025 13:14

	Average Annual Totals for Years 1 - 30*			
	(inches)	[std dev]	(cubic feet)	(percent)
Precipitation	36.29	[5.56]	131,746.2	100.00
Runoff	5.556	[1.952]	20,167.0	15.31
Evapotranspiration	30.176	[3.723]	109,538.9	83.14
Subprofile1				
Lateral drainage collected from Layer 2	0.5548	[0.6806]	2,013.9	1.53
Percolation/leakage through Layer 4	0.000000	[0]	0.0012	0.00
Average Head on Top of Layer 3	0.0000	[0.0001]	---	---
Subprofile2				
Lateral drainage collected from Layer 7	0.0000	[0]	0.0000	0.00
Percolation/leakage through Layer 8	0.000000	[0]	0.0012	0.00
Average Head on Top of Layer 8	0.0000	[0]	---	---
Subprofile3				
Lateral drainage collected from Layer 10	0.0000	[0]	0.0011	0.00
Percolation/leakage through Layer 12	0.000000	[0]	0.0001	0.00
Average Head on Top of Layer 11	0.0000	[0]	---	---
Water storage				
Change in water storage	0.0073	[1.6373]	26.4	0.02

* Note: Average inches are converted to volume based on the user-specified area.

Peak Values Summary

Title: Skyline Landfill
Simulated on: 8/22/2025 13:15

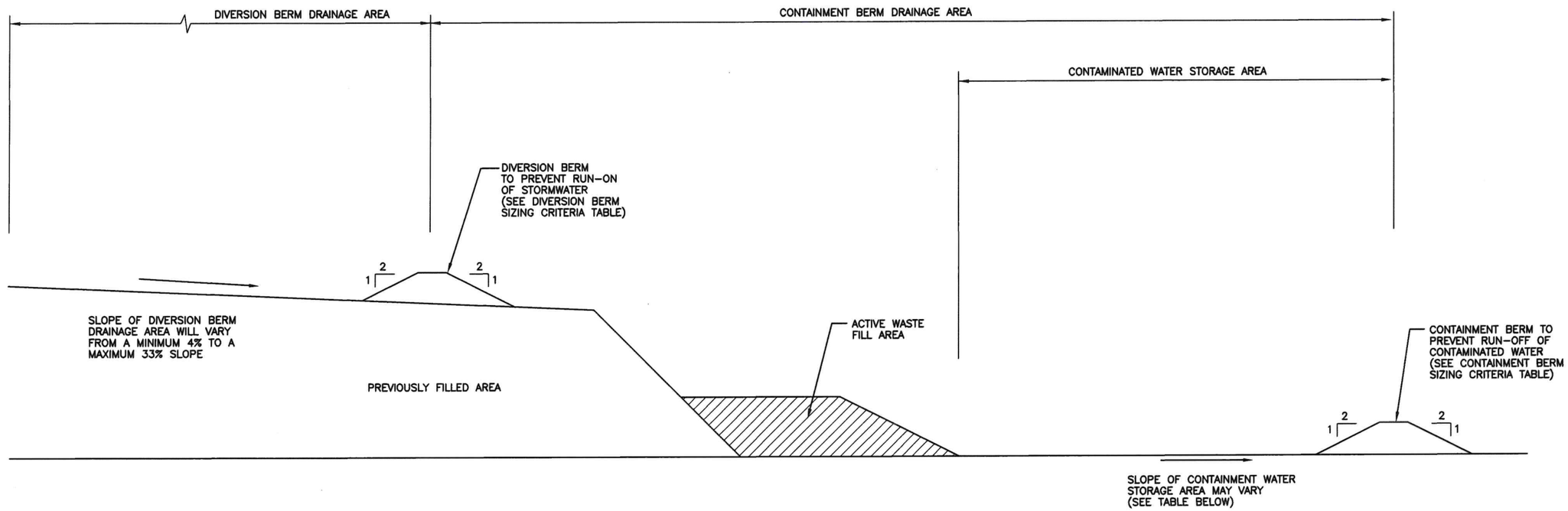
	Peak Values for Years 1 - 30*		
	(inches)		(cubic feet)
Precipitation	4.82		17,502.4
Runoff	3.351		12,165.1
Subprofile1			
Drainage collected from Layer 2	0.3204		1,163.0
Percolation/leakage through Layer 4	0.000000		0.0002
Average head on Layer 3	0.0098		---
Maximum head on Layer 3	0.0196		---
Location of maximum head in Layer 2	0.43	(feet from drain)	
Subprofile2			
Drainage collected from Layer 7	0.0000		0.0000
Percolation/leakage through Layer 8	0.000000		0.0002
Average head on Layer 8	0.0000		---
Maximum head on Layer 8	0.0000		---
Location of maximum head in Layer 7	0.00	(feet from drain)	
Subprofile3			
Drainage collected from Layer 10	0.0000		0.0002
Percolation/leakage through Layer 12	0.000000		0.0000
Average head on Layer 11	0.0000		---
Maximum head on Layer 11	0.0000		---
Location of maximum head in Layer 10	0.00	(feet from drain)	
Other Parameters			
Snow water	2.9848		10,834.7
Maximum vegetation soil water	0.4019	(vol/vol)	
Minimum vegetation soil water	0.2100	(vol/vol)	

Final Water Storage in Landfill Profile at End of Simulation Period

Title: Skyline Landfill
Simulated on: 8/22/2025 13:15
Simulation period: 30 years

	Final Water Storage	
Layer	(inches)	(vol/vol)
1	6.1162	0.2548
2	0.0248	0.0999
3	0.0000	0.0000
4	5.1240	0.4270
5	4.5360	0.3780
6	1,044.1920	0.2920
7	7.0080	0.2920
8	0.9500	0.4750
9	8.3160	0.3780
10	0.0164	0.1000
11	0.0000	0.0000
12	10.2480	0.4270
Snow water	0.0000	---

APPENDIX D6C
CONTAINMENT/DIVERSION BERM DESIGN



DIVERSION BERM SIZING CRITERIA

DIVERSION BERM DRAINAGE AREA (ACRES)	4%			33%		
	FLOW RATE (CFS)	FLOW DEPTH (FT)	REQUIRED MINIMUM DIVERSION BERM HEIGHT (FT)	FLOW RATE (CFS)	FLOW DEPTH (FT)	REQUIRED MINIMUM DIVERSION BERM HEIGHT (FT)
0.5	4.7	0.5	1.5	4.0	0.9	1.9
1.0	7.6	0.6	1.6	6.8	1.1	2.1
1.5	11.5	0.7	1.7	10.6	1.3	2.3

NOTE: DIVERSION BERMS WILL BE SIZED TO DIVERT STORMWATER FROM THE 25 YEAR, 24 HOUR STORM EVENT WITH A FREEBOARD OF 1 FT.

CONTAINMENT BERM SIZING CRITERIA

CONTAINMENT BERM DRAINAGE AREA (ACRES)	CONTAINMENT WATER STORAGE AREA (ACRES)	FLOOR SLOPE OF CONTAMINATED WATER STORAGE AREA	REQUIRED MINIMUM HEIGHT OF CONTAINMENT BERM (FT)
0.5	0.35	1 %	1.5
	0.25	2 %	2.2
	0.20	4 %	3.5
1.0	0.50	1 %	2.2
	0.35	2 %	3.0
	0.25	4 %	4.4
1.5	0.60	1 %	2.6
	0.40	2 %	3.5
	0.30	4 %	5.2

NOTE: CONTAINMENT BERMS WILL BE SIZED TO CONTAIN STORMWATER FROM THE 25 YEAR, 24 HOUR STORM EVENT. THE CRITERIA ARE BASED ON A MINIMUM DOWNSLOPE CONTAINMENT BERM LENGTH OF 100 FEET WITH A FREEBOARD OF 0.5 FT.

STATE OF TEXAS
GREGORY W. ADAMS
73356
LICENSED
PROFESSIONAL ENGINEER

3/31/2026

REVISIONS			
REV	DATE	DESCRIPTION	DWN BY

CONTAINMENT/ DIVERSION BERMS

WASTE MANAGEMENT OF TEXAS, INC. SKYLINE LANDFILL

BME
BIGGS & MATHEWS ENVIRONMENTAL
1700 ROBERT ROAD, STE. 100
MANSFIELD, TEXAS 76063
817-563-1144

TBPELS FIRM NO. F-256 AND NO. 10194895
TBPG FIRM NO. 50222

DRAWING D6C.1

O:\Waste Management\Skyline\Solid Waste\P\Drawings\Part III\Att. D\D6C.1.dwg Layout: Layout1 User: awhite

Diversion Berm Design

Required: Size the diversion berms.

Method:

1. Determine the flow using the Rational Method.
2. Calculate flow capacity using Manning's Method.

References:

1. Dodson's and Associates, Inc., *Hands-On HEC-1,* June 1997.
2. Ponce, Victor M., *Engineering Hydrology Principles and Practices,* 1989.
3. Texas Department of Transportation, Hydraulic Design Manual, Revised October 2011.
4. NOAA Atlas 14 Point Precipitation Frequency Estimates: Ferris, TX

Solution: Diversion berms will be designed to pass the 25-year storm event. The Rational Method (Q=CiA) was used to determine the runoff.

25-Year Rainfall Depth (Pd) =	1.3		(Ref. 4, 25 yr, 10 min. duration)
Time of Concentration (tc) =	10.0	min	(conservative minimum value)
Rainfall Intensity (I) =	8.0	in/hr	(Ref. 3, I = Pd/tc)
Runoff Coefficient (C) =	0.7		
Time of Concentration (tc) =	10	min	
Running berm slope =	0.5	%	
Manning's n =	0.03		
Right side slope =	2	:1	

Drainage Area (ac)	0.5		1.0		1.5	
Peak Flow (cfs)	2.8		5.6		8.4	
Berm Evaluation						
Left Side Slope	3:1	25:1	3:1	25:1	3:1	25:1
Flow Depth (ft)	0.9	0.5	1.1	0.6	1.3	0.7
Flow Area (sf)	2.0	3.4	3.0	4.9	4.2	6.6
Wetted Perimeter (ft)	4.9	13.6	5.9	16.4	7.0	19.1
Velocity (fps)	2.0	1.4	2.2	1.6	2.5	1.7
Berm Capacity (cfs)	4.0	4.7	6.8	7.6	10.6	11.5

Containment Berm Design

Required: Size containment berms to contain contaminated water around the working face.

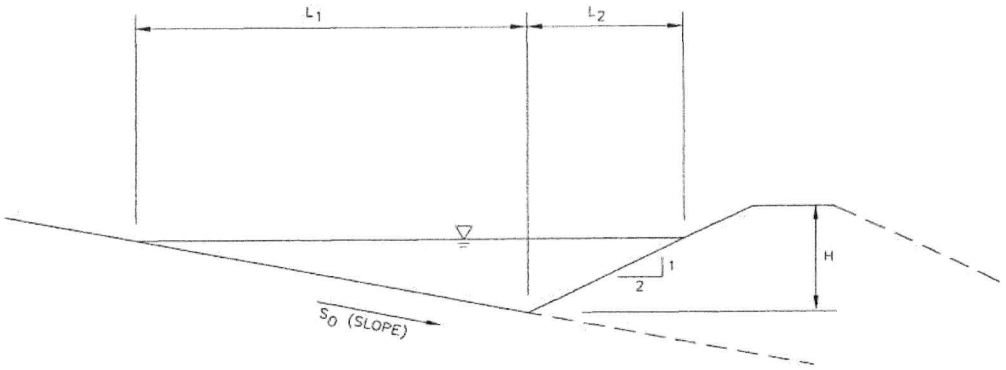
References:
1) Texas Department of Transportation, Hydraulic Design Manual, Revised October 2011.
2) NOAA Atlas 14 Point Precipitation Frequency Estimates: Ferris, TX

Solution: Determine the storage volume required for the 25-year rainfall for Ellis County.

$V_R = CAR$

where: V_R = required storage volume (cf)
C = runoff coeffecient = 0.7
A = drainage area (acres)
R = 25-year rainfall = 7.51 in (24 hr)

Size the storage area from the following figure:



$A_s = (L_1 + L_2)H / 2$ Storage Area = $W(L_1 + L_2)$

where: A_s = cross section area (sf) W = storage width (ft)
$L_1 = H / S_o$
$L_2 = 2H$

Drainage area ac	Required Volume cf	W ft	Storage Area ac	S_o ft/ft	L_1 ft	L_2 ft	H ft	As sf	Vs cf
0.5	9,541	100	0.35	0.01	152	3.0	1.5	118.5	11,854
0.5	9,541	100	0.25	0.02	109	4.4	2.2	123.3	12,334
0.5	9,541	100	0.20	0.04	87	7.0	3.5	163.9	16,394
1	19,083	100	0.50	0.01	218	4.4	2.2	241.9	24,193
1	19,083	100	0.35	0.02	152	6.1	3.0	241.7	24,174
1	19,083	100	0.25	0.04	109	8.7	4.4	256.2	25,616
1.5	28,624	100	0.60	0.01	261	5.2	2.6	348.4	34,838
1.5	28,624	100	0.40	0.02	174	7.0	3.5	315.7	31,574
1.5	28,624	100	0.30	0.04	131	10.5	5.2	368.9	36,887

APPENDIX D6D
SECONDARY CONTAINMENT VOLUME CALCULATIONS

SECONDARY CONTAINMENT CALCULATION

Required:

1. Verify that the secondary containment area will contain a worst-case release from both one 24,500-gallon and one 17,000-gallon storage tanks, in addition to the precipitation from the 25-year, 24-hour rainfall event.

References:

1. NOAA ATLAS 14 Point Precipitation Frequency Estimates, Ferris TX

Solution:

a) ***Provided Volume***

Calculate the provided secondary containment volume.

Length of containment area =	L =	400 ft
Width of containment area =	W =	200 ft
Containment area =	A =	80,000 sf
Containment wall height =	hw=	3 ft
Storage height with 6" of freeboard =	h=	2.5 ft

$$V_{PROVIDED} = A \times h$$

$$\boldsymbol{V_{PROVIDED}} = \mathbf{200{,}000\ cf}$$

b) ***Required Volume***

Calculate the required secondary containment volume. The requried volume is the sum of rainfall volume and tank volume.

Rainfall Volume

Calculate the rainfall volume that will collect in the containment area during the 25 year, 24-hour rainfall event.

From Reference 1, the 25-year, 24-hour rainfall event for Ferris, Texas is 7.5 inches.

Rainfall depth =	D =	7.5 in.	(Ref. 1)
Containment area =	A =	80,000 sf	

$$V_{RAINFALL} = D \times A$$

$$V_{RAINFALL} = 50{,}067\ cf$$

Storage Tank Volume

Tank volume =

$$V_{TANK} = 41{,}500\ gal$$

$$V_{TANK} = 5{,}548\ cf$$

Required Secondary Containment Volume

$$V_{REQUIRED} = V_{RAINFALL} + V_{TANK}$$

$$\boldsymbol{V_{REQUIRED}} = \mathbf{55{,}615\ cf}$$

c) ***Conclusion***

$$\boldsymbol{V_{PROVIDED}} = \mathbf{200{,}000\ cf}$$

$$\boldsymbol{V_{REQUIRED}} = \mathbf{55{,}615\ cf}$$

Therefore, the provided secondary containment area will contain the required worst-case release from the storage tank and precipitation from the 25-year, 24-hour rainfall event.

WASTE MANAGEMENT SKYLINE LANDFILL
DALLAS AND ELLIS COUNTIES, TEXAS
PERMIT AMENDMENT APPLICATION NO. MSW 42E

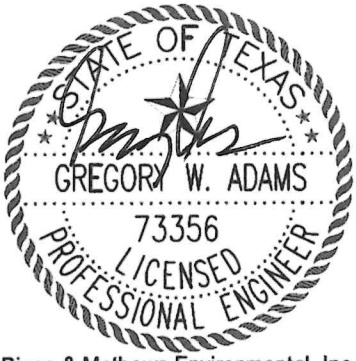
PART III – FACILITY INVESTIGATION AND DESIGN

ATTACHMENT D7
LINER QUALITY CONTROL PLAN

Prepared for

WASTE MANAGEMENT OF TEXAS, INC.

March 2026



Biggs & Mathews Environmental, Inc.
Firm Registration No. F-256

3/31/2026

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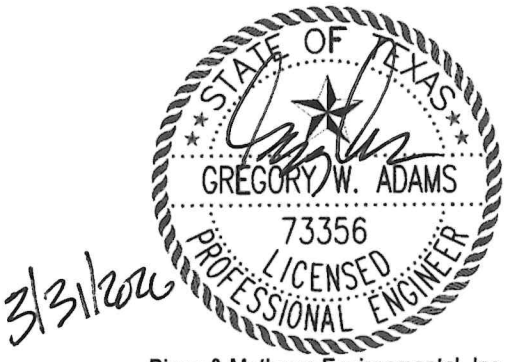

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1 INTRODUCTION

30 TAC §330.339

1.1 Purpose

This Liner Quality Control Plan (LQCP) has been prepared in accordance with the requirements of 30 TAC §330.339 to establish procedures for the design, construction, testing, and documentation of the liner and leachate collection system for the Skyline Landfill.

1.2 Definitions

Specific terms and acronyms that are used in this LQCP are defined below.

ASTM – American Society for Testing and Material

BER – Ballast Evaluation Report

Construction Quality Assurance (CQA) – CQA is a planned system of activities that provides the owner and permitting agency assurance that the facility was constructed as specified in the design. CQA includes the observations, evaluations, and testing necessary to assess and document the quality of the constructed facility. CQA includes measures taken by the CQA organization to assess whether the work is in compliance with the plans, specifications, and permit requirements for a project.

GLER – Geomembrane Liner Evaluation Report

Geotechnical Professional (GP) – The GP is the authorized representative of the operator who is responsible for all CQA activities for the project. The GP must be registered as a Professional Engineer in Texas. Experience and education should include geotechnical engineering, engineering geology, soil mechanics, geotechnical laboratory testing, construction quality assurance and quality control testing, and hydrogeology. The GP must also have competency and experience in certifying similar projects.

CQA Monitors – CQA monitors are representatives of the GP who work under direct supervision of the GP. The CQA monitor is responsible for quality assurance monitoring and performing on-site tests and observations.

Quality Assurance – Quality assurance is a planned program that is designed to assure that the work meets the requirements of the plans, specifications, and permit for a project. Quality assurance includes procedures, quality control activities, and documentation that are performed by the GP and CQA monitor.

Quality Control – Quality control includes the activities that implement the quality assurance program. The GP, CQA monitor, and contractor will perform quality control.

1.3 Sequence of Construction Activities

Generally, construction of lined areas at the Skyline Landfill will proceed in the following sequence of activities:

- The area will be excavated to the proposed subgrade elevations.
- A temporary dewatering system, if required, will be installed as described in Section 3.3.
- The subgrade elevations will be verified.
- The compacted soil liner will be constructed, tested, and verified in accordance with Section 4.
- The SLER will be submitted to the TCEQ.
- The geomembrane liner will be constructed, tested, and verified in accordance with Section 5.
- The leachate collection system will be constructed and verified in accordance with Section 6.
- The protective cover will be constructed and verified in accordance with Section 7.
- The GLER will be submitted to the TCEQ.

2 LINER SYSTEM

30 TAC §330.331

2.1 Liner System

The components of the composite liner system are listed from top to bottom on the following table. Details of the composite liner system are provided in Attachment D3.

Components of the Composite Liner System

Liner System Component	Description	Minimum Thickness
Protective Cover	General Earthfill	24 inches
Leachate Collection Layer	Double-sided geocomposite	0.25 inches
Geomembrane Liner	Textured HDPE geomembrane	60 mil
Compacted Soil Liner	Compacted soil with a coefficient of permeability less than or equal to 1×10^{-7} cm/sec	24 inches

The leachate collection layer will be graded to drain to a collection trench along the centerline of each cell. The leachate collection trench will consist of perforated HDPE pipe encased in aggregate. The leachate collection trench will convey leachate to a sump located along the toe of the side slope. A description of the leachate collection system is provided in Attachment D6, and details of the leachate collection system are provided in Attachment D3.

2.2 Construction Monitoring

Continuous on-site monitoring is necessary to confirm that the components of the liner system are constructed in accordance with this LQCP. In accordance with 30 TAC §330.339(a)(2), the CQA monitor shall provide continuous on-site observation and field sampling and testing as required during the following construction activities:

- Temporary dewatering system (if required) installation.
- Subgrade preparation.
- Compacted soil liner placement, processing, compaction, and testing.
- Geomembrane liner deployment, trial welds, seaming, testing, and repairing.
- Leachate collection layer deployment and seaming.
- Anchor trench backfill.
- Protective cover layer placement.

The GP will document and certify that the liner system was constructed in accordance with this LQCP. The GP shall make sufficient site visits to observe critical construction activities and to verify that the construction and quality assurance activities are performed in accordance with this LQCP.

3 EARTHWORK

30 TAC §§330.337, 330.339

3.1 General

The proposed grading plan (Attachment D1, Drawing D1.5) provides for the landfill floor to slope at 1 percent to the perimeter sidewalls, which will slope at 5H:1V. The fill area will be divided into cells, each of which has a 2 percent cross slope to a leachate collection trench along the centerline of the cell. Collection trenches will slope to sumps located along the perimeter of the landfill. Earthwork activities and testing will be documented in the SLER in accordance with Section 9.2.

3.2 Materials

The following material classifications will be encountered in excavations or will be required for landfill construction.

General Fill

General fill consists of soil that is free from debris, rubbish, solid waste, organic matter, and particles larger than 4 inches in diameter.

Compacted Soil Liner

Compacted soil liner materials consist of soil that is free from debris, rubbish, solid waste, organic matter, and meets the requirements of Section 4.2.

Protective Cover

Protective cover materials consist of soil that is free from debris, rubbish, solid waste, organic matter, and meets the requirements of Section 7.2.

Leachate Aggregate

Drainage aggregate consists of natural or manufactured granular material that meets the requirements of Section 6.2.4.

Anchor Trench Backfill

Anchor trench backfill consists of general fill that is free of particles larger than 1 inch in diameter.

Daily and Intermediate Cover

Daily and intermediate cover materials consist of soil that has not been previously mixed with solid waste.

Topsoil

Topsoil consists of soil that is capable of sustaining vegetation and is free of debris, rubbish, and solid waste.

Unsuitable Materials

Unsuitable materials consist of any material that is determined by the GP to not be suitable for use as classified above.

3.3 Construction Below Groundwater

3.3.1 Highest Measured Water Elevations

The highest measured water elevations will be used as the design groundwater elevations. The most recent groundwater elevations must be reviewed before the construction of each cell and, if necessary, the highest measured water elevations will be adjusted upward.

3.3.2 Temporary Dewatering

Temporary dewatering will be required to construct the liner system in portions of the site that are excavated into Stratum I material that has recorded groundwater. The temporary dewatering system will provide a drainage system to intercept the Stratum I groundwater and convey it to an adjacent open excavation or to a sump from which the groundwater can be pumped into the perimeter drainage system. The temporary dewatering system will be operated to prevent potential uplift of the constructed liner system until sufficient ballast has been placed over the liner system to counteract hydrostatic pressure on the liner system from the Stratum I groundwater and the ballast has been documented in a Ballast Evaluation Report.

As shown on Drawing D7A.1, portions of the side slopes in Cells 19 through 24 will be excavated in Stratum I materials below the highest recorded groundwater levels and these areas will require dewatering. The remainder of the excavation area will be excavated in Stratum I materials where groundwater has not been measured or will be isolated from recharge, or in Stratum II materials that do not convey groundwater. The temporary dewatering system on the side slopes will consist of drainage trenches with either prefabricated composite drains encased in sand or drainage pipe encased in aggregate.

The sidewall drains will discharge into open sumps beyond the lined areas or closed sumps beneath the lined areas. The groundwater will be pumped from the closed sumps into the perimeter drainage system using an automated pump and control system that starts the pump electronically when groundwater levels begin to approach the top of the sump and turns the pump off when it reaches the lower operational limit of the pump. The pump system will be inspected regularly or equipped with a beacon to alert site personnel to pump system malfunctions.

The anticipated location of the temporary dewatering system based on the information from the boring logs is shown in Attachment D3, Drawing D3.6. The actual location of the dewatering system will be adjusted based upon where the Stratum I and II interface is

exposed in the subgrade during construction activities. The design procedures and typical details of the temporary dewatering system are provided in Appendix D7B. Design and installation of the temporary dewatering system will be documented in the Soils and Liner Evaluation Report (SLER) in accordance with the LQCP. The facility will submit a Ballast Evaluation Report (BER) to the TCEQ once it is determined that ballasting or dewatering is no longer necessary. If the TCEQ does not provide a response within 14 days of the date of receipt of the BER, the facility will discontinue dewatering or ballasting operations.

3.4 Excavation

A description of the materials that will be encountered in the excavations is provided in Attachment D5. The slope stability analyses are provided in Attachment D5, Appendix D5B. The slope stability analyses are only valid for the conditions that were analyzed. Any changes to the excavation plan, dewatering system, ballast system, liner system, final cover system, or landfill completion plan will necessitate that the slope stability analyses be revised to reflect the actual conditions. Temporary construction slopes shall not be steeper than the interim slopes and concentrated loadings such as heavy equipment and soil stockpiles should not be placed near the crest of slopes unless additional slope stability analyses are performed.

4 COMPACTED SOIL LINER

30 TAC §§330.337, 330.339

4.1 General

The compacted soil liner component of the composite liner system consists of a 24-inch-thick layer of compacted, relatively homogeneous, cohesive material. The CQA monitor shall provide continuous on-site observation during compacted soil liner placement, compaction, and testing in accordance with 30 TAC §330.339(a)(2). The GP shall make sufficient site visits during compacted soil liner construction to document the construction activities, testing, and thickness verification in the SLER, in accordance with Section 9.2.

4.2 Materials

Compacted soil liner material shall consist of soil that is free from debris, rubbish, frozen materials, foreign objects, and organic material. The required compacted soil liner material properties are summarized in the table below.

Compacted Soil Liner Material Properties

Test	Standard	Required Property
Plasticity Index	ASTM D 4318	15 or greater
Liquid Limit	ASTM D 4318	30 or greater
Percent Passing No. 200 Mesh Sieve	ASTM D 1140	30 or greater
Percent Passing 1-inch Sieve	ASTM D 422	100
Coefficient of Permeability	ASTM D 5084 or COE EM 1110-2-1906 Appendix VII	Less than or equal to 1×10^{-7} cm/sec

Preconstruction testing procedures and frequencies for infiltration layer materials are listed in Section 4.8.1.

4.3 Subgrade Preparation

Prior to placing soil liner material, the subgrade should be graded and proof rolled with heavy, rubber-tired construction equipment to detect soft areas. The GP or CQA monitor must observe the proof-rolling operation. Soft areas should be undercut to firm material then backfilled and compacted with general fill material. The GP will observe the subgrade for signs of groundwater seepage and take appropriate actions, if necessary.

The subgrade elevations shall be verified in accordance with the requirements of Section 4.8.3 prior to the placement of compacted soil liner.

4.4 Placement and Processing

The compacted soil subgrade and surface of each lift should be roughened prior to placement of the next lift of the soil liner. The soil liner material should be placed in maximum 8-inch loose lifts to produce a compacted lift thickness of approximately six inches. The material should be processed to a maximum particle size of 1-inch or less before water is added. Rocks and clods less than 1-inch in diameter should not total more than 10 percent by weight. The surface of the top lift shall contain no material larger than 3/8-inch.

If additional water is necessary to adjust the moisture content, it should be applied after initial processing but prior to compaction. Water should be applied evenly across the lift and worked into the material. Waste or any objectionable material must not contaminate compaction water.

4.5 Compaction

The soil liner shall be compacted with a pad/tamping-foot or prong-foot roller. A footed roller is necessary to bond the lifts, to distribute the water, and to blend the soil matrix through kneading action. Soil liner shall not be compacted with a bulldozer, rubber-tired roller, flat-wheel roller, scraper, truck, or any track equipment unless it is used to pull a footed roller. The compactor should weigh at least 40,000 pounds. The lift thickness shall be controlled to achieve penetration into the top of the previously compacted lift; therefore, the lift thickness should not be greater than the pad or prong length. Cleaning devices on the roller must be in place and maintained to prevent the prongs or pad feet from becoming clogged to the point that they cannot achieve full penetration.

The compactor should make approximately four passes across the area being compacted. A pass is defined as one pass of the compactor, front and rear drums. The material should be compacted to a minimum of 95 percent of the maximum dry density determined by standard Proctor (ASTM D 698) at a moisture content at or above optimum moisture. Areas with failing tests shall be reworked, recompacted, and retested, and passing tests must be achieved before another lift is added.

After a lift is compacted, it must be watered to prevent drying and desiccation until the next lift can be placed. If desiccation occurs, the GP must determine if the lift can be rehydrated by surface application of water or if the lift must be scarified, watered, and recompacted. Following compaction and fine grading of the final lift, the surface of the compacted soil liner shall be smooth drum rolled.

4.6 Protection

The completed compacted soil liner must be protected from drying, desiccation, rutting, erosion, and ponded water until the geomembrane is installed. Areas that undergo excessive desiccation or damage shall be reworked, recompacted, and retested as directed by the GP.

4.7 Tie-In to Existing Liners

The edge of existing compacted soil liners shall be cut back on either a slope or step to prevent the formation of a vertical joint. Details for the tie-in to existing liner are provided in Attachment D3, Drawing D3.2.

4.8 Testing and Verification

4.8.1 Preconstruction Testing

The table below lists the minimum testing required for material proposed for use as compacted soil liner.

Infiltration Layer Material Preconstruction Tests

Test	Standard	Frequency
Plasticity Index	ASTM D 4318	1 per material type
Liquid Limit	ASTM D 4318	1 per material type
Percent Passing No. 200 Mesh Sieve	ASTM D 1140	1 per material type
Percent Passing 1-inch Sieve	ASTM D 422	1 per material type
Standard Proctor Test	ASTM D 698	1 per material type
Coefficient of Permeability	ASTM D 5084 or COE EM 1110-2-1906 Appendix VII	1 per material type

After the moisture density relationship has been determined for a material type, a soil sample should be remolded to about 95 percent of the maximum dry density at the optimum moisture content. This sample will be tested to determine if the soil can be compacted to achieve a suitable coefficient of permeability. Either falling head or constant head laboratory permeability tests may be performed to determine the coefficient of permeability. The permeant fluid for testing must be as required by ASTM D 5084. Distilled or deionized water shall not be used as the permeant fluid.

4.8.2 Construction Testing

All quality control testing will be performed during construction of the liner, except for testing that is required after individual lifts are constructed. The table below lists the minimum testing required for material used as compacted soil liner.

Compacted Soil Liner Material Construction Tests

Test	Standard	Frequency
Field Density	ASTM D 2922	1/8,000 sf per 6-inch lift
Plasticity Index	ASTM D 4318	1/100,000 sf per 6-inch lift
Liquid Limit	ASTM D 4318	1/100,000 sf per 6-inch lift
Percent Passing 1-inch and No. 200 Sieve	ASTM D 1140 ASTM D 422	1/100,000 sf per 6-inch lift
Standard Proctor Test	ASTM D 698	1 per material type
Coefficient of Permeability	ASTM D 5084 or COE EM 1110-2-1906 Appendix VII	1/100,000 sf per 6-inch lift
Moisture Content	ASTM D 2216	1/100,000 sf per 6-inch lift

The Atterberg limits of the in-place compacted soil liner must be compared to the Atterberg limits of the Proctor curve sample to assure that the Proctor curve represents the in-place material. Any variance of more than 10 points between the liquid limit or plasticity index of the in-place soil and those of the Proctor curve sample will require that a new Proctor curve be developed. Permeability testing will be performed on undisturbed samples from the compacted soil liner as described in Section 4.8.1 and all test data will be reported.

4.8.3 Thickness Verification

The as-built thickness of the compacted soil liner shall be determined by standard survey methods. Prior to the placement of liner material, the subgrade elevations will be determined at a minimum rate of one survey point per 5,000 square feet of lined area. After the compacted soil liner is completed, the top of liner elevations will be determined at the same locations as the subgrade elevations.

5 GEOMEMBRANE LINER

30 TAC §§330.331, 330.339

5.1 General

The geomembrane liner (GM) component of the composite liner system consists of a textured 60-mil-thick high-density polyethylene (HDPE) geomembrane placed over the compacted soil liner. The CQA monitor shall provide continuous on-site observation during GM deployment, trial welds, seaming, testing, and repairing in accordance with 30 TAC §330.339(a)(2). The GP shall make sufficient site visits during the GM installation to document the installation and testing in the GLER, in accordance with Section 9.3.

5.2 Materials

5.2.1 Properties

GM selected for liner system construction shall consist of smooth or textured HDPE geomembrane produced from virgin raw materials. Recycled materials are not acceptable. The GM shall not be manufactured from resin from differing suppliers. The GM shall meet the requirements in the most current revisions of Geosynthetics Research Institute (GRI) Standard GM13 (HDPE). A copy of the current revision of GRI GM13 is included in Appendix D7E.

Manufacturer quality control testing procedures and frequencies for GM are listed in Section 5.5.1. Third party conformance testing procedures and frequencies for GM are listed in Section 5.5.2.

5.2.2 Delivery and Storage

GM shall be shipped in rolls labeled with the manufacturer's name, roll number, and lot or batch number. The CQA monitor shall inspect the rolls for shipping damage and complete a geosynthetics receipt log for all materials delivered to the site.

Upon delivery of the geomembrane, the CQA monitor will observe that:

- Equipment used to unload and store the rolls or pallets does not damage the geomembrane.
- The geomembrane is stored in an acceptable location and not stacked more than three rolls high.
- The geomembrane is protected from puncture, dirt, grease, water, moisture, and excessive heat, or other damage.
- All manufacturing documentation required by the specifications has been received and reviewed for compliance with the specifications.
- The geomembrane receipt log form has been completed for all materials received.

Damaged geomembrane may be rejected and removed from the site or stored at a location separate from accepted geomembrane.

5.3 Preparation

The surface of the compacted soil liner shall be protected until the GM is installed in accordance with Section 4.6. Prior to installation of the GM the compacted soil liner shall be tested and verified in accordance with Section 4.8, and the GP or CQA monitor and geosynthetics installer shall inspect the surface of the soil liner to verify that:

- The compacted soil liner surface has been smooth drum rolled.
- The compacted soil liner surface is free of irregularities, soft areas, or loose soil.
- The compacted soil liner surface is free of stones, protrusions, or objects that could damage the GM.

The geosynthetics installer must accept the condition of the compacted soil liner and sign a subgrade acceptance form prior to the installation of the GM.

5.4 Installation

5.4.1 Deployment and Placement

The following activities must take place prior to GM deployment:

- The manufacturer's quality control and third-party conformance tests shall be completed and approved by the GP in accordance with the requirements of Section 5.5.
- The GP or CQA monitor and geosynthetics installer shall approve the subgrade in accordance with the requirements of Section 5.3.
- The geosynthetics installer shall sign the subgrade acceptance form.
- The geosynthetics installer shall submit a drawing showing the proposed panel layout.

GM shall be deployed by equipment that will unroll the GM without damaging, crimping, or stretching it, and deployment equipment must not damage the underlying compacted soil liner. GM must not be deployed during periods of rain or high winds and shall not be deployed on frozen subgrade. The installer must only deploy the amount of GM that can be seamed on the same day. The GM shall be installed in direct and uniform contact with the underlying compacted soil liner.

Upon deployment, each panel shall be assigned a unique identification number. All panels must be anchored with adequate ballast to prevent uplift from wind. Smoking and damaging shoes shall not be permitted on the liner and only low-ground pressure supporting equipment shall be allowed on the GM.

During GM placement, the CQA monitor must:

- Provide full-time observation.

- Record panel numbers, panel dimensions, and roll numbers on the panel layout drawing.
- Record weather conditions.
- Observe the condition of the subgrade and note any deficiencies. All deficiencies shall be repaired and approved by the CQA monitor.
- Observe the condition of the GM and note any defects. All defects must be repaired in accordance with the requirements of Section 5.4.4.
- Observe that people working on the GM do not smoke, wear shoes that could damage the GM, or engage in activities that could damage the GM.
- Observe that the deployment method minimizes wrinkles, and that the GM is anchored to prevent movement from wind.
- Observe that no more panels are deployed than can be seamed on the same day.
- Observe that there are no horizontal seams on side slopes and that the textured GM material extends a minimum of five feet past the toe of slopes.

Any panels that are not deployed in accordance with this section shall be marked by the CQA monitor and repaired in accordance with Section 5.4.4 or be removed and replaced by the installer.

5.4.2 Seaming

Seaming shall be performed in accordance with methods approved or recommended by the geomembrane manufacturer. Only welding apparatus and operators that have completed approved trial welds, in accordance with Section 5.5.3, shall be allowed to weld panel seams. Each seam shall be assigned a unique number, which is preferably consistent with the panel numbering system. Prior to welding, the proper panel overlap shall be provided; dirt, grease, and free moisture shall be cleaned from the panel contact area; and wrinkles shall be removed as much as practical. For extrusion welds, oxidation shall be ground from the seam area within one hour of the welding operation and the extrudate shall be purged from the extrusion welding apparatus. Seaming operations shall not be allowed when the ambient temperature is below 40°F or above 104°F unless trial welds have demonstrated that adequate welds can be achieved outside these limits.

During GM seaming operations, the CQA monitor must:

- Provide full-time observation.
- Record seam numbers on the panel layout drawing.
- Record weather conditions.
- Observe that only approved welding apparatus and operators are allowed to weld seams.
- Observe the condition of the seams and note any defects. All defects must be repaired in accordance with the requirements of Section 5.4.4.
- Observe that people working on the GM do not smoke, wear shoes that could damage the GM, or engage in activities that could damage the GM.
- Observe that the seams are free of grease, dirt, moisture, and wrinkles.
- Observe that welding operations take place within the approved ambient temperature range.

- Observe that seam grinding has been completed less than one hour before extrusion welding and the extrudate has been purged from extrusion welders.
- Observe that there are no horizontal seams on side slopes.

5.4.3 Anchor Trenches

The GM anchor trench shall be left open until the seaming is completed. Expansion and contraction of the GM should be accounted for during deployment. The top corner of the anchor trenches shall be rounded to prevent crimping the GM. The bottom of the anchor trench shall be dry, stable and be free of loose particles and rocks. Anchor trenches shall be backfilled with compacted general fill that is free of particles larger than one inch in diameter. The anchor trenches shall be backfilled and compacted in a manner that does not damage or induce stress to the GM.

5.4.4 Repairs

Geomembrane repairs shall be performed in strict accordance with the methods approved or recommended by the geomembrane manufacturer. Defects in the GM, defects in seams, failing destructive tests, failing nondestructive tests, holes from nondestructive tests, and destructive test sample locations shall be repaired by one of the following repair techniques:

- Patching - used to repair large holes, tears, large GM defects, and destructive test locations.
- Extrusion - used to repair small GM defects, cuts, holes from nondestructive tests, and seam defects less than ½-inch long.
- Capping - used to repair failed seams or seams where nondestructive tests cannot be performed.
- Removal - used to replace areas with large defects where other repair techniques are not appropriate.

Repair procedures include the following:

- Abrade geomembrane surfaces to be repaired (extrusion welds only) no more than one hour prior to the repair.
- Clean and dry all surfaces at the time of repair.
- Extend patches or caps at least six inches beyond the edge of the defect, and round all corners of material to be patched and the patches to a radius of at least three inches. Bevel the top edges of patches prior to extrusion welding.

Destructive and non-destructive testing will be performed on all repairs in accordance with Section 5.5.4.

5.5 Testing and Verification

5.5.1 Manufacturer's Quality Control Testing

The GM manufacturer shall test the geomembrane and raw materials in accordance with GRI Standard GM13 to assure the quality of the material. Resin shall be tested at a frequency of one test per 200,000 lbs and every resin lot for density and melt flow index. See Appendix D7E for testing methods.

5.5.2 Conformance Testing

Conformance samples of the GM shall be cut across the full width of selected rolls in accordance with the test frequency specified in the table below. Conformance samples may be taken at the manufacturing plant or at the project site and will be forwarded to a third-party laboratory for testing. Material property requirements are provided in Section 5.2.1. Minimum conformance testing requirements are provided in below.

Geomembrane Conformance Tests

Test	Standard	Frequency
Sheet Thickness	ASTM D 5199, 1593, or 5994	1 per 100,000 sf and every resin lot
Specific Gravity	ASTM D 1505	1 per 100,000 sf and every resin lot
Carbon Black Content	ASTM D 1603	1 per 100,000 sf and every resin lot
Carbon Black Dispersion	ASTM D 3015 or 5596	1 per 100,000 sf and every resin lot
Tensile Properties	ASTM D 638	1 per 100,000 sf and every resin lot

5.5.3 Trial Welds

Each operator and welding apparatus must be tested to verify that seam welds that meet the specifications can be achieved under the site conditions. Trial welds must be performed at the beginning and midpoint of each day for each operator and apparatus used that day. If welding continues past 6:00 p.m., additional trial welds may be required.

The trial weld samples shall be three feet long and 12 inches wide, with the seam centered lengthwise. At least four 1-inch-wide coupons will be cut from each trial weld sample. Two coupons from each sample will be tested for shear and two samples will be tested for peel. Peel test coupons for dual-track welds shall be tested on both sides of the air channel. Each coupon must meet the minimum strength requirements listed in the Geomembrane Seam Properties table and exhibit a Film Tear Bond (FTB). If the trial weld fails, two more trial seams must be welded and tested. This process will continue until passing trial welds are achieved.

The CQA monitor must observe the trial welding operations and document the operator's initials, apparatus number, time, date, air temperature, apparatus temperature, and peel and shear test results. If the CQA monitor believes that an operator or apparatus is not

functioning properly, or if the weather conditions have substantially changed since the trial welds were performed, new trial welds must be performed.

5.5.4 Construction Testing

Nondestructive Tests

Nondestructive seam tests include vacuum testing and air pressure testing. Nondestructive testing shall be performed for the entire length of each seam by the GM installer.

Vacuum testing shall be used to test extrusion-welded seams and fusion-welded seams that cannot be tested by air pressure methods. The vacuum box shall be placed over a seam section, which has been thoroughly saturated with a soapy water solution. The rubber gasket on the bottom of the vacuum box must seal against the GM to prevent leaks. The vacuum box pressure shall be reduced to about three to five inches of Hg. Soap bubbles will indicate the presence of holes or non-bonded seams. The vacuum box dwell time shall be at least 10 seconds.

Air pressure testing shall be used to test fusion-welded seams that have an air channel. Both ends of the air channel shall be sealed and air shall be pumped into the channel to at least 30 psi or 1/2 psi per mil of thickness, whichever is greater. The air channel must sustain the pressure for at least five minutes, without more than a 4-psi pressure drop. Following a passing pressure test, the pressure shall be released from the end of the seam that is opposite of the pressure gauge. The pressure gauge must return to zero; if it does not, the seam is probably blocked. After the blockage has been located, the seam shall be pressure tested on both sides of the blockage. All penetration holes shall be sealed after the air pressure testing is completed.

During the nondestructive testing, the CQA monitor must:

- Observe that equipment and operators perform the tests properly.
- Observe that the entire length of each seam is tested and record the results of the test.
- Identify failed seams and inform the installer of any required repairs.
- Record all completed and tested repairs.

Destructive Tests

Destructive testing shall be performed at a frequency of one stratified test location per 500 linear feet of seam. Repairs over 15 feet long shall be included in the total seam length. Additional destructive test samples may be taken if deemed necessary by the geotechnical professional or his representative. Destructive test samples should be 45 inches long by 12 inches wide with the seam centered along the length of the sample.

Two coupons should be cut from each end of the sample and the installer must test these coupons with a tensiometer capable of measuring the seam strength. The installer shall test two coupons in shear and two coupons in peel. For double wedge-welded seams, both sides of the air channel shall be tested in peel. The CQA monitor must observe the tests and record the results on the destructive testing log. The minimum requirements for

destructive testing are provided in the Geomembrane Seam Properties table. If one of the coupons fails in either peel or shear, the installer shall reconstruct the entire seam between passed test locations or take additional samples 10 feet in both directions of the failed test. If the additional tests pass, the contractor shall reconstruct or cap the seam between the passing test locations. If the additional tests fail, the sampling and testing procedure shall be repeated until the length of the faulty seam is established.

If the field test results are satisfactory, the remaining sample shall be divided into three parts: one-third for the installer, one-third for third-party testing, and one-third for the owner to archive. The third-party testing shall test five coupons from each sample in shear and test five coupons from each sample in peel (10 when testing both inner and outer welds of dual-track welds). The minimum requirements for destructive testing are provided in the table below. If the third-party test fails in either peel or shear, the installer shall reconstruct the entire seam between passed test locations or take additional samples 10 feet in both directions of the failed test. If the additional tests pass, the contractor shall reconstruct or cap the seam between the passing test locations. If the additional tests fail, the sampling and testing procedure shall be repeated until the length of the faulty seam is established. All seams shall be bracketed by passing third-party tests; field test results shall not be used for final acceptance.

Geomembrane Seam Properties

Test	Standard	Frequency	Minimum Criteria
Shear	ASTM D 4437	1 sample per 500 feet of seam	All field specimens and four of five third-party specimens from each sample must have a shear strength greater than or equal to 95% of sheet strength but not less than 120 ppi. All field specimens and the average shear strength value of all third-party specimens must be greater than or equal to 95% of sheet strength but not less than 120 ppi.
Peel	ASTM D 4437	1 sample per 500 feet of seam	All field specimens and four of five third-party specimens from each sample must have a peel strength greater than or equal to 62% of sheet strength but not less than 78 ppi. All field specimens and the average peel strength value of all third-party specimens must be greater than or equal to 62% of sheet strength but not less than 78 ppi. Both sides of dual track seams shall meet the minimum criteria. Each track is considered a separate sample. All specimens shall exhibit Film Tear Bond.

During destructive seam testing, the CQA monitor must:

- Select sample locations and observe sample cutting.
- Assign sample numbers and label samples.
- Observe installer-performed tests.
- Record sample locations, sample number, sample purpose, and field test results.

6 LEACHATE COLLECTION SYSTEM

30 TAC §330.333

6.1 General

The leachate collection system consists of the collection layer, collection trenches, piping, and sumps. Details of the leachate collection system design are included in the construction details in Attachment D3. The design capacity calculations are provided in Attachment D6, Appendix D6A. Material properties are described in Section 6.2. The CQA monitor shall provide on-site observation during leachate collection layer and piping installation in accordance with 30 TAC §330.339(a)(2). The GP shall make sufficient site visits during the leachate collection system installation to document the installation in the GLER, in accordance with Section 9.3.

6.2 Materials

6.2.1 Geocomposite

The leachate collection layer consists of a double-sided geocomposite drainage net installed above the GM. The geocomposite shall have the minimum properties listed in the table below.

Geocomposite Properties

Material	Test	Standard	Required Property
Geotextile	Material		Nonwoven polypropylene or polyester
	Apparent Opening Size	ASTM D 4751	70 sieve maximum
	Unit Weight	ASTM D 5261	6 oz/yd^2 nominal
	Grab Strength	ASTM D 4632	150 lb
	Puncture Strength	ASTM D 6241	300 lb
HDPE Drainage Net	Specific Gravity	ASTM D 1505	0.93 g/cm^3
	Thickness	ASTM D 5199	250 mil
	Carbon Black	ASTM D 1603	Minimum 2%, maximum 3%
	Tensile Strength	ASTM D 7179	40 lb/in
	Transmissivity	ASTM D 4716	3 x 10^{-3} m^2/sec

Manufacturer quality control testing procedures for geocomposite are listed in Section 6.5.1.

6.2.2 Geotextile

Nonwoven geotextile filter fabric will be wrapped around the aggregate installed for leachate collection trenches and sumps. The geotextile shall have the minimum properties listed in the table below.

Geotextile Properties

Test	Standard	Required Property
Material		Nonwoven polypropylene or polyester
Apparent Opening Size	ASTM D 4751	70 sieve maximum
Unit Weight	ASTM D 5261	6 oz/yd^2
Grab Strength	ASTM D 4632	150 lb
Tear Strength	ASTM D 4533	60 lb
Puncture Strength	ASTM D 4833	300 lb

Manufacturer quality control testing procedures for geotextile are listed in Section 6.5.1.

6.2.3 HDPE Leachate Piping

The leachate collection system piping includes perforated HDPE collection trench pipes and solid sidewall riser pipes. The pipe shall have the minimum SDR rating and perforation schedule shown on the construction details in Attachment D3.

6.2.4 Leachate Aggregate

Leachate aggregate will be placed in the collection trenches and in the sumps. The aggregate shall consist of manufactured or natural materials having the properties listed in the table below. Alternate gradations may be approved by the GP.

Leachate Aggregate Properties

Test	Standard	Required Property	
Gradation	ASTM D 422	Sieve 1" 1/2" 3/8"	% Passing 90-100 20-50 0-15
Hydraulic Conductivity	ASTM D 2434	≥ 1 x 10^{-2} cm/sec	
Carbonate Content	JLT-S-105-89 or ASTM D 3042[a]	Maximum 15% loss	

[a] Use an HCL solution having a pH of 5 or lower.

Conformance testing procedures and frequencies for leachate aggregate are listed in Section 6.5.2.

6.2.5 Delivery and Storage

Geocomposite and geotextile shall be shipped in rolls with opaque wrappers labeled with the manufacturer's name, roll number, and lot or batch number. The CQA monitor shall inspect the rolls for shipping damage and complete a geosynthetics receipt log for all materials delivered to the site. Damaged rolls shall be rejected.

The geocomposite, geotextile, and pipe shall be unloaded and handled with equipment that does not cause damage. Rolls should not be pushed, slid, or dragged to the storage location. The geocomposite and geotextile must not be stored on wet, soft, or rocky subgrade, but must be stored on a stable subgrade. Geocomposite and geotextile must not be stacked more than three rolls high to avoid crushing the roll cores. The stored geocomposite, geotextile, and pipe must be protected from puncture, grease, dirt, excessive heat, or other damage.

6.3 Preparation

Prior to installation of the leachate collection layer, the GM shall be tested and verified in accordance with Sections 4.8 and 5.5. The CQA monitor shall observe that the surface to receive the geosynthetics is free of debris, stones, and dirt and verify that the conformance documentation has been submitted and approved.

6.4 Installation

6.4.1 Geocomposite and Geotextile

Geocomposite and geotextile shall be deployed by equipment that will not damage, crimp, or stretch it nor damage any underlying liner. All panels must be anchored with adequate ballast to prevent uplift from wind. Smoking and damaging shoes shall not be permitted on the geocomposite or geotextile and only low-ground pressure supporting equipment shall be allowed on the liner. Adjacent rolls of geocomposite shall be securely tied through the drainage net with plastic fasteners every five feet along the length of the panel and every 6 inches along the ends of the panels. Adjacent rolls of geotextile shall be overlapped and sewn or heat bonded together.

During drainage layer placement, the CQA monitor must:

- Provide full time observation.
- Record weather conditions.
- Observe the condition of the geocomposite and geotextile and note any defects. All defects must be repaired or replaced.
- Observe that people working on the GM do not smoke, wear shoes that could damage the GM, or engage in activities that could damage the GM.
- Observe that the deployment method minimizes wrinkles in the GM and the geocomposite.
- Observe that the geocomposite and geotextile panels have been properly tied and seamed.

Any panels that are not installed in accordance with this section shall be marked by the CQA monitor and be repaired or removed and replaced by the installer.

6.4.2 Pipe

Leachate collection pipe shall be placed to the lines and grades shown on the plans. The pipe shall be joined in accordance with the manufacturer's recommendations and project specifications. Construction equipment shall not be allowed to travel directly over the collection pipes to prevent crushing or excessive deflection until protective cover has been placed.

During pipe placement, the CQA monitor must:

- Provide full-time observation of construction activities.
- Observe the condition of the pipes and note any defects. All defective pipes must be replaced.
- Observe that construction equipment does not damage pipes, geotextile, geocomposite, or GM.
- Observe that the perforations and pipe orientation are in accordance with the plans and specifications.
- Observe that the pipes and fittings are joined in accordance with the manufacturer's recommendations.

Any pipes that are not installed in accordance with this section shall be marked by the CQA monitor and be repaired or removed and replaced by the installer.

6.4.3 Leachate Aggregate

Leachate aggregate shall be placed in the collection trenches and sumps to the lines and grades shown on the plans. During leachate aggregate placement, the CQA monitor must:

- Observe that leachate aggregate is placed in accordance with the plans and specifications.
- Observe that the leachate aggregate is consistent with the conformance test samples.
- Observe that leachate aggregate placement activities do not dislodge or damage leachate pipes or underlying geosynthetics.

6.5 Testing and Verification

6.5.1 Manufacturer's Testing

The geocomposite manufacturer shall test the geocomposite to assure the quality of the geocomposite. Material property requirements are provided in Section 6.2.1. Minimum manufacturer's testing requirements are provided in the Geocomposite Manufacturer's Tests table below. The manufacturer's testing shall be conducted at a minimum frequency of 1 test per 100,000 sf of material.

Geocomposite Manufacturer's Tests

Material	Test	Standard
Geotextile	Weight	ASTM D 5261
	Apparent Opening Size	ASTM D 4751
	Grab Strength	ASTM D 4632
	Puncture Strength	ASTM D 6241
HDPE Drainage Net	Specific Gravity	ASTM D 1505
	Thickness	ASTM D 5199
	Carbon Black	ASTM D 4218
Geocomposite	Transmissivity	ASTM D 4716

The geotextile manufacturer shall test the geotextile to assure the quality of the geotextile. Material property requirements are provided in Section 6.2.2. Minimum manufacturer's testing requirements are provided in the table below. The manufacturer's testing shall be conducted at a minimum frequency of 1 test per 100,000 sf of material.

Geotextile Manufacturer's Tests

Test	Standard
Weight	ASTM D 5261
Apparent Opening Size	ASTM D 4751
Grab Strength	ASTM D 4632
Tear Strength	ASTM D 4533
Puncture Strength	ASTM D 6241

The leachate piping manufacturer shall provide a certification that the pipe meets the minimum SDR rating and perforation schedule shown on the plans and specifications.

6.5.2 Construction Testing

The leachate aggregate shall be tested to assure that the aggregate meets the specifications. Material property requirements are provided in Section 6.2.4. Minimum construction testing requirements are provided in the table below.

Leachate Aggregate Construction Tests

Test	Standard	Frequency
Gradation	ASTM D 422	1 per source
Hydraulic Conductivity	ASTM D 2434	1 per source
Carbonate Content	JLT-S-105-89 or ASTM D 3042[a]	1 per source

[a] Use an HCL solution having a pH of 5 or lower.

6.5.3 Verification

The as-built location of the leachate piping shall be determined and reported in the GLER. All components of the leachate collection system shall be verified and documented in the GLER in accordance with Section 9.3.

7 PROTECTIVE COVER

30 TAC §330.339

7.1 General

The protective cover component of the composite liner system consists of a 24-inch-thick layer of soil placed over the leachate collection layer. The drainage aggregate around the leachate collection pipes will extend through the protective cover to form a chimney drain for the leachate collection system. The CQA monitor shall provide continuous on-site observation during protective cover placement to assure that protective cover placement does not damage underlying geosynthetics (geomembrane liner and geocomposite leachate collection layer) in accordance with 30 TAC §330.339(a)(2). The GP shall make sufficient site visits during protective cover placement to document the construction activities, testing, and thickness verification in the GLER in accordance with Section 9.3.

7.2 Materials

Protective cover material shall consist of soil that is free from debris, rubbish, frozen materials, foreign objects, and organic material, or any material that could damage the underlying geosynthetics. Since drainage aggregate chimneys will be provided above the LCS trenches, there are no permeability requirements for protective cover materials.

7.3 Preparation

Prior to placing the protective cover material, the top of compacted soil liner elevations shall be verified in accordance with the requirements of Section 4.8.3 and all testing on the underlying geosynthetics shall be completed.

7.4 Placement

The protective cover shall be placed in a manner that minimizes the potential to damage the underlying geosynthetics. Hauling equipment shall be restricted to haul roads of sufficient thickness to protect the underlying geosynthetics. The protective cover shall be dumped from the haul road and spread by low ground pressure equipment in a manner that minimizes wrinkles and stress in the geosynthetics. On sidewalls, protective cover shall be placed from the bottom to the top. The minimum separation distances between construction equipment and the geosynthetics are listed in the table below.

Minimum Separation Distance

Equipment Ground Pressure (psi)	Minimum Separation Distance (in)
< 4	12
4 - 8	18
8 - 16	24
> 16	36

Any geosynthetic material that, in the opinion of the CQA monitor, has been damaged by the protective cover layer placement must be repaired and retested in accordance with Sections 5 and 6.

7.5 Testing and Verification

7.5.1 Preconstruction Testing

If the protective cover is counted as ballast against hydrostatic forces, the field density of the in-place protective cover shall be determined at a rate of 1 test per 10,000 sf. The in-place field density will be determined for information only, and there is no minimum compaction requirement for protective cover.

7.5.2 Thickness Verification

The as-built thickness of the protective cover layer shall be determined by standard survey methods. Prior to the placement of protective cover, the top of the underlying compacted soil liner elevations will be determined at a minimum rate of one survey point per 5,000 square feet of lined area. After the protective cover is completed, the top of the protective cover elevations will be determined at the same locations.

8 BALLAST

30 TAC §330.337

8.1 General

The highest measured water elevations are presented in Appendix D7A and represent the highest groundwater elevations that have been encountered at the site. The highest measured water levels will be used as the design groundwater elevations. The most recent groundwater elevations must be reviewed before the construction of each cell and, if necessary, the highest measured water levels must be adjusted upward. Lined areas will be dewatered during and after construction using a temporary dewatering system as described in Section 3.3.2.

If required, long-term hydrostatic uplift pressures will be resisted by the weight of the materials placed above the geomembrane liner in accordance with §330.337. Ballast includes the weight of the leachate collection system, protective cover, and compacted waste. The ballast will be documented in the BER in accordance with Section 9.4.

8.2 Ballast Geometry

If temporary dewatering is required in lined area, the GP will prepare calculations to determine the geometry of the ballast that is required to prevent hydrostatic uplift of the liner system with a minimum factor of safety of 1.5. Procedures for calculating the height of compacted waste or additional protective cover soil above the liner system needed to ballast hydrostatic pressure are provided in Appendix D7C of this attachment, along with example calculations.

8.3 Ballast Materials

Ballast will consist of protective cover, leachate aggregate, infiltration layer, erosion layer, and solid waste. Material properties for protective cover are listed in Section 7.2 and material properties for leachate aggregate are listed in Section 6.2.4. Solid waste ballast will consist of waste accepted at the site in accordance with the Site Operating Plan. Large, bulky items must be excluded from the initial 5 feet of waste ballast.

8.4 Ballast Placement

Landfill personnel will be on site full-time during the placement of the first five feet of waste over the liner system. They will verify and document that the initial five feet of waste does not contain large, bulky items which could damage the liner system, or which cannot be compacted to the required density. Waste ballast must be compacted to a density of not less than 1,200 lb/cy or 44 pcf. The site manager will document that the waste used for ballast has been compacted with multiple passes of a wheeled compactor that weighs more than 40,000 pounds. The form to be used by the landfill manager is included in

Appendix D7D. This documentation will be placed in the site operating record and attached to the BER.

8.5 Testing and Verification

Where protective cover is used as ballast, it will be tested in accordance with Section 7.5.1 and test results will be used to calculate the required ballast thickness. Where protective cover is not tested, the protective cover will be assumed to have a density of 90 percent of the maximum dry density of the material. Waste ballast compaction will be verified by the site manager and documented on the Waste-for-Ballast Placement Record. The GP will verify that the temporary dewatering system prevented uplift forces on the liner during construction of the liner. The verification will include observations of water levels in the dewatering sumps or survey data as deemed appropriate by the GP. The site manager will document that the dewatering system remained operational until ballast was placed. The documentation will be placed in the site operating record.

Once the calculated height of compacted waste has been achieved for each cell area, the temporary dewatering system no longer needs to remain operational, and the groundwater can be allowed to rebound against the bottom of the liner system. Before submittal of the BER, the GP will review compaction information and density of material used as ballast, and the thickness of all materials used in Ballast Calculations. A BER must be submitted to the TCEQ in accordance with Section 9.4 to document that adequate ballast height has been achieved and to request that the temporary dewatering system operations be discontinued.

9 DOCUMENTATION

9.1 Reports

Each report shall be submitted to the TCEQ and shall be prepared in accordance with the methods and procedures contained in this LQCP. The evaluated area should not be used for the receipt of solid waste until acceptance is received from the executive director. The executive director may respond to the permittee either verbally or in writing within 14 days from the date on which the document is received by the TCEQ. For documents transmitted to the TCEQ via the online portal, the day of transmission shall be considered the date on which the document was received by the TCEQ. Verbal acceptance may be obtained from the executive director, which will be followed by written concurrence. If no response, either written or verbal, is received within 14 days, the SLER or GLER shall be considered accepted, and the owner or operator may continue facility construction or operations. Each report must be signed and, where applicable, sealed by the individual performing the evaluation and countersigned by the site operator or his authorized representative.

Markers will be placed to identify all disposal areas for which a SLER/GLER has been submitted and accepted by the executive director. These markers shall be located so that they are not destroyed during operations. The surface of a liner should be covered with a layer of solid waste within a period of six months to mitigate the effects of surface erosion and rutting due to traffic. Liner surfaces not covered with waste within six months shall be checked by the GP or other qualified personnel, who shall then submit a letter report on his findings to the executive director. Any required repairs shall be performed properly. A new report shall be submitted on the new construction for all liners that need repair due to damage.

9.2 Soils and Liner Evaluation Report

After construction of the compacted soil liner, the GP will submit a Soils and Liner Evaluation Report (SLER) to the TCEQ on behalf of the owner. Preparation and submission of the SLER shall be in accordance with TCEQ MSWR. The purpose of the SLER is to document that the construction methods and test procedures are consistent with this LQCP, the TCEQ MSWR, and the project specifications.

At a minimum, the SLER will contain the properly completed TCEQ SLER form and necessary documents to supplement the form including:

- A summary of all construction activities.
- A summary of all laboratory and field test results.
- Sampling and testing location drawings.
- A description of significant construction problems and the resolution of these problems.
- Record drawings.
- A statement of compliance with the LQCP.

- Updated highest measured water levels.
- A detailed description of the temporary dewatering system, if required.
- The seal and signature of the GP and assistant GP, if applicable, in accordance with the Texas Engineering Practice Act.

9.3 Geomembrane Liner Evaluation Report

After construction of the geosynthetics portion of the liner, the GP will submit a Geomembrane Liner Evaluation Report (GLER) to the TCEQ on behalf of the owner. Preparation and submission of the GLER shall be in accordance with TCEQ MSWR. The purpose of the GLER is to document that the construction methods and test procedures are consistent with this LQCP, the TCEQ MSWR, and the project specifications.

At a minimum, the GLER will contain the properly completed TCEQ GLER form and necessary documents to supplement the form including the following:

- A summary of all construction activities.
- A summary of all laboratory and field test results.
- Sampling and testing location.
- A description of significant construction problems and the resolution of these problems.
- Record drawings.
- A statement of compliance with the LQCP.
- Updated highest measured water levels.
- A brief description of the temporary dewatering system.
- Calculations for the required ballast thickness.
- The seal and signature of the GP and assistant GP, if applicable, in accordance with the Texas Engineering Practice Act.

9.4 Ballast Evaluation Report

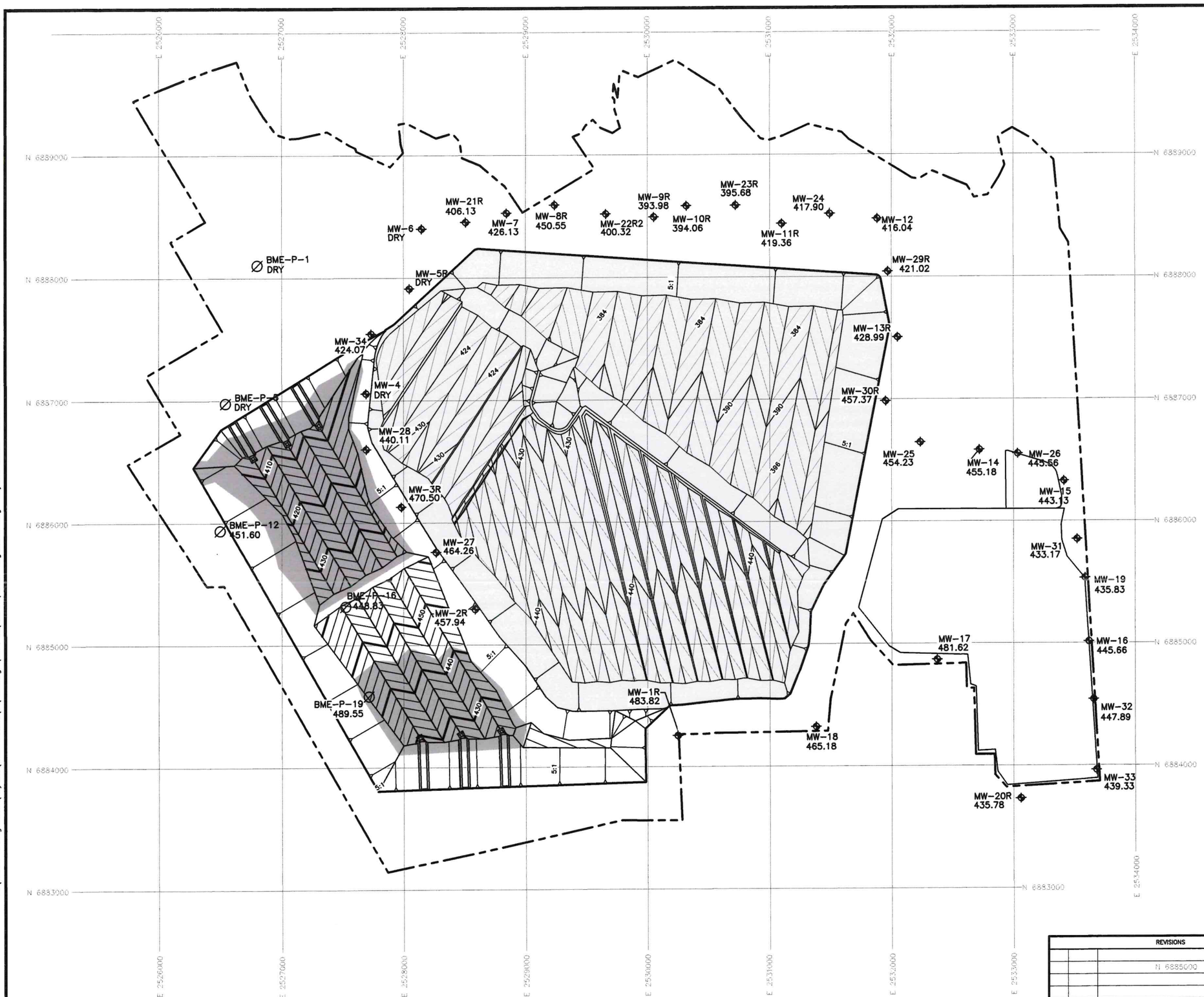
For areas where waste is used for ballast, a BER will be completed and submitted to the TCEQ. The purpose of the BER is to document that sufficient ballast has been placed to offset the potential long-term hydrostatic uplift forces that may exist below the liner system. The BER will provide documentation that the temporary groundwater control system is no longer required. The BER shall include the following information:

- Names and phone numbers of contact persons.
- Certification from the owner of the type of waste placed in the lower five feet and documentation of the compaction from the Site Operating Record (see form in Appendix D7D).
- Survey of the top of waste to document that the required thickness has been placed.
- Documentation that any dewatering system used to lower the groundwater level during liner construction was in effect throughout the completion of the ballast placement.

- Documentation that the highest measured water level has not increased from that presented in Appendix D7A, or that additional ballast has been provided to compensate for upward changes in the high water table during ballast placement.
- The signature and seal of the registered professional engineer performing the evaluation and the signature of the owner's authorized representative.

If adequate ballast is placed on a liner as part of the construction process it will be documented in the GLER. If it is documented in the GLER that adequate ballast is present to counteract any hydrostatic uplift, a separate BER will not be required or submitted for that particular liner installation.

APPENDIX D7A
HIGHEST MEASURED WATER LEVELS



NOTE:

1. CONTOURS DEPICT EXCAVATION GRADES.

STATE OF TEXAS
GREGORY W. ADAMS
73356
LICENSED
PROFESSIONAL ENGINEER

3/31/2026

REVISIONS			
REV	DATE	DESCRIPTION	DWN BY
		N 6885000	

HIGHEST MEASURED WATER LEVELS

WASTE MANAGEMENT OF TEXAS, INC. SKYLINE LANDFILL

BIGGS & MATHEWS ENVIRONMENTAL
1700 ROBERT ROAD, STE. 100
MANSFIELD, TEXAS 76063
817-563-1144

TBPELS FIRM NO. F-256 AND NO. 10194895
TBPG FIRM NO. 50222

DRAWING D7A.1

O:\Waste Management\Skyline\Solid Waste\P\Drawings\Part III\Att. D\D7A.1-HighWater.dwg Layout: D7A.1 User: awhite

APPENDIX D7B
TEMPORARY DEWATERING SYSTEM

Temporary Dewatering System Design
Sideslope Drains

Required: Determine the inflow rate to the sidewall drains.

References: *Dewatering and Groundwater Control*, UFC 3-220-05, January 2004.

Assumptions: The temporary dewatering system will be designed for the highest recorded water levels in Stratum I.
The boundary of the uppermost ground water bearing unit (GWBU) is at the top ofStratum II.

Solution: The sidewall drain consist of 8 segments located at the base of Stratum I.



$Q = (KX/2L)(H^2 - h_o^2)$ (Reference Figure 4-1)

Q = design flowrate
k = hydraulic conductivity of GWBU = 3.50E-03 ft/yr
1.11E-10 fps

x = segment length
L = drawdown length from Reference Figure 4-2
H = original height of water
h_o = height of water in drain
h_s = height of water above drain

Temporary Dewatering System Design
Sideslope Drains

Drain Segment	*H* (ft)	h_o (ft)	h_s (ft)	*L* (ft)	*x (ft)*	*Q (cfs)*	*Q (gpd)*
1	47.0	1.0	1.0	235.0	1,790.0	0.0000009	0.60
2	44.0	1.0	1.0	220.0	960.0	0.0000005	0.30
3	16.0	1.0	1.0	80.0	1,000.0	0.0000002	0.11
4	31.0	1.0	1.0	155.0	860.0	0.0000003	0.19
5	9.0	1.0	1.0	45.0	1,600.0	0.0000002	0.10
6	22.0	1.0	0.0	110.0	600.0	0.0000001	0.09
7	22.0	1.0	1.0	110.0	350.0	0.0000001	0.06
8	12.0	1.0	1.0	60.0	500.0	0.0000001	0.04

The peak flow for the sidewall drain = 0.6 gpd

Temporary Dewatering System Design
Toe Drains

Required: Determine the inflow rate to the toe drains.

References: *Dewatering and Groundwater Control*, UFC 3-220-05, January 2004.

Assumptions: The temporary dewatering system will be designed for the highest recorded water levels in Stratum I.
The boundary of the uppermost ground water bearing unit (GWBU) is at the top of Stratum II.

Solution: The toe drain consist of 4 segments located at the toe of the slope.



$Q = (kx/2L)(H^2 - h_o^2)$ (Reference Figure 4-1)

Q = design flowrate
k = hydraulic conductivity of GWBU = 3.50E-03 ft/yr
1.11E-10 fps

x = segment length
L = drawdown length from Reference Figure 4-2
H = origiinal height of water
h_o = height of water in drain
h_s = height of water above drain

Temporary Dewatering System Design
Toe Drains

Drain Segment	*H* (ft)	h_o (ft)	h_s (ft)	*L* (ft)	*x (ft)*	*Q (cfs)*	*Q (gpd)*
1	47.0	1.0	1.0	235.0	800.0	0.0000004	0.27
2	47.0	1.0	1.0	235.0	800.0	0.0000004	0.27
3	15.0	1.0	1.0	75.0	1,650.0	0.0000003	0.18
4	39.0	1.0	1.0	195.0	550.0	0.0000002	0.15

The peak flow for the toe drain = 0.3 gpd

Temporary Dewatering System Design
Trench Capacity

Required: Check the size of the sidewall and toe drains.

References: *AdvanEDGE Pipe (L-1074) Literature referencing KTC-97-5, SPR-92-143, "Performance and Cost Effectiveness of Pavement Edge Drains",* L. John Fleckenstein, Kentucky Transportation Center, 1997.

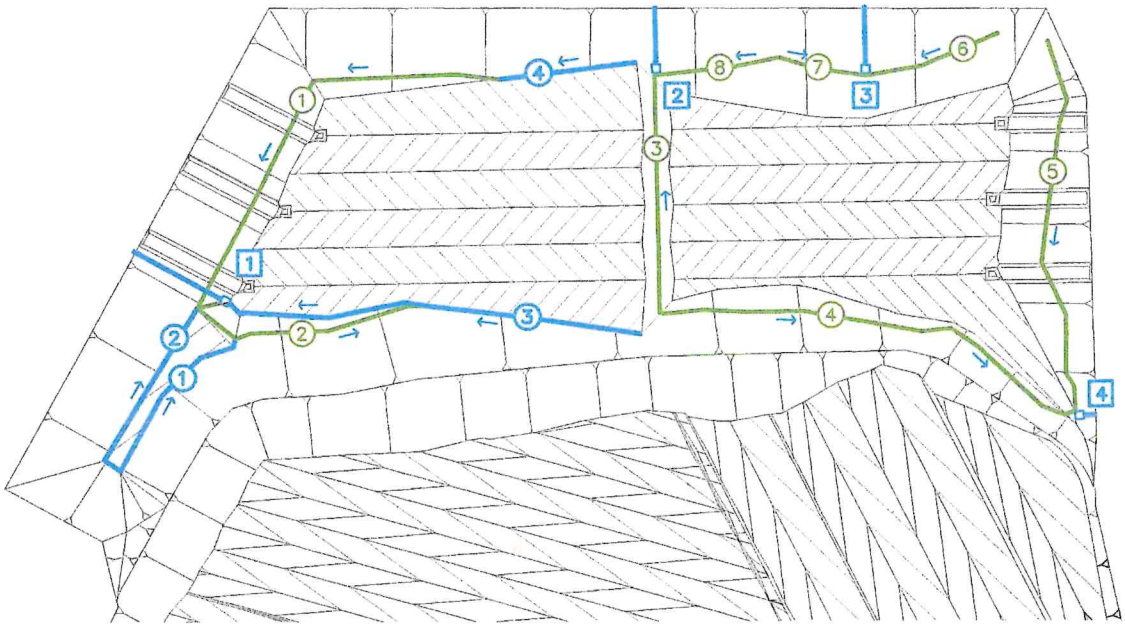
Solution: **Sidewall composite drain**

The peak flow rate for the sidewall drain =	0.000007 gpm
The peak flow rate for the toe drain =	0.000003 gpm
Flow capacity of 12" ADS Composite Drain =	**39.0 gpm**

Temporary Dewatering System Design
Sump Capacity

Required: Determine the inflow rate to the sumps.

Solution: There will be 4 sumps required.



Drain Segment	Sump 1	Sump 2	Sump 3	Sump 4
Sideslope 1	0.60			
Sideslope 2	0.30			
Sideslope 3		0.11		
Sideslope 4				0.19
Sideslope 5				0.10
Sideslope 6			0.09	
Sideslope 7			0.06	
Sideslope 8		0.04		
Toe 1	0.27			
Toe 2	0.27			
Toe 3	0.18			
Toe 4	0.15			
Total	1.78	0.16	0.15	0.29

Peak flow to a sump = 2 gpd

APPENDIX D7C
BALLAST CALCULATIONS

LINER BALLAST CALCULATIONS

The required ballast thickness shall be calculated by the GP and included in the GLER. The ballast calculation shall be based on the as-built conditions and the updated highest groundwater elevations. The required ballast thickness shall be calculated as follows:

A. Review and update, as necessary, the water level elevations (see Attachment D7, Appendix D7-A). Adjust the seasonal high-water table upward, if necessary, across the area being lined using the current highest measured water levels. Determine the design water level for the area being analyzed. The lined area may be subdivided into more than one area as appropriate.

B. Determine the hydrostatic uplift pressure on the base of the bottom and sidewall liner system including normal, vertical, and horizontal components of the uplift pressure as follows:

1. Bottom Liner: Determine the maximum hydrostatic uplift pressures acting normal to the base of the bottom liner system using the unit weight of water, γ_W, times the vertical distance from the geomembrane (GM) to the design water level, H.

$$P_N = \gamma_W H$$

2. Sidewall Liner: Determine the maximum hydrostatic uplift pressures acting normal, vertical, and horizontal to the base of the sidewall liner system using the following steps.

(a) Determine the maximum normal uplift pressure on the sidewall liner using the unit weight of water times the vertical distance from the GM to the design water level, H.

$$P_N = \gamma_W H$$

(b) Determine the maximum vertical uplift pressure on the sidewall liner using the normal uplift pressure times the cosine of the slope angle.

$$P_V = P_N \cos \beta$$

(c) Determine the maximum horizontal uplift pressure on the sidewall liner using the normal uplift pressure times the sine of the slope angle.

$$P_H = P_N \sin \beta$$

C. Determine the resisting pressure of the protective cover soil against uplift of the bottom and sidewall liner system including normal, vertical, and horizontal components of the resisting pressures as follows:

1. Bottom Liner: Determine the normal resisting pressure at the GM using the unit weight of the protective cover times the thickness of the protective cover.

$$R_N = (\gamma_{pc} T_{pc})$$

Where: γ_{pc} = Wet unit weight of the protective cover
T_{pc} = Thickness of the protective cover

The unit weight of the protective cover shall be determined from field measured unit weights or assumed to equal 100 pcf.

2. Sidewall Liner:

(a) Determine the vertical resisting pressure of the sidewall liner using the unit weight of the protective cover material times the vertical thickness of the protective cover layer. This is equal to the normal resisting pressure divided by the cosine of the slope angle.

$$R_v = R_N / \cos \beta$$

(b) Determine the horizontal resisting pressure of the sidewall liner using the coefficient of at-rest earth pressure of the liner system components times the vertical resisting pressure.

$$R_H = K_O R_V$$

The coefficient of at-rest earth pressure, K_O, is based on the assumed angle of internal friction, ϕ, of the material resisting hydrostatic pressures (compacted soil).

(c) Determine the normal resisting pressure of the sidewall liner system using the normal components of the horizontal and vertical resisting pressures calculated in steps (a) and (b) above.

$$R_N = R_H \sin \beta + R_V \cos \beta$$

D. Evaluate the factor of safety against uplift of the bottom and sidewall liner system due to hydrostatic pressures.

1. Bottom Liner: Determine the factor of safety against uplift of the bottom liner system due to hydrostatic forces acting normal to the base of the bottom liner system.

$$FS = R_N / P_N$$

If the factor of safety is greater than or equal to 1.2, the protective cover provides sufficient ballast to offset the hydrostatic uplift forces.

If the factor of safety is less than 1.2, additional ballast in the form of solid waste or additional soil will be necessary to offset the hydrostatic forces. See Step E for determining the geometry of solid waste or additional ballast.

2. Sidewall Liner:

Determine the factor of safety against uplift of the sidewall liner system due to hydrostatic pressures acting normal, vertical, and horizontal to the sidewall liner system.

(a) $FS_N = R_N / P_N$

(b) $FS_V = R_V / P_V$

(c) $FS_H = R_H / P_H$

If the factors of safety are greater than or equal to 1.2, the protective cover provides sufficient ballast to offset the hydrostatic forces.

If the factor of safety is less than 1.2 for any of the components (normal, vertical, or horizontal), additional ballast in the form of solid waste or additional soil will be necessary to offset the hydrostatic forces. See Step E for determining the geometry of solid waste or additional soil ballast.

E. Use a factor of safety of 1.5 against uplift of the liner and ballast system for solid waste ballast.

Assume a unit weight of 44 pcf for solid waste and a unit weight of 100 pcf for soil if field measurements are not available, or if conditions indicate the field measurements are no longer applicable.

1. Bottom Liner

The factor of safety against uplift of the liner and ballast system is calculated as follows:

$$FS = (R_N + B_N) / P_N$$

Where R_N = Normal protective cover pressure
B_N = Normal ballast pressure
B_N = $H_{sw} * \gamma_{sw}$ (Height and unit weight of solid waste ballast)
FS = 1.5 for waste

Solving the above equation for the height of ballast:

$$H = (FS\ P_N - R_N) / \gamma$$

2. Sidewall Liner

The factor of safety against uplift of the liner and ballast system is calculated as follows:

(a) $FS = (R_V + B_V) / P_V$ (Vertical Components)

Where R_V = Vertical protective cover pressure
B_V = Vertical ballast pressure
$B_V = H * \gamma$
FS = 1.5 for waste

Solving the above equation for the height of ballast:

$$H = (FS\ P_V - R_V) / \gamma$$

(b) $FS = (R_H + B_H) / P_H$ (Horizontal Components)

Where R_H = Horizontal protective cover pressure
B_H = Horizontal ballast pressure
$B_H = B_V * K_0$
$B_H = H * \gamma * 0.7$
FS = 1.5 for waste, 1.2 for soil

Solving the above equation for the height of ballast:

$$H = (FS\ P_H - R_H) / \gamma * k_0$$

(c) $FS = ((R_v+B_v)cosB + (R_h+B_h)sinB) / P_n$ (Normal Components)

Example calculations are provided on pages 5 and 6 of this Appendix.

Example Ballast Calculation

Required: Example calculation to evaluate the long-term hydrostatic uplift pressures on the liner system and determine the ballast requirements.

Assumptions:
1) The design water elevations are shown on Drawing D7A.1.
2) All cells must be re-evaluated based on updated groundwater data prior to construction.
3) Uplift is evaluated at the bottom of the compacted soil liner.

Solution: Calculations are shown for Cell 19 where the largest differential occurs between the base of the unit and the groundwater elevation.

The forces acting upon the liner system are:

P_N = normal pressure	R_N = normal resistance
P_V = vertical pressure	R_V = vertical resistance
P_H = horizontal pressure	R_H = horizontal resistance

1) Determine the uplift pressure upon the liner at the base of Stratum I.

γ_w = unit weight of water =	62.4 pcf
Groundwater elevation =	483 ft-msl
Liner elevation =	438 ft-msl
H = design water level above liner =	40 ft
β = sidewall slope =	11.3 deg
$P_N = H\gamma_w$ =	2496.0 psf
$P_V = P_N \cos\beta$ =	2447.6 psf
$P_H = P_N \sin\beta$ =	489.1 psf

2) Determine the resistance pressure provided by the liner.

γ = density =	120.0 pcf
T_N = normal thickness =	4.0 ft
T_V = vertical thickness =	4.08 ft
ϕ = angle of internal friction =	15.0 deg
$R_V = R_N / \cos\beta$	506.8 psf
$R_H = k_o R_V$ =	253.4 psf (k_0 assumed as 0.5)
$R_N = R_H \sin\beta + R_V \cos\beta$ =	546.6 psf

3) Determine the factors of safety against uplift and evaluate the need for additional ballast.

$FS_N = R_N / P_N$ =	0.2
$FS_V = R_V / P_V$ =	0.2
$FS_H = R_H / P_H$ =	0.5

Example Ballast Calculation

The factor of safety for the liner providing ballast against hydrostatic uplift is less than 1.2. Evaluate the height of waste ballast required to provide a factor of safety of at least 1.5.

γ_{sw} = unit weight of solid waste = 44.0 pcf

$FS = (R_v + B_v) / P_v$

For FS = 1.5 $H = (FS * P_v - R_v) / \gamma_{sw}$

$H =$ 71.9 ft

$FS = (R_H + B_H) / P_H$

For FS = 1.5 $H = (FS*P_H - R_H) / (\gamma_{sw}*k_0)$

$H =$ 21.8 ft

Using waste height calculated for vertical forces, check FS with normal forces:

For H_{sw} = 71.9 ft

$FS = ((R_v + B_v)cosB + (R_h + B_h)sinB) / P_n$

$FS =$ 1.9 Factor of safety is greater than 1.5 so vertical forces control

The GP will evaluate the highest measured water levels to determine where the largest hydrostatic force is located and perform these calculations to determine how much ballast is required when preparing the Ballast Evaluation Report for submittal to the TCEQ prior to decommissioning any dewatering system.

APPENDIX D7D
WASTE-FOR-BALLAST PLACEMENT RECORD

Texas Commission on Environmental Quality
Municipal Solid Waste Facility
Waste-As-Ballast Placement Record

This form is to be completed by the landfill manager or designated representative for all landfilled areas using waste as ballast. One form must be completed for each area, or combination of areas, described by approved liner evaluation reports. This form is to be submitted with the Ballast Evaluation Report (BER) (TCEQ-10072) for the evaluated area and may be referenced by the Professional of Record (POR) to verify that the placement of ballast is compliant with the Soils and Liner Quality Control Plan (SLQCP). The site operator must prepare and sign supporting documentation daily verifying the area of waste placement, the waste material in the first 5 feet of waste was free of brush and large bulky items, daily operation of the pressure relief/dewatering system, and a wheeled trash compactor having a minimum weight of 40,000 pounds was used.

1. General Information

Area documented by this record (provide site grid coordinates of each corner):

Soils and Liner Evaluation Report and Geomembrane Liner Evaluation Report document date(s) and approval date(s) for this area:

Date of initial waste placement: _____

Date of completion of first 5 feet of waste in place over entire area: _____

Total required waste-as-ballast thickness for this area:
Note: Calculations for determining the required thickness of waste as ballast are included with the SLQCP/BER for this area.

Date when minimum required thickness of waste was achieved: _____

2. Waste Equipment Used

Type of compaction equipment was used: _____

Did the compactor have a minimum gross weight of 40,000 pounds? ☐ Yes ☐ No

Was this compactor used throughout the entire period covered by this record? ☐ Yes ☐ No

If "no" was selected for either of the two preceding questions, attach documentation of initial and final survey data of the ballasted area and scale house truck weight measurements for the time period covered by the BER used in determining in-place waste density. Documentation already included for the BER does not need to be reattached. Is this documentation provided, complete, and accurate? ☐ Yes ☐ No

3. First Waste Lift Considerations

Describe type(s) of waste placed in first 5 feet of waste over the top of the liner protective cover:

Does the first 5 feet of waste contain any brush or large bulky waste items which would damage the underlying liner system, or which cannot be compacted to the required density?
☐ Yes ☐ No

4. Waste Compaction Methods

Approximate loose waste layer thickness prior to compaction: _____

Minimum number of compactor passes for each waste layer: _____

Maximum slope of compacted waste layers: _____

5. Pressure Relief/Dewatering System

Was the pressure relief/dewatering system operated continuously during the period covered by this record, if required? ☐ Yes ☐ No

Is the pressure relief/dewatering system presently in operation? ☐ Yes ☐ No

Signature of Permittee or Operator

The waste overlying the area described in this record has been placed and compacted as described in this record and in accordance with the Soils and Liner Quality Control Plan and Site Operating Plan.

_____ *signature*

_____ *date signed*

_____ *typed or printed name*

_____ *title*

_____ *phone number*

_____ *company or business name*

_____ *address, city, state, zip code*

Note: This completed form must be submitted with the BER and placed in the Operating Record and be available for review.

APPENDIX D7E
GRI-GM13

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Revision 16: March 17, 2021
Revision schedule on pg. 11

GRI - GM13 Standard Specification*

Standard Specification for

"Test Methods, Test Properties and Testing Frequency for
High Density Polyethylene (HDPE) Smooth and Textured Geomembranes" SM

This specification was developed by the Geosynthetic Research Institute (GRI), with the cooperation of the member organizations for general use by the public. It is completely optional in this regard and can be superseded by other existing or new specifications on the subject matter in whole or in part. Neither GRI, the Geosynthetic Institute, nor any of its related institutes, warrant or indemnifies any materials produced according to this specification either at this time or in the future.

1. Scope

1.1 This specification covers high density polyethylene (HDPE) geomembranes with a formulated sheet density of 0.940 g/ml, or higher, in the thickness range of 0.75 mm (30 mils) to 3.0 mm (120 mils). Both smooth and textured geomembrane surfaces are included.

1.2 This specification sets forth a set of minimum, physical, mechanical and chemical properties that must be met, or exceeded by the geomembrane being manufactured. In a few cases a range is specified.

1.3 In the context of quality systems and management, this specification represents manufacturing quality control (MQC).

Note 1: Manufacturing quality control represents those actions taken by a manufacturer to ensure that the product represents the stated objective and properties set forth in this specification.

1.4 This standard specification is intended to ensure good quality and performance of HDPE geomembranes in general applications, but is possibly not adequate for the complete specification in a specific situation. Additional tests, or more restrictive

*This GRI standard specification is developed by the Geosynthetic Research Institute through consultation and review by the member organizations. This specification will be reviewed at least every 2-years, or on an as-required basis. In this regard it is subject to change at any time. The most recent revision date is the effective version and it is kept current on the Institute's Website <<geosynthetic-institute.org>>.

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values for test indicated, may be necessary under conditions of a particular application.

Note 2: For information on installation techniques, users of this standard are referred to the geosynthetics literature, which is abundant on the subject.

2. Referenced Documents

2.1 ASTM Standards

D 792 Specific Gravity (Relative Density) and Density of Plastics by Displacement
D 1004 Test Method for Initial Tear Resistance of Plastics Film and Sheeting
D 1238 Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer
D 1505 Test Method for Density of Plastics by the Density-Gradient Technique
D 1603 Test Method for Carbon Black in Olefin Plastics
D 4218 Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique
D 4833 Test Method for Index Puncture Resistance of Geotextiles, Geomembranes and Related Products
D 5199 Test Method for Measuring Nominal Thickness of Geotextiles and Geomembranes
D 5397 Procedure to Perform a Single Point Notched Constant Tensile Load – (SP-NCTL) Test: Appendix
D 5596 Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics
D 5721 Practice for Air-Oven Aging of Polyolefin Geomembranes
D 5885 Test method for Oxidative Induction Time of Polyolefin Geosynthetics by High Pressure Differential Scanning Calorimetry
D 5994 Test Method for Measuring the Core Thickness of Textured Geomembranes
D 6370 Standard Test Method for Rubber-Compositional Analysis by Thermogravimetry (TGA)
D 6693 Test Method for Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polypropylene Geomembranes
D 7238 Test Method for Effect of Exposure of Unreinforced Polyolefin Geomembrane Using Fluorescent UV Condensation Apparatus
D 7466 Test Method for Measuring the Asperity Height of Textured Geomembranes
D 8117 Standard Test Method for Oxidative Induction Time of Polyolefin Geosynthetics by Differential Scanning Calorimetry

2.2 GRI Standards

GM10 Specification for the Stress Crack Resistance of Geomembrane Sheet

2.3 U. S. Environmental Protection Agency Technical Guidance Document "Quality Control Assurance and Quality Control for Waste Containment Facilities," EPA/600/R-93/182, September 1993, 305 pgs.

3. Definitions

Manufacturing Quality Control (MQC) - A planned system of inspections that is used to directly monitor and control the manufacture of a material which is factory originated. MQC is normally performed by the manufacturer of geosynthetic materials and is necessary to ensure minimum (or maximum) specified values in the manufactured product. MQC refers to measures taken by the manufacturer to determine compliance with the requirements for materials and workmanship as stated in certification documents and contract specifications.
ref. EPA/600/R-93/182

Manufacturing Quality Assurance (MQA) - A planned system of activities that provides assurance that the materials were constructed as specified in the certification documents and contract specifications. MQA includes manufacturing facility inspections, verifications, audits and evaluation of the raw materials (resins and additives) and geosynthetic products to assess the quality of the manufactured materials. MQA refers to measures taken by the MQA organization to determine if the manufacturer is in compliance with the product certification and contract specifications for the project.
ref. EPA/600/R-93/182

Formulation - The mixture of a unique combination of ingredients identified by type, properties and quantity. For HDPE polyethylene geomembranes, a formulation is defined as the exact percentages and types of resin(s), additives and carbon black.

Nominal - Representative value of a measurable property determined under a set of conditions, by which a product may be described. Abbreviated as nom. in Tables 1 and 2.

4. Material Classification and Formulation

4.1 This specification covers high density polyethylene geomembranes with a formulated sheet density of 0.940 g/ml, or higher. Density can be measured by ASTM D1505 or ASTM D792. If the latter, Method B is recommended.

4.2 The polyethylene resin from which the geomembrane is made will generally be in the density range of 0.932 g/ml or higher, and have a melt index value per ASTM D1238 of less than 1.0 g/10 min.

4.3 The resin shall be virgin material with no more than 10% rework. If rework is used, it must be a similar HDPE as the parent material.

4.4 No post consumer resin (PCR) of any type shall be added to the formulation.

5. Physical, Mechanical and Chemical Property Requirements

5.1 The geomembrane shall conform to the test property requirements prescribed in Tables 1 and 2. Table 1 is for smooth HDPE geomembranes and Table 2 is for single and double sided textured HDPE geomembranes. Each of the tables are given in English and SI (metric) units. The conversion from English to SI (metric) is soft.

Note 3: The tensile strength properties in this specification were originally based on ASTM D 638 which uses a laboratory testing temperature of 23°C ± 2°C. Since ASTM Committee D35 on Geosynthetics adopted ASTM D 6693 (in place of D 638), this GRI Specification followed accordingly. The difference is that D 6693 uses a testing temperature of 21°C ± 2°C. The numeric values of strength and elongation were not changed in this specification. If a dispute arises in this regard, the original temperature of 23°C ± 2°C should be utilized for testing purposes.

Note 4: There are several tests often included in other HDPE specifications which are omitted from this standard because they are outdated, irrelevant or generate information that is not necessary to evaluate on a routine MQC basis. The following tests have been purposely omitted:

- Volatile Loss
- Dimensional Stability
- Coeff. of Linear Expansion
- Resistance to Soil Burial
- Low Temperature Impact
- ESCR Test (D 1693)
- Wide Width Tensile
- Water Vapor Transmission
- Water Absorption
- Ozone Resistance
- Modulus of Elasticity
- Hydrostatic Resistance
- Tensile Impact
- Field Seam Strength
- Multi-Axial Burst
- Various Toxicity Tests

Note 5: There are several tests which are included in this standard (that are not customarily required in other HDPE specifications) because they are relevant and important in the context of current manufacturing processes. The following tests have been purposely added:

- Oxidative Induction Time
- Oven Aging
- Ultraviolet Resistance
- Asperity Height of Textured Sheet (see Note 6)

Note 6: The minimum average value of asperity height does not represent an expected value of interface shear strength. Shear strength associated with geomembranes is both site-specific and product-specific and should be determined by direct shear testing using ASTM D5321/ASTM D6243 as prescribed. This testing should be included in the particular site's CQA conformance testing protocol for the geosynthetic materials involved, or formally waived by the Design Engineer, with concurrence from the Owner prior to the deployment of the geosynthetic materials.

Note 7: There are other tests in this standard, focused on a particular property, which are updated to current standards. The following are in this category:

- Thickness of Textured Sheet
- Puncture Resistance
- Stress Crack Resistance
- Carbon Black Dispersion (In the viewing and subsequent quantitative interpretation of ASTM D 5596 only near spherical agglomerates shall be included in the assessment).

5.2 The values listed in the tables of this specification are to be interpreted according to the designated test method. In this respect they are neither minimum average roll values (MARV) nor maximum average roll values (MaxARV).

5.3 The properties of the HDPE geomembrane shall be tested at the minimum frequencies shown in Tables 1 and 2. If the specific manufacturer's quality control guide is more stringent and is certified accordingly, it must be followed in like manner.

Note 8: This specification is focused on manufacturing quality control (MQC). Conformance testing and manufacturing quality assurance (MQA) testing are at the discretion of the purchaser and/or quality assurance engineer, respectively.

6. Workmanship and Appearance

6.1 Smooth geomembrane shall have good appearance qualities. It shall be free from such defects that would affect the specified properties of the geomembrane.

6.2 Textured geomembrane shall generally have uniform texturing appearance. It shall be free from agglomerated texturing material and such defects that would affect the specified properties of the geomembrane.

6.3 General manufacturing procedures shall be performed in accordance with the manufacturer's internal quality control guide and/or documents.

7. MQC Sampling

7.1 Sampling shall be in accordance with the specific test methods listed in Tables 1 and 2. If no sampling protocol is stipulated in the particular test method, then test specimens shall be taken evenly spaced across the entire roll width.

7.2 The number of tests shall be in accordance with the appropriate test methods listed in Tables 1 and 2.

7.3 The average of the test results should be calculated per the particular standard cited and compared to the minimum value listed in these tables, hence the values listed are the minimum average values and are designated as "min. ave."

8. MQC Retest and Rejection

8.1 If the results of any test do not conform to the requirements of this specification, retesting to determine conformance or rejection should be done in accordance with the manufacturing protocol as set forth in the manufacturer's quality manual.

9. Packaging and Marketing

9.1 The geomembrane shall be rolled onto a substantial core or core segments and held firm by dedicated straps/slings, or other suitable means. The rolls must be adequate for safe transportation to the point of delivery, unless otherwise specified in the contract or order.

10. Certification

10.1 Upon request of the purchaser in the contract or order, a manufacturer's certification that the material was manufactured and tested in accordance with this specification, together with a report of the test results, shall be furnished at the time of shipment.

ENGLISH UNITS

Table 1(a) – High Density Polyethylene (HDPE) Geomembrane -Smooth

Properties	Test Method	Test Value							Testing Frequency (minimum)
		30 mils	40 mils	50 mils	60 mils	80 mils	100 mils	120 mils	
Thickness (min. ave.) - mils • lowest individual of 10 values - %	D5199	nom. -10	nom. -10	nom. -10	nom. -10	nom. -10	nom. -10	nom. -10	per roll
Formulated Density (min. ave.) - g/cc	D 1505/D 792	0.940	0.940	0.940	0.940	0.940	0.940	0.940	200,000 lb
Tensile Properties *(1)* (min. ave.) • yield strength - lb/in. • break strength - lb/in. • yield elongation - % • break elongation - %	D 6693 Type IV	 63 114 12 700	 84 152 12 700	 105 190 12 700	 126 228 12 700	 168 304 12 700	 210 380 12 700	 252 456 12 700	20,000 lb
Tear Resistance (min. ave.) - lb	D 1004	21	28	35	42	56	70	84	45,000 lb
Puncture Resistance (min. ave.) - lb	D 4833	54	72	90	108	144	180	216	45,000 lb
Stress Crack Resistance *(2)* - hr.	D5397 (App.)	500	500	500	500	500	500	500	per GRI-GM10
Carbon Black Content (range) - %	D 4218 *(3)*	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	20,000 lb
Carbon Black Dispersion	D 5596	note *(4)*	note *(4)*	note *(4)*	note *(4)*	note *(4)*	note *(4)*	note *(4)*	45,000 lb
Oxidative Induction Time (OIT) (min. ave.) *(5)* (a) Standard OIT - min. — or — (b) High Pressure OIT - min.	 D 8117 D 5885	 100 400	 100 400	 100 400	 100 400	 100 400	 100 400	 100 400	200,000 lb
Oven Aging at 85°C *(5), (6)* (a) Standard OIT (min. ave.) - % retained after 90 days — or — (b) High Pressure OIT (min. ave.) - % retained after 90 days	D 5721 D 8117 D 5885	 55 80	 55 80	 55 80	 55 80	 55 80	 55 80	 55 80	per each formulation
UV Resistance *(7)* (a) Standard OIT (min. ave.) — or — (b) High Pressure OIT (min. ave.) - % retained after 1600 hrs *(9)*	D 7238 D 8117 D 5885	 N.R. *(8)* 50	 N.R. *(8)* 50	 N.R. *(8)* 50	 N.R. *(8)* 50	 N.R. *(8)* 50	 N.R. *(8)* 50	 N.R. *(8)* 50	per each formulation

(1) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction.
Yield elongation is calculated using a gage length of 1.3 inches
Break elongation is calculated using a gage length of 2.0 in.

(2) The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQC testing.

(3) Other methods such as D 1603 (tube furnace) or D 6370 (TGA) are acceptable if an appropriate correlation to D 4218 (muffle furnace) can be established.

(4) Carbon black dispersion (only near spherical agglomerates) for 10 different views:
9 in Categories 1 or 2 and 1 in Category 3

(5) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.

(6) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.

(7) The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.

(8) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.

(9) UV resistance is based on percent retained value regardless of the original HP-OIT value.

SI (METRIC) UNITS

Table 1(b) – High Density Polyethylene (HPDE) Geomembrane - Smooth

Properties	Test Method	Test Value							Testing Frequency (minimum)
		0.75 mm	1.00 mm	1.25 mm	1.50 mm	2.00 mm	2.50 mm	3.00 mm	
Thickness - (min. ave.) - mm	D5199	nom.	nom.	nom.	nom.	nom.	nom.	nom.	per roll
• lowest individual of 10 values - %		-10	-10	-10	-10	-10	-10	-10	
Formulated Density (min. ave.) - g/cc	D 1505/D 792	0.940	0.940	0.940	0.940	0.940	0.940	0.940	90,000 kg
Tensile Properties *(1)* (min. ave.)	D 6693								9,000 kg
• yield strength - kN/m	Type IV	11	15	18	22	29	37	44	
• break strength - kN/m		20	27	33	40	53	67	80	
• yield elongation - %		12	12	12	12	12	12	12	
• break elongation - %		700	700	700	700	700	700	700	
Tear Resistance (min. ave.) - N	D 1004	93	125	156	187	249	311	374	20,000 kg
Puncture Resistance (min. ave.) - N	D 4833	240	320	400	480	640	800	960	20,000 kg
Stress Crack Resistance *(2)* - hr.	D 5397 (App.)	500	500	500	500	500	500	500	per GRI GM-10
Carbon Black Content (range) - %	D 4218 *(3)*	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	9,000 kg
Carbon Black Dispersion	D 5596	note *(4)*	note *(4)*	note *(4)*	note *(4)*	note *(4)*	note *(4)*	note *(4)*	20,000 kg
Oxidative Induction Time (OIT) (min. ave.) *(5)*									90,000 kg
(a) Standard OIT - min.	D 8117	100	100	100	100	100	100	100	
— or —									
(b) High Pressure OIT - min.	D 5885	400	400	400	400	400	400	400	
Oven Aging at 85°C *(5), (6)*	D 5721								
(a) Standard OIT (min. ave.) - % retained after 90 days	D 8117	55	55	55	55	55	55	55	per each formulation
— or —									
(b) High Pressure OIT (min. ave.) - % retained after 90 days	D 5885	80	80	80	80	80	80	80	
UV Resistance *(7)*	D 7238								
(a) Standard OIT (min. ave.)	D 8117	N. R. *(8)*	N.R. *(8)*	N.R. *(8)*	N.R. *(8)*	N.R. *(8)*	N.R. *(8)*	N.R. *(8)*	per each formulation
— or —									
(b) High Pressure OIT (min. ave.) - % retained after 1600 hrs *(9)*	D 5885	50	50	50	50	50	50	50	

(1) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction
Yield elongation is calculated using a gage length of 33 mm
Break elongation is calculated using a gage length of 50 mm

(2) The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQC testing.

(3) Other methods such as D 1603 (tube furnace) or D 6370 (TGA) are acceptable if an appropriate correlation to D 4218 (muffle furnace) can be established.

(4) Carbon black dispersion (only near spherical agglomerates) for 10 different views:
9 in Categories 1 or 2 and 1 in Category 3

(5) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.

(6) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.

(7) The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.

(8) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.

(9) UV resistance is based on percent retained value regardless of the original HP-OIT value.

ENGLISH UNITS

Table 2(a) – High Density Polyethylene (HDPE) Geomembrane - Textured

Properties	Test Method	Test Value							Testing Frequency (minimum)
		30 mils	40 mils	50 mils	60 mils	80 mils	100 mils	120 mils	
Thickness mils (min. ave.) - mils	D 5994	nom. -5%	nom. -5%	nom. -5%	nom. -5%	nom. -5%	nom. -5%	nom. -5%	per roll
• lowest individual for 8 out of 10 values - %		-10	-10	-10	-10	-10	-10	-10	
• lowest individual for any of the 10 values - %		-15	-15	-15	-15	-15	-15	-15	
Asperity Height mils (min. ave.) - mils	D 7466	16	16	16	16	16	16	16	every 2nd roll *(1)*
Formulated Density (min. ave.) - g/cc	D 1505/D 792	0.940	0.940	0.940	0.940	0.940	0.940	0.940	200,000 lb
Tensile Properties (min. ave.) *(2)*	D 6693								20,000 lb
• yield strength - lb/in.	Type IV	63	84	105	126	168	210	252	
• break strength - lb/in.		45	60	75	90	120	150	180	
• yield elongation - %		12	12	12	12	12	12	12	
• break elongation - %		100	100	100	100	100	100	100	
Tear Resistance (min. ave.) - lb	D 1004	21	28	35	42	56	70	84	45,000 lb
Puncture Resistance (min. ave.) - lb	D 4833	45	60	75	90	120	150	180	45,000 lb
Stress Crack Resistance *(3)* - hr.	D 5397 (App.)	500	500	500	500	500	500	500	per GRI GM10
Carbon Black Content (range) - %	D 4218 *(4)*	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	20,000 lb
Carbon Black Dispersion	D 5596	note *(5)*	note *(5)*	note *(5)*	note *(5)*	note *(5)*	note *(5)*	note *(5)*	45,000 lb
Oxidative Induction Time (OIT) (min. ave.) *(6)*									200,000 lb
(a) Standard OIT - min.	D 8117	100	100	100	100	100	100	100	
— or —									
(b) High Pressure OIT - min.	D 5885	400	400	400	400	400	400	400	
Oven Aging at 85°C *(6), (7)*	D 5721								
(a) Standard OIT (min. ave.) - % retained after 90 days	D 8117	55	55	55	55	55	55	55	per each formulation
— or —									
(b) High Pressure OIT (min. ave.) - % retained after 90 days	D 5885	80	80	80	80	80	80	80	
UV Resistance *(8)*	D 7238								
(a) Standard OIT (min. ave.)	D 8117	N.R. *(9)*	N.R. *(9)*	N.R. *(9)*	N.R. *(9)*	N.R. *(9)*	N.R. *(9)*	N.R. *(9)*	per each formulation
— or —									
(b) High Pressure OIT (min. ave.) - % retained after 1600 hrs *(10)*	D 5885	50	50	50	50	50	50	50	

(1) Alternate the measurement side for double sided textured sheet

(2) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction.
Yield elongation is calculated using a gage length of 1.3 inches
Break elongation is calculated using a gage length of 2.0 inches

(3) SP-NCTL per ASTM D5397 Appendix, is not appropriate for testing geomembranes with textured or irregular rough surfaces. Test should be conducted on smooth edges of textured rolls or on smooth sheets made from the same formulation as being used for the textured sheet materials.
The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQC testing.

(4) Other methods such as D 1603 (tube furnace) or D 6370 (TGA) are acceptable if an appropriate correlation to D 4218 (muffle furnace) can be established.

(5) Carbon black dispersion (only near spherical agglomerates) for 10 different views:
9 in Categories 1 or 2 and 1 in Category 3

(6) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.

(7) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.

(8) The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.

(9) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.

(10) UV resistance is based on percent retained value regardless of the original HP-OIT value.

Table 2(b) – High Density Polyethylene (HDPE) Geomembrane - Textured

Properties	Test Method	Test Value							Testing Frequency (minimum)
		0.75 mm	1.00 mm	1.25 mm	1.50 mm	2.00 mm	2.50 mm	3.00 mm	
Thickness (min. ave.) - mm	D 5994	nom. -5%	nom. -5%	nom. -5%	nom. -5%	nom. -5%	nom. -5%	nom. -5%	per roll
• lowest individual for 8 out of 10 values - %		-10	-10	-10	-10	-10	-10	-10	
• lowest individual for any of the 10 values - %		-15	-15	-15	-15	-15	-15	-15	
Asperity Height mils (min. ave.) - mm	D 7466	0.40	0.40	0.40	0.40	0.40	0.40	0.40	every 2nd roll *(1)*
Formulated Density (min. ave.) - g/cc	D 1505/D 792	0.940	0.940	0.940	0.940	0.940	0.940	0.940	90,000 kg
Tensile Properties (min. ave.) *(2)*	D 6693								9,000 kg
• yield strength - kN/m	Type IV	11	15	18	22	29	37	44	
• break strength - kN/m		8	10	13	16	21	26	32	
• yield elongation - %		12	12	12	12	12	12	12	
• break elongation - %		100	100	100	100	100	100	100	
Tear Resistance (min. ave.) - N	D 1004	93	125	156	187	249	311	374	20,000 kg
Puncture Resistance (min. ave.) - N	D 4833	200	267	333	400	534	667	800	20,000 kg
Stress Crack Resistance *(3)* - hr.	D 5397 (App.)	500	500	500	500	500	500	500	per GRI GM10
Carbon Black Content (range) - %	D 4218 *(4)*	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	9,000 kg
Carbon Black Dispersion	D 5596	note *(5)*	note *(5)*	note *(5)*	note *(5)*	note *(5)*	note *(5)*	note *(5)*	20,000 kg
Oxidative Induction Time (OIT) (min. ave.) *(6)*									90,000 kg
(a) Standard OIT - min.	D 8117	100	100	100	100	100	100	100	
— or —									
(b) High Pressure OIT - min.	D 5885	400	400	400	400	400	400	400	
Oven Aging at 85°C *(6), (7)*	D 5721								per each formulation
(a) Standard OIT (min. ave.) - % retained after 90 days	D 8117	55	55	55	55	55	55	55	
— or —									
(b) High Pressure OIT (min. ave.) - % retained after 90 days	D 5885	80	80	80	80	80	80	80	
UV Resistance *(8)*	D 7238								per each formulation
(a) Standard OIT (min. ave.)	D 8117	N.R. *(9)*	N.R. *(9)*	N.R. *(9)*	N.R. *(9)*	N.R. *(9)*	N.R. *(9)*	N.R. *(9)*	
— or —									
(b) High Pressure OIT (min. ave.) - % retained after 1600 hrs *(10)*	D 5885	50	50	50	50	50	50	50	

(1) Alternate the measurement side for double sided textured sheet

(2) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction.
Yield elongation is calculated using a gage length of 33 mm
Break elongation is calculated using a gage length of 50 mm

(3) The SP-NCTL test is not appropriate for testing geomembranes with textured or irregular rough surfaces. Test should be conducted on smooth edges of textured rolls or on smooth sheets made from the same formulation as being used for the textured sheet materials.
The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQC testing.

(4) Other methods such as D 1603 (tube furnace) or D 6370 (TGA) are acceptable if an appropriate correlation to D 4218 (muffle furnace) can be established.

(5) Carbon black dispersion (only near spherical agglomerates) for 10 different views:
9 in Categories 1 or 2 and 1 in Category 3

(6) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.

(7) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.

(8) The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.

(9) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.

(10) UV resistance is based on percent retained value regardless of the original HP-OIT value.

Adoption and Revision Schedule
for
HDPE Specification per GRI-GM13

"Test Methods, Test Properties, Testing Frequency for
High Density Polyethylene (HDPE) Smooth and Textured Geomembranes"

Adopted:	June 17, 1997
Revision 1:	November 20, 1998; changed CB dispersion from allowing 2 views to be in Category 3 to requiring all 10 views to be in Category 1 or 2. Also reduced UV percent retained from 60% to 50%.
Revision 2:	April 29, 1999: added to Note 5 after the listing of Carbon Black Dispersion the following: "(In the viewing and subsequent quantitative interpretation of ASTM D5596 only near spherical agglomerates shall be included in the assessment)" and to Note (4) in the property tables.
Revision 3:	June 28, 2000: added a new Section 5.2 that the numeric table values are neither MARV or MaxARV. They are to be interpreted per the the designated test method.
Revision 4:	December 13, 2000: added one Category 3 is allowed for carbon black dispersion. Also, unified terminology to "strength" and "elongation".
Revision 5:	May 15, 2003: Increased minimum acceptable stress crack resistance time from 200 hrs to 300 hrs.
Revision 6:	June 23, 2003: Adopted ASTM D 6693, in place of ASTM D 638, for tensile strength testing. Also, added Note 2.
Revision 7:	February 20, 2006: Added Note 6 on Asperity Height clarification with respect to shear strength.
Revision 8:	Removed recommended warranty from specification.
Revision 9:	June 1, 2009: Replaced GRI-GM12 test for asperity height of textured geomembranes with ASTM D 7466.
Revision 10	April 11, 2011: Added alternative carbon black content test methods
Revision 11	December 13, 2012: Replaced GRI-GM11 with the equivalent ASTM D 7238.
Revision 12	November 14, 2014: Increased minimum acceptable stress crack resistance time from 300 to 500 hours. Also, increased asperity height of textured sheet from 10 to 16 mils (0.25 to 0.40 mm).
Revision 13	November 4, 2015: Removed Footnote (1) on asperity height from tables.
Revision 14	January 6, 2016: Removed Trouser Tear from Note 5.
Revision 15:	September 9, 2019: Editorial update to harmonize tables.
Revision 16:	March 17, 2021: Updated Standard OIT Test from ASTM D3895 to D8117

WASTE MANAGEMENT SKYLINE LANDFILL
DALLAS AND ELLIS COUNTIES, TEXAS
PERMIT AMENDMENT APPLICATION NO. MSW 42E

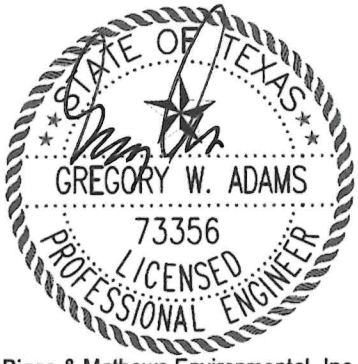
PART III – FACILITY INVESTIGATION AND DESIGN

ATTACHMENT D8
FINAL COVER QUALITY CONTROL PLAN

Prepared for

WASTE MANAGEMENT OF TEXAS, INC.

March 2026



Biggs & Mathews Environmental, Inc.
Firm Registration No. F-256

3/31/2026

Prepared by

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TEXAS BOARD OF PROFESSIONAL GEOSCIENTISTS
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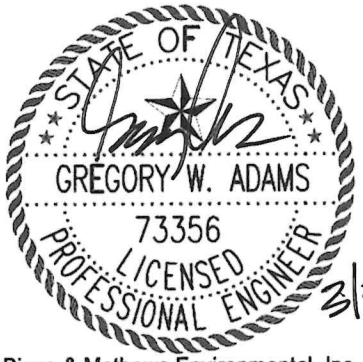

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APPENDIX D8A – GRI GM17

1 INTRODUCTION

30 TAC §330.457

1.1 Purpose

This Final Cover Quality Control Plan (FCQCP) has been prepared in accordance with the requirements of 30 TAC §330.457 to establish procedures for the design, construction, testing, and documentation of the final cover system for the Skyline Landfill.

1.2 Definitions

Specific terms and acronyms that are used in this FCQCP are defined below.

ASTM – American Society for Testing and Material

Construction Quality Assurance (CQA) – CQA is a planned system of activities that provides the owner and permitting agency assurance that the facility was constructed as specified in the design. CQA includes the observations, evaluations, and testing necessary to assess and document the quality of the constructed facility. CQA includes measures taken by the CQA organization to assess whether the work is in compliance with the plans, specifications, and permit requirements for a project.

Geotechnical Professional (GP) – The GP is the authorized representative of the owner who is responsible for all CQA activities for the project. The GP must be registered as a Professional Engineer in Texas. Experience and education should include geotechnical engineering, engineering geology, soil mechanics, geotechnical laboratory testing, construction quality assurance and quality control testing, and hydrogeology. The GP must also have competency and experience in certifying similar projects.

CQA Monitors – CQA monitors are representatives of the GP who work under direct supervision of the GP. The CQA monitor is responsible for quality assurance monitoring and performing on-site tests and observations.

Quality Assurance – Quality assurance is a planned program that is designed to assure that the work meets the requirements of the plans, specifications, and permit for a project. Quality assurance includes procedures, quality control activities, and documentation that are performed by the GP and CQA monitor.

Quality Control – Quality control includes the activities that implement the quality assurance program. The GP, CQA monitor, and contractor will perform quality control.

2 FINAL COVER SYSTEM

30 TAC §330.457

2.1 Final Cover System

Components of the final cover system are listed in the table below. The alternate final cover demonstration is provided in Attachment D9.

Components of the Final Cover System

FINAL COVER SYSTEM – LISTED TOP TO BOTTOM		
Cover System Component	**Description**	**Minimum Thickness**
TOP DECK		
Erosion Layer	Soil that is capable of sustaining plant growth	24 inches
Drainage Layer	Double-sided geocomposite	0.25 inches
Flexible Membrane Cover	Textured LLDPE geomembrane	40 mil
Infiltration Layer	Compacted soil with a coefficient of permeability less than or equal to 1×10^{-7} cm/sec	12 inches
SIDESLOPE		
OPTION A		
Erosion Layer	Soil that is capable of sustaining plant growth	36 inches
Drainage Layer	Double-sided geocomposite	0.25 inches
Infiltration Layer	Compacted soil with a coefficient of permeability less than or equal to 1×10^{-7} cm/sec	12 inches
OPTION B		
Erosion Layer	Soil that is capable of sustaining plant growth	36 inches
Drainage Layer	Double-sided geocomposite	0.20 inches
Infiltration Layer	Compacted soil with a coefficient of permeability less than or equal to 1×10^{-7} cm/sec	18 inches

2.2 Construction Monitoring

Continuous on-site monitoring is necessary during construction activities to assure that the components of the final cover system are constructed in accordance with this FCQCP. The CQA monitor shall provide continuous on-site observation during the following construction activities:

- Infiltration layer placement, processing, compaction, and testing.
- Flexible membrane cover deployment, trial welds, seaming, testing, and repairing.
- Drainage layer deployment and seaming.
- Erosion layer placement.

- Any work that could damage the installed components of the final cover system.

The GP will document and certify that the final cover system was constructed in accordance with this FCQCP. The GP shall make sufficient site visits to observe critical construction activities and to verify that the construction and quality assurance activities are performed in accordance with this FCQCP.

3 INFILTRATION LAYER

30 TAC §330.457

3.1 General

The infiltration layer consists of a 12-inch-thick layer of compacted, relatively homogeneous, cohesive clay soil material. The CQA monitor shall provide continuous on-site observation during infiltration layer placement, processing, compaction, and testing. The GP shall make sufficient site visits during infiltration layer construction to document the construction activities, testing, and thickness verification in the Final Cover System Report, in accordance with Section 7.

3.2 Materials

Infiltration layer materials shall consist of clay soil that is free from debris, rubbish, frozen materials, foreign objects, and organic material. The required infiltration layer material properties are summarized in the table below.

Infiltration Layer Material Properties

Test	Standard	Required Property
Plasticity Index	ASTM D 4318	15 or greater
Liquid Limit	ASTM D 4318	30 or greater
Percent Passing No. 200 Mesh Sieve	ASTM D 1140	30 or greater
Percent Passing 1-inch Sieve	ASTM D 422	100
Coefficient of Permeability	ASTM D 5084 or COE EM 1110-2-1906 Appendix VII	Less than or equal to 1×10^{-7} cm/sec

Preconstruction testing procedures and frequencies for infiltration layer materials are listed in Section 3.8.1.

3.3 Subgrade Preparation

Prior to placing infiltration layer material, the subgrade should be stripped of vegetation, graded, and proof rolled with heavy, rubber-tired construction equipment to detect soft areas. The GP or CQA monitor must observe the proof-rolling operation. Soft areas should be compacted and then be proof rolled again.

The subgrade elevations shall be verified in accordance with the requirements of Section 3.8.3 prior to the placement of the infiltration layer.

3.4 Placement and Processing

The infiltration layer subgrade and surface of each lift should be roughened prior to placement of the next lift of the infiltration layer. The infiltration layer material should be placed in maximum 8-inch loose lifts to produce a compacted lift thickness of approximately 6 inches. The material should be processed to a maximum particle size of 1-inch or less before water is added. Rocks and clods less than 1-inch in diameter should not total more than 10 percent by weight.

If additional water is necessary to adjust the moisture content, it should be applied after initial processing but prior to compaction. Water should be applied evenly across the lift and worked into the material. Waste or any objectionable material must not contaminate compaction water.

3.5 Compaction

The infiltration layer shall be compacted with a pad/tamping-foot or prong-foot roller. A footed roller is necessary to bond the lifts, distribute the water, and blend the soil matrix through kneading action. The infiltration layer shall not be compacted with a bulldozer, rubber-tired roller, flat-wheel roller, scrapers, or any track equipment unless it is used to pull a footed roller. The compactor should weigh at least 40,000 pounds. The lift thickness shall be controlled to achieve total penetration into the top of the previously compacted lift; therefore, the lift thickness must not be greater than the pad or prong length. Cleaning devices on the roller must be in place and maintained to prevent the prongs or pad feet from becoming clogged to the point that they cannot achieve full penetration.

The compactor shall make at least four passes across the area being compacted. A pass is defined as one pass of the compactor, front and rear drums. The material should be compacted to a minimum of 95 percent of the maximum dry density determined by standard Proctor (ASTM D 698) at a moisture content at or above optimum moisture. Areas with failing tests shall be reworked, recompacted, and retested, and passing tests must be achieved before another lift is added.

After a lift is compacted, it must be watered to prevent drying and desiccation until the next lift can be placed. If desiccation occurs, the GP must determine if the lift can be rehydrated by surface application of water or if the lift must be scarified, watered, and recompacted. Following compaction and fine grading of the final lift, the surface of the infiltration layer shall be smooth drum rolled.

3.6 Protection

The completed infiltration layer must be protected from drying, desiccation, rutting, erosion and ponded water until the geocomposite is installed. Areas that undergo excessive desiccation or damage shall be scarified, reworked, recompacted, and retested as directed by the GP.

3.7 Tie-In to Existing Covers

The edge of existing infiltration layers shall be cut back on either a slope or step to prevent the formation of a vertical joint. Details for the tie-in to existing cover are provided in Attachment D3, Drawing D3.3.

3.8 Testing and Verification

3.8.1 Preconstruction Testing

The table below lists the minimum testing required for material proposed for use as the infiltration layer.

Infiltration Layer Material Preconstruction Tests

Test	Standard	Frequency
Plasticity Index	ASTM D 4318	1 per material type
Liquid Limit	ASTM D 4318	1 per material type
Percent Passing No. 200 Mesh Sieve	ASTM D 1140	1 per material type
Percent Passing 1-inch Sieve	ASTM D 422	1 per material type
Standard Proctor Test	ASTM D 698	1 per material type
Coefficient of Permeability	ASTM D 5084 or COE EM 1110-2-1906 Appendix VII	1 per material type

After the moisture density relationship has been determined for a material type, a soil sample should be remolded to about 95 percent of the maximum dry density at the optimum moisture content. This sample will be tested to determine if the soil can be compacted to achieve a suitable coefficient of permeability. Either falling head or constant head laboratory permeability tests may be performed to determine the coefficient of permeability. The permeant fluid for testing must be as required by ASTM D 5084. Distilled or deionized water shall not be used as the permeant fluid.

3.8.2 Construction Testing

The table below lists the minimum testing required for material used as the infiltration layer.

Infiltration Layer Material Construction Tests

Test	Standard	Frequency
Field Density	ASTM D 2922	1/8,000 sf per 6-inch lift
Plasticity Index	ASTM D 4318	1 per acre
Liquid Limit	ASTM D 4318	1 per acre
Percent Passing No. 200 Mesh Sieve	ASTM D 1140	1 per acre
Standard Proctor Test	ASTM D 698	1 per material type
Coefficient of Permeability	ASTM D 5084 or COE EM 1110-2-1906 Appendix VII	1 per acre (on undisturbed sample)

The Atterberg limits of the in-place infiltration layer must be compared to the Atterberg limits of the Proctor curve sample to assure that the Proctor curve represents the in-place material. Any variance of more than 10 points between the liquid limit or plasticity index of the in-place soil and those of the Proctor curve sample will require that a new Proctor curve be developed.

3.8.3 Thickness Verification

The as-built thickness of the infiltration layer shall be determined by standard survey methods. Prior to the placement of infiltration layer material, the subgrade elevations will be determined at a minimum rate of one survey point per 5,000 square feet of lined area. After the infiltration layer is completed, the top of infiltration layer elevations will be determined at the same locations as the subgrade elevations.

4 FLEXIBLE MEMBRANE COVER

30 TAC §330.457

4.1 General

The flexible membrane cover consists of a 40-mil-thick textured linear low-density polyethylene (LLDPE) geomembrane placed over the infiltration layer. The CQA monitor shall provide continuous on-site observation during FMC deployment, trial welds, seaming, testing, and repairing. The GP shall make sufficient site visits during the FMC installation to document the installation and testing in the Final Cover Evaluation Report, in accordance with Section 7.

4.2 Materials

4.2.1 Properties

FMC selected for final cover system construction shall consist of smooth or textured LLDPE geomembrane produced from virgin raw materials. Recycled materials are not acceptable. The FMC shall not be manufactured from resin from differing suppliers. The FMC shall meet the requirements in the most current revisions of Geosynthetics Research Institute (GRI) Standard GM17 (LLDPE). A copy of the current revision of GRI GM17 is included in Appendix D8A.

Manufacturer quality control testing procedures and frequencies for FMC are listed in Section 4.5.1. Third party conformance testing procedures and frequencies for FMC are listed in Section 4.5.2.

4.2.2 Delivery and Storage

FMC shall be shipped in rolls labeled with the manufacturer's name, roll number, and lot or batch number. The CQA monitor shall inspect the rolls for shipping damage and complete a geosynthetics receipt log for all materials delivered to the site. Damaged rolls shall be rejected.

The FMC shall be unloaded and handled with equipment that does not damage the rolls. Rolls should not be pushed, slid, or dragged to the storage location. The FMC must not be stored on wet, soft, or rocky subgrade, but must be stored on a stable subgrade. FMC must not be stacked more than five rolls high to avoid crushing the roll cores. The stored FMC must be protected from puncture, grease, dirt, excessive heat, or other damage.

4.3 Preparation

The surface of the infiltration layer shall be protected until the FMC is installed in accordance with Section 3.6. Prior to installation of the FMC the infiltration layer shall be tested and verified in accordance with Section 3.8, and the GP or CQA monitor and geosynthetics installer shall inspect the surface of the infiltration layer to verify that:

- The infiltration layer surface has been smooth drum rolled.
- The infiltration layer surface is free of irregularities, soft areas, or loose soil.
- The infiltration layer surface is free of stones, protrusions, or objects that could damage the FMC.

The geosynthetics installer must accept the condition of the infiltration layer and sign a subgrade acceptance form prior to the installation of the FMC.

4.4 Installation

4.4.1 Deployment and Placement

The following activities must take place prior to FMC deployment:

- The manufacturer's quality control and third-party conformance tests shall be completed and approved by the GP in accordance with the requirements of Section 4.5.
- The GP or CQA monitor and geosynthetics installer shall approve the subgrade in accordance with the requirements of Section 4.3.
- The geosynthetics installer shall sign the subgrade acceptance form.
- The geosynthetics installer shall submit a drawing showing the proposed panel layout.

FMC shall be deployed by equipment that will unroll the FMC without damaging, crimping, or stretching it, and deployment equipment must not damage the underlying compacted infiltration layer. FMC must not be deployed during periods of rain or high winds and shall not be deployed on frozen subgrade. The installer must only deploy the amount of FMC that can be seamed on the same day.

Upon deployment, each panel shall be assigned a unique identification number. All panels must be anchored with adequate ballast to prevent uplift from wind. Smoking and damaging shoes shall not be permitted on the FMC and only low-ground pressure supporting equipment shall be allowed on the FMC.

During FMC placement, the CQA monitor must:

- Provide full-time observation.
- Record panel numbers, panel dimensions, and roll numbers on the panel layout drawing.
- Record weather conditions.
- Observe the condition of the subgrade and note any deficiencies. All deficiencies shall be repaired and approved by the CQA monitor.
- Observe the condition of the FMC and note any defects. All defects must be repaired in accordance with the requirements of Section 4.4.3.
- Observe that people working on the FMC do not smoke, wear shoes that could damage the FMC, or engage in activities that could damage the FMC.
- Observe that the deployment method minimizes wrinkles, and that the FMC is anchored to prevent movement from wind.

- Observe that no more panels are deployed than can be seamed on the same day.

Any panels that are not deployed in accordance with this section shall be marked by the CQA monitor and repaired in accordance with Section 4.4.3 or be removed and replaced by the installer.

4.4.2 Seaming

Seaming shall be performed in accordance with methods approved or recommended by the geomembrane manufacturer. Only welding apparatuses and operators that have completed approved trial welds, in accordance with Section 4.5.3, shall be allowed to weld panel seams. Each seam shall be assigned a unique number, which is preferably consistent with the panel numbering system. Prior to welding, the proper panel overlap shall be provided; dirt, grease, and free moisture shall be cleaned from the panel contact area; and wrinkles shall be removed as much as practical. For extrusion welds, oxidation shall be ground from the seam area within one hour of the welding operation and the extrudate shall be purged from the extrusion welding apparatus. Seaming operations shall not be allowed when the ambient temperature is below 40°F or above 104°F unless trial welds have demonstrated that adequate welds can be achieved outside these limits.

During FMC seaming operations, the CQA monitor must:

- Provide full-time observation.
- Record seam numbers on the panel layout drawing.
- Record weather conditions.
- Observe that only approved welding apparatuses and operators are allowed to weld seams.
- Observe the condition of the seams and note any defects. All defects must be repaired in accordance with the requirements of Section 4.4.3.
- Observe that people working on the FMC do not smoke, wear shoes that could damage the FMC, or engage in activities that could damage the FMC.
- Observe that the seams are free of grease, dirt, moisture, and wrinkles.
- Observe that welding operations take place within the approved ambient temperature range.
- Observe that seam grinding has been completed less than one hour before extrusion welding and the extrudate has been purged from extrusion welders.

4.4.3 Repairs

Defects in the FMC, defects in seams, failing destructive tests, failing nondestructive tests, holes from nondestructive tests, and destructive test sample locations shall be repaired by one of the following repair techniques:

- Patching - used to repair large holes, tears, large FMC defects, and destructive test locations.
- Extrusion - used to repair small FMC defects, cuts, holes from nondestructive tests, and seam defects less than 1/2-inch long.
- Capping - used to repair failed seams or seams where nondestructive tests cannot be performed.

- Removal - used to replace areas with large defects where other repair techniques are not appropriate.

Patches and caps should extend six inches beyond the edge of the defect and the repair surfaces shall be clean and dry. The area to be repaired shall be abraded to remove oxidation and the top edges of patches should be beveled.

4.5 Testing and Verification

4.5.1 Manufacturer's Quality Control Testing

The FMC manufacturer shall test the geomembrane and raw materials in accordance with GRI Standard GM17 to assure the quality of the FMC. Material property requirements are provided in Section 4.2.1.

4.5.2 Conformance Testing

Conformance samples of the FMC shall be cut across the full width of selected rolls in accordance with the test frequency specified in the table below. Conformance samples may be taken at the manufacturing plant or at the project site and will be forwarded to a third-party laboratory for testing. Material property requirements are provided in Section 4.2.1. Minimum conformance testing requirements are provided in the table below.

FMC Conformance Tests

Test	Standard	Frequency
Sheet Thickness	ASTM D 5199, 1593, or 5994	1 per 100,000 sf
Specific Gravity	ASTM D 1505	1 per 100,000 sf and every resin lot
Carbon Black Content	ASTM D 1603	1 per 100,000 sf and every resin lot
Carbon Black Dispersion	ASTM D 3015 or 5596	1 per 100,000 sf and every resin lot
Tensile Properties	ASTM D 638	1 per 100,000 sf and every resin lot

4.5.3 Trial Welds

Each operator and welding apparatus must be tested to verify that seam welds that meet the specifications can be achieved under the site conditions. Trial welds must be performed at the beginning and midpoint of each day for each operator and apparatus used that day. If welding continues past 6:00 p.m., additional trial welds may be required.

The trial weld samples shall be three feet long and 12 inches wide, with the seam centered lengthwise. At least four 1-inch-wide coupons will be cut from each trial weld sample. Two coupons from each sample will be tested for shear and two samples will be tested for peel. Peel test coupons for dual-track welds shall be tested on both sides of the air channel. Each coupon must meet the minimum strength requirements listed in Section 4.5.4 and

exhibit a Film Tear Bond (FTB). If the trial weld fails, two more trial seams must be welded and tested. This process will continue until passing trial welds are achieved.

If the CQA monitor believes that an operator or apparatus is not functioning properly, or if the weather conditions have substantially changed since the trial welds were performed, new trial welds must be performed.

4.5.4 Construction Testing

Nondestructive Tests

Nondestructive seam tests include vacuum testing and air pressure testing. Nondestructive testing shall be performed for the entire length of each seam by the FMC installer.

Vacuum testing shall be used to test extrusion-welded seams and fusion-welded seams that cannot be tested by air pressure methods. The vacuum box shall be placed over a seam section, which has been thoroughly saturated with a soapy water solution. The rubber gasket on the bottom of the vacuum box must seal against the FMC to prevent leaks. The vacuum box pressure shall be reduced to about three to five inches of Hg. Soap bubbles will indicate the presence of holes or non-bonded seams. The vacuum box dwell time shall be at least 10 seconds.

Air pressure testing shall be used to test fusion-welded seams that have an air channel. Both ends of the air channel shall be sealed and air shall be pumped into the channel to at least 30 psi or 1/2 psi per mil of thickness, whichever is greater. The air channel must sustain the pressure for at least five minutes without more than a 4-psi pressure drop. Following a passing pressure test, the pressure shall be released from the end of the seam that is opposite of the pressure gauge. The pressure gauge must return to zero; if it does not, the seam is probably blocked. After the blockage has been located, the seam shall be pressure tested on both sides of the blockage. All penetration holes shall be sealed after the air pressure testing is completed.

During the nondestructive testing, the CQA monitor must:

- Observe that equipment and operators perform the tests properly.
- Observe that the entire length of each seam is tested and record the results of the test.
- Identify failed seams and inform the installer of any required repairs.
- Record all completed and tested repairs.

Destructive Tests

Destructive testing shall be performed at a frequency of one stratified test location per 500 linear feet of seam. Repairs over 15 feet long shall be included in the total seam length. Additional destructive test samples may be taken if deemed necessary by the geotechnical professional or his representative. Destructive test samples should be 45 inches long by 12 inches wide with the seam centered along the length of the sample.

Two coupons should be cut from each end of the sample and the installer must test these coupons with a tensiometer capable of measuring the seam strength. The installer shall test two coupons in shear and two coupons in peel. For double wedge-welded seams, both sides of the air channel shall be tested in peel. The CQA monitor must observe the tests and record the results on the destructive testing log. The minimum requirements for destructive testing are provided in the table below. If one of the coupons fails in either peel or shear, the installer shall reconstruct the entire seam between passed test locations or take additional samples 10 feet in both directions of the failed test. If the additional tests pass, the contractor shall reconstruct or cap the seam between the passing test locations. If the additional tests fail, the sampling and testing procedure shall be repeated until the length of the faulty seam is established.

If the field test results are satisfactory, the remaining sample shall be divided into three parts: one-third for the installer, one-third for third-party testing, and one-third for the owner to archive. The third-party testing shall test five coupons from each sample in shear and test five coupons from each sample in peel (10 when testing both inner and outer welds of dual-track welds). The minimum requirements for destructive testing are provided in the table below. If the third-party test fails in either peel or shear, the installer shall reconstruct the entire seam between passed test locations or take additional samples 10 feet in both directions of the failed test. If the additional tests pass, the contractor shall reconstruct or cap the seam between the passing test locations. If the additional tests fail, the sampling and testing procedure shall be repeated until the length of the faulty seam is established. All seams shall be bracketed by passing third-party tests; field test results shall not be used for final acceptance.

FMC Seam Properties

Test	Standard	Frequency	Minimum Criteria
Shear	ASTM D 4437	1 sample per 500 feet of seam	All field specimens and four of five third-party specimens from each sample must have a shear strength greater than or equal to 95% of sheet strength but not less than 40 ppi (LLDPE). All field specimens and the average shear strength value of all third-party specimens must be greater than or equal to 95% of sheet strength but not less than 40 ppi (LLDPE).
Peel	ASTM D 4437	1 sample per 500 feet of seam	All field specimens and four of five third-party specimens from each sample must have a peel strength greater than or equal to 62% of sheet strength but not less than 36 ppi (LLDPE). All field specimens and the average peel strength value of all third-party specimens must be greater than or equal to 62% of sheet strength but not less than 36 ppi (LLDPE). Both sides of dual track seams shall meet the minimum criteria. Each track is considered a separate sample. All specimens shall exhibit Film Tear Bond.

During destructive seam testing, the CQA monitor must:

- Select sample locations and observe sample cutting.

- Assign sample numbers and label samples.
- Observe installer-performed tests.
- Record sample locations, sample number, sample purpose, and field test results.

5 DRAINAGE LAYER

30 TAC §330.457

5.1 General

The drainage layer consists of a double-sided geocomposite. The CQA monitor shall provide on-site observation during geocomposite installation. The GP shall make sufficient site visits during the geocomposite drainage layer to document the installation in the Final Cover Evaluation Report.

Perforated HDPE pipe will be installed at the toe of the slope and at intervals approximately 250 feet apart across the sideslopes to collect drainage from the geocomposite drainage layer. The perforated piping will collect the drainage and direct the flow into the perimeter drainage system. Calculations for the drain system are included in Attachment D9.

5.2 Materials

5.2.1 Geocomposite

Double-sided geocomposite (nonwoven geotextile bonded to the top and bottom of HDPE drainage net) will be installed on the sideslopes of the alternate final cover system. The geocomposite shall have the minimum properties listed below.

Geocomposite Properties

Material	Test	Standard	Required Property
Geotextile	Material Apparent Opening Size	ASTM D 4751	Nonwoven polypropylene or polyester 70 sieve
	Unit Weight	ASTM D 5261	6 oz/yd^2
	Grab Strength	ASTM D 4632	150 lb
	Puncture Resistance	ASTM D 6241	300 lb
	Trapezoidal Tear Strength	ASTM D 4533	65 lb
	Permittivity	ASTM D 4491	1.0 sec^{-1}
	UV Resistance	ASTM D 4355	70%/500 hrs
HDPE Drainage Net	Density Thickness Carbon Black	ASTM D 1505 ASTM D 5199 ASTM D 4218	0.93 g/cm^3 0.25 inch Minimum 2%, maximum 3%
	Resin Melt Flow Index	ASTM D 1238	1 g/10 min
	Tensile Strength	ASTM D 5035 or 7179	40 lb/in
Geocomposite	Transmissivity	ASTM D 4716	5 x 10^{-4} m^2/ sec
	Ply Adhesion	ASTM D 7005	1 lb/in

Manufacturer quality control testing procedures for geocomposite are listed in Section 5.5.

5.2.2 HDPE Drainage Collection Piping

The drainage layer collection piping includes perforated HDPE collection trench pipes. The pipe shall have the minimum SDR rating and perforation schedule shown on the construction details in Attachment D3.

5.2.3 Delivery and Storage

Geocomposite shall be shipped in rolls with opaque wrappers labeled with the manufacturer's name, roll number, and lot or batch number. The CQA monitor shall inspect the rolls for shipping damage and complete a geosynthetics receipt log for all materials delivered to the site. Damaged rolls shall be rejected.

The geocomposite and pipe shall be unloaded and handled with equipment that does not cause damage. Rolls should not be pushed, slid, or dragged to the storage location. The geocomposite and geotextile must not be stored on wet, soft, or rocky subgrade, but must be stored on a stable subgrade. Geocomposite and geotextile must not be stacked more than five rolls high to avoid crushing the roll cores. The stored geocomposite, geotextile, and pipe must be protected from puncture, grease, dirt, excessive heat, or other damage.

5.3 Preparation

Prior to installation of the drainage layer, the FMC shall be tested and verified in accordance with Section 4.5. The CQA monitor shall observe that the surface to receive the geosynthetics is free of debris, stones, and dirt and verify that the conformance documentation has been submitted and approved.

5.4 Installation

5.4.1 Geocomposite

Geocomposite shall be deployed by equipment that will not damage, crimp, or stretch it nor damage any underlying FMC. All panels must be anchored with adequate ballast to prevent uplift from wind. Smoking and damaging shoes shall not be permitted on the geocomposite or geotextile and only low-ground pressure supporting equipment shall be allowed on the FMC. Adjacent rolls of geocomposite shall be securely tied through the drainage net with plastic fasteners every five feet along the length of the panel and every 6 inches along the ends of the panels. Adjacent rolls of geotextile shall be overlapped and sewn or heat bonded together.

During drainage layer placement, the CQA monitor must:

- Provide full time observation.
- Record weather conditions.
- Observe the condition of the geocomposite and geotextile and note any defects. All defects must be repaired or replaced.
- Observe that people working on the FMC do not smoke, wear shoes that could damage the FMC, or engage in activities that could damage the FMC.

- Observe that the deployment method minimizes wrinkles in the FMC and the geocomposite.
- Observe that the geocomposite and geotextile panels have been properly tied and seamed.

Any panels that are not installed in accordance with this section shall be marked by the CQA monitor and be repaired or removed and replaced by the installer.

5.4.2 Pipe

Drainage layer collection pipe shall be placed to the lines and grades shown on the plans. The pipe shall be joined in accordance with the manufacturer's recommendations. Construction equipment shall not be allowed to travel directly over the collection pipes to prevent crushing or excessive deflection until protective cover has been placed. Minimum equipment separation distances listed in Section 6.4.

During pipe placement, the CQA monitor must:

- Observe the condition of the pipes and note any defects. All defective pipes must be replaced.
- Observe that construction equipment does not damage pipes, geotextile, geocomposite, or FMC.
- Observe that the perforations and pipe orientation are in accordance with the plans and specifications.
- Observe that the pipes and fittings are joined in accordance with the manufacturer's recommendations.

Any pipes that are not installed in accordance with this section shall be marked by the CQA monitor and be repaired or removed and replaced by the installer.

5.5 Testing and Verification

5.5.1 Manufacturer's Testing

The manufacturer shall test the geotextile and geocomposite to assure the quality of the drainage layer materials. Material property requirements are provided in Section 5.2. Minimum manufacturer's testing requirements are provided in the Geocomposite and Geotextile Manufacturer's Tests table below. Manufacturer's testing shall be performed at a minimum frequency of one test per 100,000 sf with a minimum of 1 test per resin lot, except ASTM D 4355 which shall be tested at a frequency of 1 per formulation.

The drainage layer collection pipe manufacturer shall provide a certification that the supplied pipe meets the minimum SDR rating and perforation schedule shown on the plans and specifications.

Geocomposite Manufacturer's Tests

Material	Test	Standard
Geotextile	Unit Weight	ASTM D 5261
	Apparent Opening Size	ASTM D 4751
	Grab Strength	ASTM D 4632
	Trapezoidal Tear Strength	ASTM D 4533
	Puncture Strength	ASTM D 6241
	Permittivity	ASTM D 4491
	Deterioration	ASTM D 4355
HDPE Drainage Net	Density	ASTM D 1505
	Thickness	ASTM D 5199
	Carbon Black	ASTM D 4218
	Resin Melt Index	ASTM D 1238
	Tensile Strength	ASTM D 5035 or 7179
Geocomposite	Transmissivity	ASTM D 4716
	Ply Adhesion	ASTM D 7005

5.5.2 Verification

The as-built location of the drainage layer collection piping shall be determined and reported in the Final Cover Evaluation Report, in accordance with Section 7 of this attachment.

6 EROSION LAYER

30 TAC §330.457

6.1 General

The erosion layer consists of either a 24-inch-thick layer of soil (top deck) or a 36-inch-thick layer of soil (sideslopes) with the upper six inches capable of sustaining native plant growth. The CQA monitor shall provide continuous on-site observation during erosion layer placement to assure that erosion layer placement does not damage underlying geosynthetics. The GP shall make sufficient site visits during erosion layer placement to document the construction activities and thickness verification in the Final Cover Evaluation Report.

6.2 Materials

Erosion layer material shall consist of soil that is free from debris, rubbish, frozen materials, foreign objects, or any material that could damage underlying geosynthetics.

6.3 Preparation

Prior to placing the erosion layer material, the top of underlying layer elevations shall be verified in accordance with the requirements of Section 3.8.3 and all testing on underlying geosynthetics shall be completed.

6.4 Placement

The erosion layer shall be placed in a manner that minimizes the potential to damage underlying soil layers and/or geosynthetics. Hauling equipment shall be restricted to haul roads of sufficient thickness to protect underlying geosynthetics. The erosion layer shall be dumped from the haul road and spread by low ground pressure equipment in a manner that minimizes wrinkles and stress in geosynthetics. On sideslopes, erosion layer shall be placed from the bottom to the top, not across or down.

The erosion layer will be seeded or sodded immediately following the application of final cover to minimize erosion.

Minimum Separation Distance

Equipment Ground Pressure (psi)	Minimum Separation Distance (in)
< 4	12
4 - 8	18
8 - 16	24
> 16	36

Any geosynthetic material that, in the opinion of the CQA monitor, has been damaged by the erosion layer placement must be repaired and retested in accordance with Sections 4 and 5.

6.5 Testing and Verification

The as-built thickness of the erosion layer shall be determined by standard survey methods. Prior to the placement of erosion layer, the top of the underlying layer elevations will be determined at a minimum rate of one survey point per 5,000 square feet of lined area. After the erosion layer is completed, the top of the erosion layer elevations will be determined at the same locations.

7 DOCUMENTATION

After construction of the final cover system, the GP will submit a Final Cover Evaluation Report to the TCEQ on behalf of the owner. The purpose of the Final Cover Evaluation Report is to document that the construction methods and test procedures are consistent with this FCQCP.

At a minimum, the Final Cover Evaluation Report will contain the following:

- A summary of all construction activities;
- A summary of all third-party and field test results;
- Sampling and testing location drawings;
- A description of significant construction problems and the resolution of these problems;
- Record drawings;
- A statement of compliance with the FCQCP, and;
- The seal and signature of the GP and assistant GP, if applicable, in accordance with the Texas Engineering Practice Act.

APPENDIX D8A
GRI GM17

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Revision 14: March 17, 2021
Revision schedule on pg. 12

GRI - GM17 Standard Specification*

Standard Specification for

"Test Methods, Test Properties and Testing Frequency for
Linear Low Density Polyethylene (LLDPE) Smooth and Textured Geomembranes" SM

This specification was developed by the Geosynthetic Research Institute (GRI), with the cooperation of the member organizations for general use by the public. It is completely optional in this regard and can be superseded by other existing or new specifications on the subject matter in whole or in part. Neither GRI, the Geosynthetic Institute, nor any of its related institutes, warrant or indemnifies any materials produced according to this specification either at this time or in the future.

1. Scope

1.1 This specification covers linear low density polyethylene (LLDPE) geomembranes with a formulated sheet density of 0.939 g/ml, or lower, in the thickness range of 0.50 mm (20 mils) to 3.0 mm (120 mils). Both smooth and textured geomembrane surfaces are included.

1.2 This specification sets forth a set of minimum, maximum, or range of physical, mechanical and endurance properties that must be met, or exceeded by the geomembrane being manufactured.

1.3 In the context of quality systems and management, this specification represents manufacturing quality control (MQC).

Note 1: Manufacturing quality control represents those actions taken by a manufacturer to ensure that the product represents the stated objective and properties set forth in this specification.

*This GRI standard specification is developed by the Geosynthetic Research Institute through consultation and review by the member organizations. This specification will be reviewed at least every 2-years, or on an as-required basis. In this regard it is subject to change at any time. The most recent revision date is the effective version and it is kept current on the Institute's Website <<geosynthetic-institute.org>>.

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1.4 This standard specification is intended to ensure good uniform quality LLDPE geomembranes for use in general applications.

Note 2: Additional tests, or more restrictive values for the tests indicated, may be necessary under conditions of a particular application. In this situation, interactions with the manufacturers are required.

Note 3: For information on installation techniques, users of this standard are referred to the geosynthetics literature, which is abundant on the subject.

2. Referenced Documents

2.1 ASTM Standards

D 792 Specific Gravity (Relative Density) and Density of Plastics by Displacement
D 1004 Test Method for Initial Tear Resistance of Plastics Film and Sheeting
D 1238 Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer
D 1505 Test Method for Density of Plastics by the Density-Gradient Technique
D 1603 Test Method for Carbon Black in Olefin Plastics
D 4218 Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique
D 4833 Test Method for Index Puncture Resistance of Geotextiles, Geomembranes and Related Products
D 5199 Test Method for Measuring Nominal Thickness of Geotextiles and Geomembranes
D 5323 Practice for Determination of 2% Secant Modulus for Polyethylene Geomembranes
D 5596 Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics
D 5617 Test Method for Multi-Axial Tension Test for Geosynthetics
D 5721 Practice for Air-Oven Aging of Polyolefin Geomembranes
D 5885 Test method for Oxidative Induction Time of Polyolefin Geosynthetics by High Pressure Differential Scanning Calorimetry
D 5994 Test Method for Measuring the Core Thickness of Textured Geomembranes
D 6370 Standard Test Method for Rubber-Compositional Analysis by Thermogravimetry (TGA)
D 6693 Test Method for Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polypropylene Geomembranes
D 7238 Test Method for Effect of Exposure of Unreinforced Polyolefin Geomembrane Using Fluorescent Condensation Device
D 7466 Test Method for Measuring the Asperity Height of Textured Geomembranes

D 8117 Standard Test Method for Oxidative Induction Time of Polyolefin Geosynthetics by Differential Scanning Calorimetry

2.2 U. S. Environmental Protection Agency Technical Guidance Document "Quality Control Assurance and Quality Control for Waste Containment Facilities," EPA/600/R-93/182, September 1993, 305 pgs.

3. Definitions

Manufacturing Quality Control (MQC) - A planned system of inspections that is used to directly monitor and control the manufacture of a material which is factory originated. MQC is normally performed by the manufacturer of geosynthetic materials and is necessary to ensure minimum (or maximum) specified values in the manufactured product. MQC refers to measures taken by the manufacturer to determine compliance with the requirements for materials and workmanship as stated in certification documents and contract specifications.
ref. EPA/600/R-93/182

Manufacturing Quality Assurance (MQA) - A planned system of activities that provides assurance that the materials were constructed as specified in the certification documents and contract specifications. MQA includes manufacturing facility inspections, verifications, audits and evaluation of the raw materials (resins and additives) and geosynthetic products to assess the quality of the manufactured materials. MQA refers to measures taken by the MQA organization to determine if the manufacturer is in compliance with the product certification and contract specifications for the project.
ref. EPA/600/R-93/182

Linear Low Density Polyethylene (LLDPE), n – A ethylene/α-olefin copolymer having a linear molecular structure. The comonomers used to produce the resin can include 1-butene, 1-hexene, 1-octene or 4-methyl-1-pentene. LLDPE resins have a natural density in the range of 0.915 to 0.926 g/ml (ref. Pate, T. J. Chapter 29 in Handbook of Plastic Materials and Technology, I.I. Rubin Ed., Wiley, 1990).

Formulation - The mixture of a unique combination of ingredients identified by type, properties and quantity. For linear low density polyethylene geomembranes, a formulation is defined as the exact percentages and types of resin(s), additives and carbon black.

Nominal - Representative value of a measurable property determined under a set of conditions, by which a product may be described. Abbreviated as nom. in Tables 1 and 2.

4. Material Classification and Formulation

4.1 This specification covers linear low density polyethylene geomembranes with a formulated sheet density of 0.939 g/ml, or lower. Density can be measured by ASTM D1505 or ASTM D792. If the latter, Method B is recommended.

4.2 The polyethylene resin from which the geomembrane is made will generally be in the density range of 0.926 g/ml or lower, and have a melt index value per ASTM D1238 of less than 1.0 g/10 min. This refers to the natural, i.e., nonformulated, resin.

4.3 The resin shall be virgin material with no more than 10% rework. If rework is used, it must be of the same formulation (or other approved formulation) as the parent material.

4.4 No post consumer resin (PCR) of any type shall be added to the formulation.

5. Physical, Mechanical and Chemical Property Requirements

5.1 The geomembrane shall conform to the test property requirements prescribed in Tables 1 and 2. Table 1 is for smooth LLDPE geomembranes and Table 2 is for single and double sided textured LLDPE geomembranes. Each of the tables are given in English and SI (metric) units. The conversion from English to SI (metric) is "soft". It is to be understood that the tables refer to the latest revision of the referenced test methods and practices.

Note 4: The tensile strength properties in this specification were originally based on ASTM D 638 which uses a laboratory testing temperature of 23°C ± 2°C. Since ASTM Committee D35 on Geosynthetics adopted ASTM D 6693 (in place of D 638), this GRI Specification followed accordingly. The difference is that D 6693 uses a testing temperature of 21°C ± 2°C. The numeric values of strength and elongation were not changed in this specification. If a dispute arises in this regard, the original temperature of 23°C ± 2°C should be utilized for testing purposes.

Note 5: There are several tests sometimes included in other LLDPE geomembrane specifications which are omitted from this standard because they are outdated, irrelevant or generate information that is not necessary to evaluate on a routine MQC basis. The following tests have been purposely omitted:

- Volatile Loss
- Dimensional Stability
- Coeff. of Linear Expansion
- Resistance to Soil Burial
- Low Temperature Impact
- ESCR Test (D 1693 and D 5397)
- Wide Width Tensile
- Water Vapor Transmission
- Solvent Vapor Transmission
- Water Absorption
- Ozone Resistance
- Hydrostatic Resistance
- Tensile Impact
- Small Scale Burst
- Various Toxicity Tests
- Field Seam Strength

Note 6: There are several tests which are included in this standard (that are not customarily required in other LLDPE geomembrane specifications) because they are relevant and important in the context of current manufacturing processes. The following tests have been purposely added:

- Oxidative Induction Time
- Oven Aging
- Ultraviolet Resistance
- Asperity Height of Textured Sheet

Note 7: There are other tests in this standard, focused on a particular property, which are updated to current standards. The following are in this category:

- Thickness of Textured Sheet
- Tensile Properties, incl. 2% Secant Modulus
- Puncture Resistance
- Axi-Symmetric Break Resistance Strain
- Carbon Black Dispersion (In the viewing and subsequent quantitative interpretation of ASTM D 5596 only near spherical agglomerates shall be included in the assessment).

Note 8: The minimum average value of asperity height does not represent an expected value of interface shear strength. Shear strength associated with geomembranes is both site-specific and product-specific and should be determined by direct shear testing using ASTM D5321/ASTM D6243 as prescribed. This testing should be included in the particular site's CQA conformance testing protocol for the geosynthetic materials involved, or formally waived by the Design Engineer, with concurrence from the Owner prior to the deployment of the geosynthetic materials.

5.2 The values listed in the tables of this specification are to be interpreted according to the designated test method. In this respect they are neither minimum average roll values (MARV) nor maximum average roll values (MaxARV).

5.3 The various properties of the LLDPE geomembrane shall be tested at the minimum frequencies shown in Tables 1 and 2. If the specific manufacturer's quality control guide is more stringent, it must be followed in like manner.

Note 9: This specification is focused on manufacturing quality control (MQC). Conformance testing and manufacturing quality assurance (MQA) testing are at the discretion of the purchaser and/or quality

assurance engineer, respectively. Communication and interaction with the manufacturer is strongly suggested.

6. Workmanship and Appearance

6.1 Smooth geomembrane shall have good appearance qualities. It shall be free from such defects that would affect the specified properties and hydraulic integrity of the geomembrane.

6.2 Textured geomembrane shall generally have uniform texturing appearance. It shall be free from such defects that would affect the specified properties and hydraulic integrity of the geomembrane.

6.3 General manufacturing procedures shall be performed in accordance with the manufacturer's internal quality control guide and/or documents.

7. MQC Sampling

7.1 Sampling shall be in accordance with the specific test methods listed in Tables 1 and 2. If no sampling protocol is stipulated in the particular test method, then test specimens shall be taken evenly spaced across the entire roll width.

7.2 The number of tests shall be in accordance with the appropriate test methods listed in Tables 1 and 2.

7.3 The average of the test results should be calculated per the particular standard cited and compared to the minimum value listed in these tables, hence the values listed are the minimum average values and are designated as "min. ave."

8. MQC Retest and Rejection

8.1 If the results of any test do not conform to the requirements of this specification, retesting to determine conformance or rejection should be done in accordance with the manufacturing protocol as set forth in the manufacturer's quality manual.

9. Packaging and Marketing

9.1 The geomembrane shall be rolled onto a substantial core or core segments and held firm by dedicated straps/slings, or other suitable means. The rolls must be adequate for safe transportation to the point of delivery, unless otherwise specified in the contract or order.

9.2 Marking of the geomembrane rolls shall be done in accordance with the manufacturers accepted procedure as set forth in their quality manual.

10. Certification

10.1 Upon request of the purchaser in the contract or order, a manufacturer's certification that the material was manufactured and tested in accordance with this specification, together with a report of the test results, shall be furnished at the time of shipment.

English Units

Table 1(a) – Linear Low Density Polyethylene (LLDPE) Geomembrane (SMOOTH)

Properties	Test Method	Test Value								Testing Frequency (minimum)
		20 mils	30 mils	40 mils	50 mils	60 mils	80 mils	100 mils	120 mils	
Thickness - (min. ave.) - mils • lowest individual of 10 values - %	D5199	nom. -10	nom. -10	nom. -10	nom. -10	nom. -10	nom. -10	nom. -10	nom. -10	per roll
Formulated Density (max.) - g/cc	D 1505/D 792	0.939	0.939	0.939	0.939	0.939	0.939	0.939	0.939	200,00 lb
Tensile Properties *(1)* (min. ave.) • break strength - lb/in. • break elongation - %	D 6693 Type IV	 76 800	 114 800	 152 800	 190 800	 228 800	 304 800	 380 800	 456 800	20,000 lb
2% Modulus (max.) - lb/in.	D 5323	1200	1800	2400	3000	3600	4800	6000	7200	per formulation
Tear Resistance (min. ave.) - lb	D 1004	11	16	22	27	33	44	55	66	45,000 lb
Puncture Resistance (min. ave.) - lb	D 4833	28	42	56	70	84	112	140	168	45,000 lb
Axi-Symmetric Break Resistance Strain (min.) - %	D 5617	30	30	30	30	30	30	30	30	per formulation
Carbon Black Content (range) - %	D 4218 *(2)*	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	45,000 lb
Carbon Black Dispersion	D 5596	note *(3)*	note *(3)*	note *(3)*	note *(3)*	note *(3)*	note *(3)*	note *(3)*	note *(3)*	45,000 lb
Oxidative Induction Time (OIT) (min. ave.) *(4)* (a) Standard OIT - min. — or — (b) High Pressure OIT - min.	 D 8117 D 5885	 100 400	 100 400	 100 400	 100 400	 100 400	 100 400	 100 400	 100 400	200,000 lb
Oven Aging at 85°C *(5)* (a) Standard OIT (min. ave.) - % retained after 90 days — or — (b) High Pressure OIT (min. ave.) - % retained after 90 days	D 5721 D 8117 D 5885	 35 60	 35 60	 35 60	 35 60	 35 60	 35 60	 35 60	 35 60	per formulation
UV Resistance *(6)* (a) Standard OIT (min. ave.) — or — (b) High Pressure OIT (min. ave.) - % retained after 1600 hrs *(8)*	D 7238 D 8117 D 5885	 N. R. *(7)* 35	 N.R. *(7)* 35	 N.R. *(7)* 35	 N.R. *(7)* 35	 N.R. *(7)* 35	 N.R. *(7)* 35	 N.R. *(7)* 35	 N.R. *(7)* 35	per formulation

(1) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction.
- Break elongation is calculated using a gage length of 2.0 in. at 2.0 in./min.

(2) Other methods such as D 1603 (tube furnace) or D 6370 (TGA) are acceptable if an appropriate correlation to D 4218 (muffle furnace) can be established.

(3) Carbon black dispersion (only near spherical agglomerates) for 10 different views:
- 9 in Categories 1 or 2 and 1 in Category 3

(4) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.

(5) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.

(6) The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.

(7) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.

(8) UV resistance is based on percent retained value regardless of the original HP-OIT value.

SI (Metric) Units

Table 1(b) – Linear Low Density Polyethylene (LLDPE) Geomembrane (SMOOTH)

Properties	Test Method	Test Value 0.50 mm	0.75 mm	1.00 mm	1.25 mm	1.50 mm	2.00 mm	2.50 mm	3.00 mm	Testing Frequency (minimum)
Thickness - (min. ave.) - mm • lowest individual of 10 values - %	D5199	nom. -10	nom. -10	nom. -10	nom. -10	nom. -10	nom. -10	nom. -10	nom. -10	per roll
Formulated Density (max.) - g/cc	D 1505/D 792	0.939	0.939	0.939	0.939	0.939	0.939	0.939	0.939	90,000 kg
Tensile Properties *(1)* (min. ave.) • break strength - N/mm • break elongation - %	D 6693 Type IV	 13 800	 20 800	 27 800	 33 800	 40 800	 53 800	 66 800	 80 800	9,000 kg
2% Modulus (max.) - N/mm	D 5323	210	315	420	520	630	840	1050	1260	per formulation
Tear Resistance (min. ave.) - N	D 1004	50	70	100	120	150	200	250	300	20,000 kg
Puncture Resistance (min. ave.) - N	D 4833	120	190	250	310	370	500	620	750	20,000 kg
Axi-Symmetric Break Resistance Strain - % (min.)	D 5617	30	30	30	30	30	30	30	30	per formulation
Carbon Black Content (range) - %	D 4218 *(3)*	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	20,000 kg
Carbon Black Dispersion	D 5596	note *(3)*	note *(3)*	note *(3)*	note *(3)*	note *(3)*	note *(3)*	note *(3)*	note *(3)*	20,000 kg
Oxidative Induction Time (OIT) (min. ave.) *(4)* (c) Standard OIT - min. — or — (d) High Pressure OIT - min.	 D 8117 D 5885	 100 400	 100 400	 100 400	 100 400	 100 400	 100 400	 100 400	 100 400	90,000 kg
Oven Aging at 85°C *(5)* (a) Standard OIT (min. ave.) - % retained after 90 days — or — (b) High Pressure OIT (min. ave.) - % retained after 90 days	D 5721 D 8117 D 5885	 35 60	 35 60	 35 60	 35 60	 35 60	 35 60	 35 60	 35 60	per formulation
UV Resistance *(6)* (a) Standard OIT (min. ave.) — or — (b) High Pressure OIT (min. ave.) - % retained after 1600 hrs *(8)*	D 7238 D 8117 D 5885	 N. R. *(7)* 35	 N.R. *(7)* 35	 N.R. *(7)* 35	 N.R. *(7)* 35	 N.R. *(7)* 35	 N.R. *(7)* 35	 N.R. *(7)* 35	 N.R. *(7)* 35	per formulation

(1) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction.
- Break elongation is calculated using a gage length of 50 mm at 50 mm/min.

(2) Other methods such as D 1603 (tube furnace) or D 6370 (TGA) are acceptable if an appropriate correlation to D 4218 (muffle furnace) can be established.

(3) Carbon black dispersion (only near spherical agglomerates) for 10 different views:
- 9 in Categories 1 or 2 and 1 in Category 3

(4) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.

(5) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.

(6) The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.

(7) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.

(8) UV resistance is based on percent retained value regardless of the original HP-OIT value.

English Units

Table 2(a) – Linear Low Density Polyethylene (LLDPE) Geomembrane (TEXTURED)

Properties	Test Method	Test Value								Testing Frequency (minimum)
		20 mils	30 mils	40 mils	50 mils	60 mils	80 mils	100 mils	120 mils	
Thickness (min. ave.) - mils • lowest individual for 8 out of 10 values - % • lowest individual for any of the 10 values - %	D 5994	nom. -5% -10 -15	nom. -5% -10 -15	nom. -5% -10 -15	nom. -5% -10 -15	nom. -5% -10 -15	nom. -5% -10 -15	nom. -5% -10 -15	nom. -5% -10 -15	per roll
Asperity Height (min. ave.) - mils	D 7466	16	16	16	16	16	16	16	16	Every 2nd roll *(1)*
Formulated Density (max.) - g/cc	D 1505/D 792	0.939	0.939	0.939	0.939	0.939	0.939	0.939	0.939	200,000 lb
Tensile Properties *(2)* (min. ave.) • break strength - lb/in. • break elongation - %	D 6693 Type IV	 30 250	 45 250	 60 250	 75 250	 90 250	 120 250	 150 250	 180 250	20,000 lb
2% Modulus – lb/in. (max.)	D 5323	1200	1800	2400	3000	3600	4800	6000	7200	per formulation
Tear Resistance (min. ave.) - lb	D 1004	11	16	22	27	33	44	55	66	45,000 lb
Puncture Resistance (min. ave.) - lb	D 4833	22	33	44	55	66	88	110	132	45,000 lb
Axi-Symmetric Break Resistance Strain (min.) - %	D 5617	30	30	30	30	30	30	30	30	per formulation
Carbon Black Content - %	D 4218 *(3)*	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	45,000 lb
Carbon Black Dispersion	D 5596	note *(4)*	note *(4)*	note *(4)*	note *(4)*	note *(4)*	note *(4)*	note *(4)*	note *(4)*	45,000 lb
Oxidative Induction Time (OIT) (min. ave.) *(5)* (e) Standard OIT - min. — or — (f) High Pressure OIT - min.	 D 8117 D 5885	 100 400	 100 400	 100 400	 100 400	 100 400	 100 400	 100 400	 100 400	200,000 lb
Oven Aging at 85°C *(6)* (a) Standard OIT (min. ave.) - % retained after 90 days — or — (b) High Pressure OIT (min. ave.) - % retained after 90 days	D 5721 D 8117 D 5885	 35 60	 35 60	 35 60	 35 60	 35 60	 35 60	 35 60	 35 60	per formulation
UV Resistance *(7)* (a) Standard OIT (min. ave.) — or — (b) High Pressure OIT (min. ave.) - % retained after 1600 hrs *(9)*	D 7238 D 8117 D 5885	 N. R. *(8)* 35	 N.R. *(8)* 35	 N.R. *(8)* 35	 N.R. *(8)* 35	 N.R. *(8)* 35	 N.R. *(8)* 35	 N.R. *(8)* 35	 N.R. *(8)* 35	per formulation

(1) Alternate the measurement side for double sided textured sheet

(2) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction.
- Break elongation is calculated using a gage length of 2.0 in. at 2.0 in./min.

(3) Other methods such as D 1603 (tube furnace) or D 6370 (TGA) are acceptable if an appropriate correlation to D 4218 (muffle furnace) can be established.

(4) Carbon black dispersion (only near spherical agglomerates) for 10 different views:
- 9 in Categories 1 or 2 and 1 in Category 3

(5) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.

(6) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.

(7) The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.

(8) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.

(9) UV resistance is based on percent retained value regardless of the original HP-OIT value.

SI (Metric) Units

Table 2(b) – Linear Low Density Polyethylene (LLDPE) Geomembrane (TEXTURED)

Properties	Test Method	Test Value								Testing Frequency (minimum)
		0.50 mm	0.75 mm	1.00 mm	1.25 mm	1.50 mm	2.00 mm	2.50 mm	3.00 mm	
Thickness (min. ave.) - mm	D 5994	nom. -5%	nom. -5%	nom. -5%	nom. -5%	nom. (5%	nom. -5%	nom. -5%	nom. -5%	per roll
• lowest individual for 8 out of 10 values		-10	-10	-10	-10	-10	-10	-10	-10	
• lowest individual for any of the 10 values		-15	-15	-15	-15	-15	-15	-15	-15	
Asperity Height mm (min. ave.)	D 7466	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	Every 2nd roll *(1)*
Formulated Density (max.) - g/cc	D 1505/D 792	0.939	0.939	0.939	0.939	0.939	0.939	0.939	0.939	90,000 kg
Tensile Properties *(2)* (min. ave.)	D 6693									9,000 kg
• break strength - N/mm	Type IV	5	9	11	13	16	21	26	31	
• break elongation - %		250	250	250	250	250	250	250	250	
2% Modulus (max.) - N/mm	D 5323	210	315	420	520	630	840	1050	1260	per formulation
Tear Resistance (min. ave.) - N	D 1004	50	70	100	120	150	200	250	300	20,000 kg
Puncture Resistance – (min. ave.) - N	D 4833	100	150	200	250	300	400	500	600	20,000 kg
Axi-Symmetric Break Resistance Strain (min.) - %	D 5617	30	30	30	30	30	30	30	30	per formulation
Carbon Black Content (range) - %	D 4218 *(3)*	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	20,000 kg
Carbon Black Dispersion	D 5596	note *(4)*	note *(4)*	note *(4)*	note *(4)*	note *(4)*	note *(4)*	note *(4)*	note *(4)*	20,000 kg
Oxidative Induction Time (OIT) (min. ave.) *(5)*										90,000 kg
(g) Standard OIT - min.	D 8117	100	100	100	100	100	100	100	100	
— or —										
(h) High Pressure OIT - min.	D 5885	400	400	400	400	400	400	400	400	
Oven Aging at 85°C *(6)*	D 5721									
(a) Standard OIT (min. ave.) - % retained after 90 days	D 8117	35	35	35	35	35	35	35	35	per formulation
— or —										
(b) High Pressure OIT (min. ave.) - % retained after 90 days	D 5885	60	60	60	60	60	60	60	60	
UV Resistance *(7)*	D 7238									
(a) Standard OIT (min. ave.)	D 8117	N. R. *(8)*	N.R. *(8)*	N.R. *(8)*	N.R. *(8)*	N.R. *(8)*	N.R. *(8)*	N.R. *(8)*	N.R. *(8)*	per formulation
— or —										
(b) High Pressure OIT (min. ave.) - % retained after 1600 hrs *(9)*	D 5885	35	35	35	35	35	35	35	35	

(1) Alternate the measurement side for double sided textured sheet

(2) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction.
- Break elongation is calculated using a gage length of 50 mm at 50 mm/min.

(3) Other methods such as D 1603 (tube furnace) or D 6370 (TGA) are acceptable if an appropriate correlation to D 4218 (muffle furnace) can be established.

(4) Carbon black dispersion (only near spherical agglomerates) for 10 different views:
- 9 in Categories 1 or 2 and 1 in Category 3

(5) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.

(6) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.

(7) The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.

(8) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.

(9) UV resistance is based on percent retained value regardless of the original HP-OIT value.

Adoption and Revision Schedule
for
GRI Test Method GM17

"Test Methods, Test Properties and Testing Frequency for Linear Low Density Polyethylene (LLDPE) Smooth and Textured Geomembranes"

Adopted:	April 3, 2000
Revision 1:	June 28, 2000: added a new Section 5.2 that the numeric tables values are neither MARV nor MaxARV. They are to be interpreted per the designated test method. Also, corrected typographical error of textured sheet thickness test method designation from D5199 to D5994.
Revision 2:	December 13, 2000: added one Category 3 is allowed for carbon black dispersion. Also, unified terminology to "strength" and "elongation".
Revision 3:	June 23, 2003: Adopted ASTM D 6693, in place of ASTM D 638, for tensile strength testing. Also, added Note 4.
Revision 4:	February 20, 2006: Added Note 9 on Asperity Height clarification with respect to shear strength.
Revision 5:	Removed recommended warranty from specification.
Revision 6:	June 1, 2009: Replaced GRI-GM12 test method for asperity height of textured geomembranes with ASTM D 7466.
Revision 7:	April 11, 2011: Added alternative carbon black test methods.
Revision 8:	October 3, 2011: Expanded types of comonomers in the definition of LLDPE.
Revision 9:	December 14, 2012: Replaced GRI-GM12 with the equivalent ASTM D7238.
Revision 10:	November 14, 2014: Increased asperity height of textured sheet from 10 to 16 mils (0.25 to 0.40 mm).
Revision 11:	April 13, 2015: Unit conversion error was corrected for 0.75 mm (30 mil) thickness for the property of 2% modulus. The test value was changed from 370 N/mm to 315 N/mm in the SI (Metric) units tables to agree with the English units tables.
Revision 12:	November 4, 2015: Removed Footnote (1) on asperity height from tables.
Revision 13:	September 9, 2019: Editorial update to harmonize tables.
Revision 14:	March 17, 2021: Updated Standard OIT Test from ASTM D3895 to D8117.

WASTE MANAGEMENT SKYLINE LANDFILL
DALLAS AND ELLIS COUNTIES, TEXAS
PERMIT AMENDMENT APPLICATION NO. MSW 42E

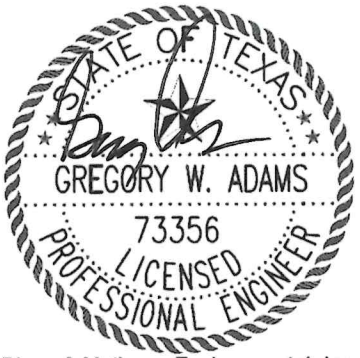
PART III – FACILITY INVESTIGATION AND DESIGN

ATTACHMENT D9
ALTERNATE FINAL COVER DEMONSTRATION

Prepared for

WASTE MANAGEMENT OF TEXAS, INC.

March 2026



Biggs & Mathews Environmental, Inc.
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3/31/2026

Prepared by

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TEXAS BOARD OF PROFESSIONAL ENGINEERS AND LAND SURVEYORS
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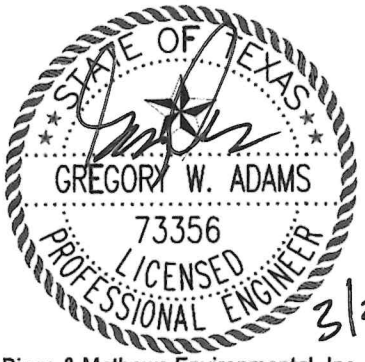
FIRM REGISTRATION NO. 50222



3/31/2020

Biggs & Mathews Environmental, Inc.
Firm Registration No. F-256

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1 ALTERNATE FINAL COVER

30 TAC §330.457(d)(1,2)

In accordance with 30 TAC §330.457(d), the proposed alternate final covers achieve an equivalent reduction in infiltration and provide equivalent erosion protection as the prescribed system. The prescribed final cover system for MSW landfill units with a synthetic bottom liner, as described in 30 TAC §330.457(a)(1,3), consists of the following components from top to bottom:

- A minimum erosion layer consisting of 6-inches of earthen material capable of sustaining native plant growth;
- A clay-rich soil cover layer consisting of a minimum of 18-inches of earthen material with a minimum coefficient of permeability of $1x10^{-5}$ cm/sec, and:
- A synthetic membrane.

The following alternate final cover systems are proposed for the Skyline Landfill:

Top Deck:

- 24-inch soil erosion layer;
- 250-mil double-sided geocomposite;
- 40-mil LLDPE geomembrane cover, and;
- 12-inch infiltration layer consisting of compacted soils ($k \leq 1x10^{-7}$cm/s).

Side Slope – Option A:

- 36-inch erosion layer;
- 250-mil double-sided geocomposite, and;
- 12-inch infiltration layer consisting of compacted soils ($k \leq 1x10^{-7}$cm/s).

Side Slope – Option B:

- 36-inch erosion layer;
- 200-mil double-sided geocomposite, and;
- 18-inch infiltration layer consisting of compacted soils ($k \leq 1x10^{-7}$cm/s).

Perforated HDPE pipe will be installed at the toe of the slope and at intervals approximately 250 feet apart across the side slopes to collect drainage from the geocomposite drainage layer. The perforated piping will collect the drainage and direct the flow into the perimeter drainage system. The plan and details of the alternate final covers are provided in Appendix D9A.

2 PERFORMANCE EVALUATION

30 TAC §330.457(d)(1)

A performances of the top deck and sideslope Option A alternate final cover designs were evaluated using the HELP computer modelling program (HELP Model Version 4.0.1). The HELP model simulates hydrologic processes for a landfill by performing daily, sequential water budget analyses using a quasi-two-dimensional deterministic approach. The model accepts weather, soil, and design data and uses solution techniques to account for key factors affecting water movement within the landfill. The model accounts for both surface and sub-surface processes including transpiration, surface runoff, evaporation, vertical percolation, saturated lateral drainage, and geosynthetics leakage to estimate the various movements of water within the selected profile.

The performance evaluations were performed for a unit area of landfill final cover modeled for thirty years. Each model assumed near steady-state values for the simulation period. The model requires input design data including daily and general climatological records, site-specific soil parameters, material properties, and landfill design data. The data used to evaluate the alternate final cover design are provided in Appendix D9B. Models for the prescriptive and alternate final cover systems are provided in Appendix D9C.

The performance evaluation for the sideslope Option B alternate final cover, which is approved in the current permit, is provided in Appendix D9D.

3 RESULTS

30 TAC §330.457(d)

Four HELP model simulations were conducted to estimate the percolation through the cover systems. Two HELP model simulations were conducted for final cover systems (top deck and sideslope) prescribed by current regulations and two HELP model simulations were conducted for alternate final cover systems (top deck and sideslope). Results from the models are summarized below.

HELP Model Results – Estimated Percolation

Final Cover System Configuration	Description	Avg. Annual Total Summary (in.)
Prescriptive	Top Deck	0.0407
	Side Slope	0.0319
Alternate	Top Deck	0.0000
	Side Slope	0.0024

Final Cover System Configuration	Description	Peak Values Summary (in.)
Prescriptive	Top Deck	0.0022
	Side Slope	0.0021
Alternate	Top Deck	0.0000
	Side Slope	0.0018

The simulations demonstrate that the proposed alternate final cover systems will provide a greater reduction in infiltration than the prescribed cover system. The erosion layer evaluation, provided in the final cover drainage structure design in Attachment C1, demonstrates the thickness of the alternate final cover erosion layer is greater than the anticipated losses due to erosion.

APPENDIX D9A
ALTERNATE FINAL COVER DETAILS



ALTERNATE FINAL COVER

WASTE MANAGEMENT OF TEXAS, INC. SKYLINE LANDFILL

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TBPELS FIRM NO. F-256 AND NO. 10194895
TBPG FIRM NO. 50222

DRAWING D9A.1

REVISIONS			
REV	DATE	DESCRIPTION	DWN BY

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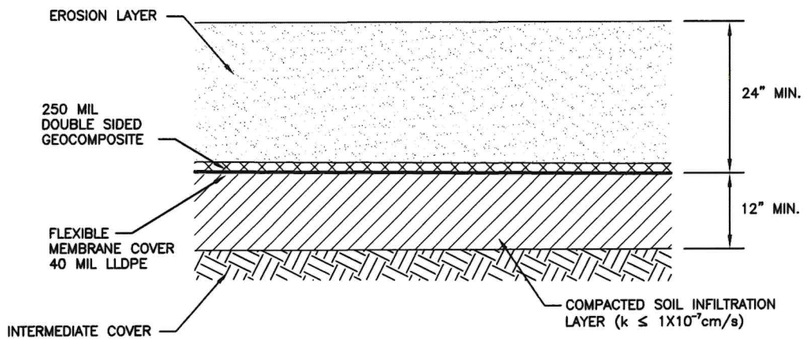
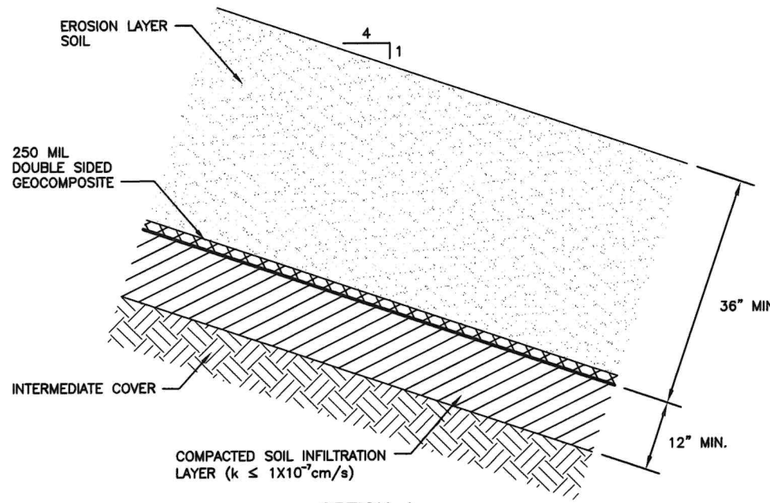


TOP DECK FINAL COVER FC1 D9A.2

0 1 2
SCALE IN FEET



OPTION A
SIDESLOPE FINAL COVER FC2 D9A.2

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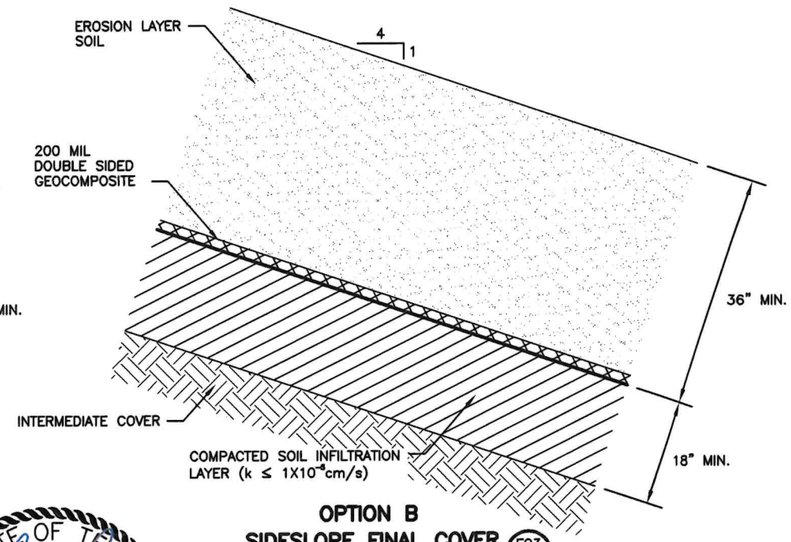
SCALE IN FEET



OPTION B
SIDESLOPE FINAL COVER FC3 D9A.2

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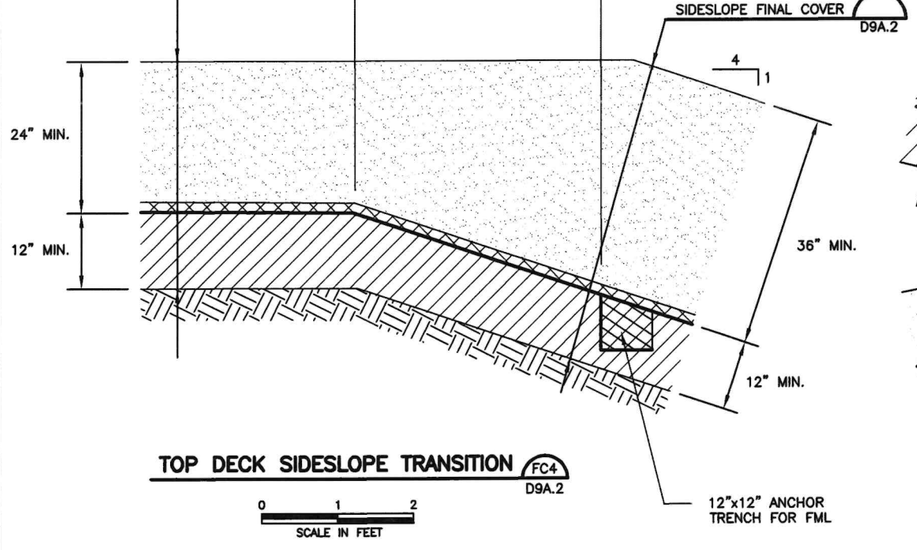
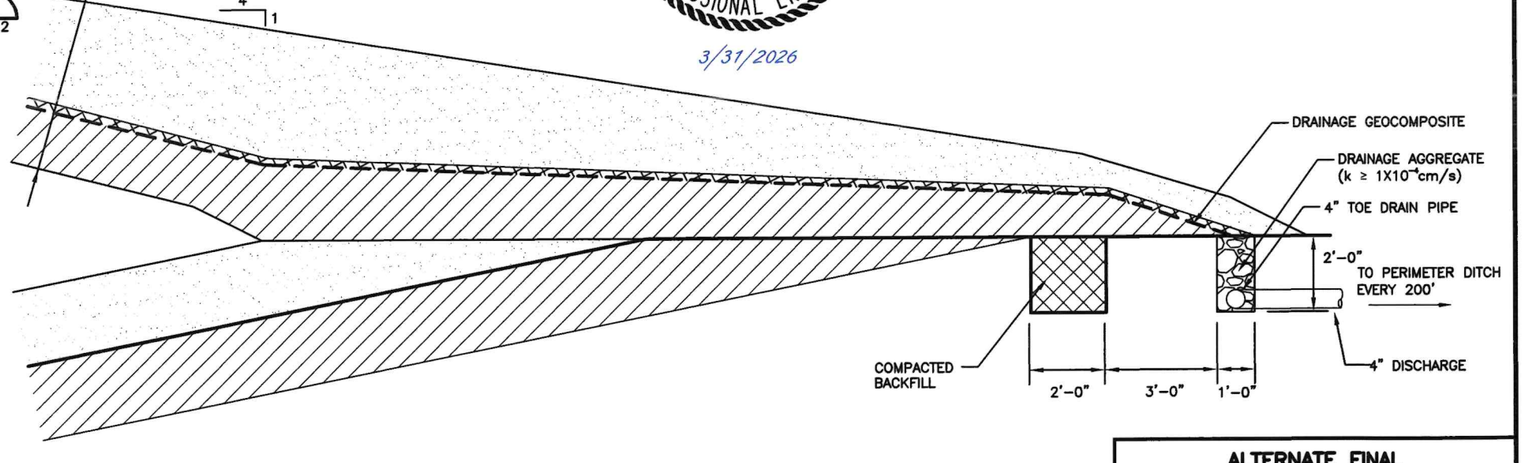
SCALE IN FEET



TOP DECK SIDESLOPE TRANSITION FC4 D9A.2

0 1 2
SCALE IN FEET



FINAL COVER ANCHOR TRENCH FC5 D9A.2

0 0.5 1
SCALE IN FEET

NOTE:

1. REFER TO ATTACHMENT D8 FOR COVER INSTALLATION AND MATERIAL.

STATE OF TEXAS
GREGORY W. ADAMS
73356
LICENSED
PROFESSIONAL ENGINEER
3/31/2026

REVISIONS			
REV	DATE	DESCRIPTION	DWN BY

ALTERNATE FINAL COVER DETAILS

WASTE MANAGEMENT OF TEXAS, INC. SKYLINE LANDFILL

BIGGS & MATHEWS ENVIRONMENTAL
1700 ROBERT ROAD, STE. 100
MANSFIELD, TEXAS 76063
817-563-1144

TBPELS FIRM NO. F-256 AND NO. 10194895
TBPG FIRM NO. 50222

DRAWING D9A.2

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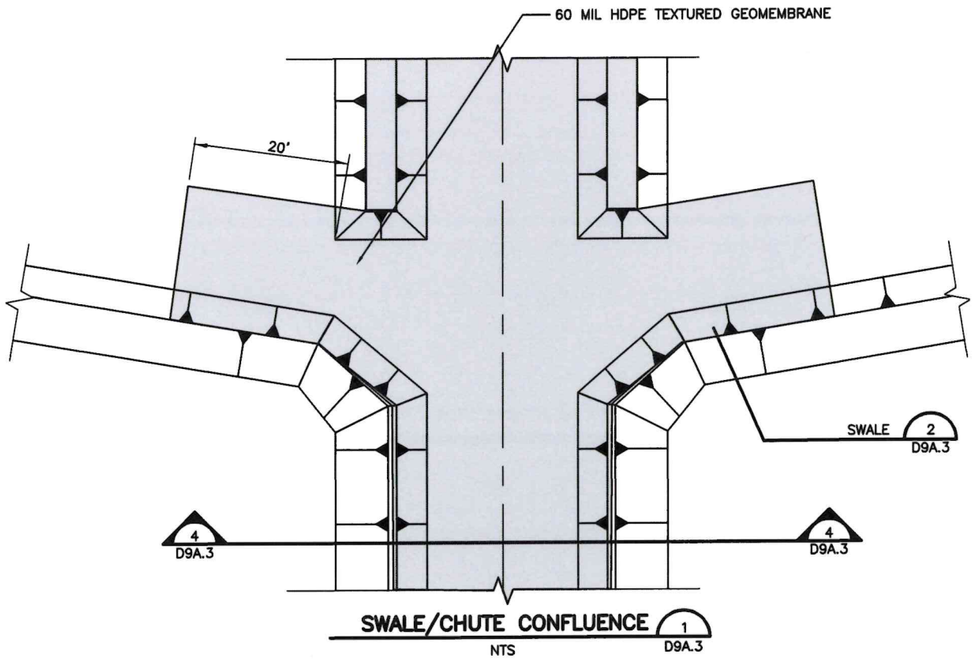
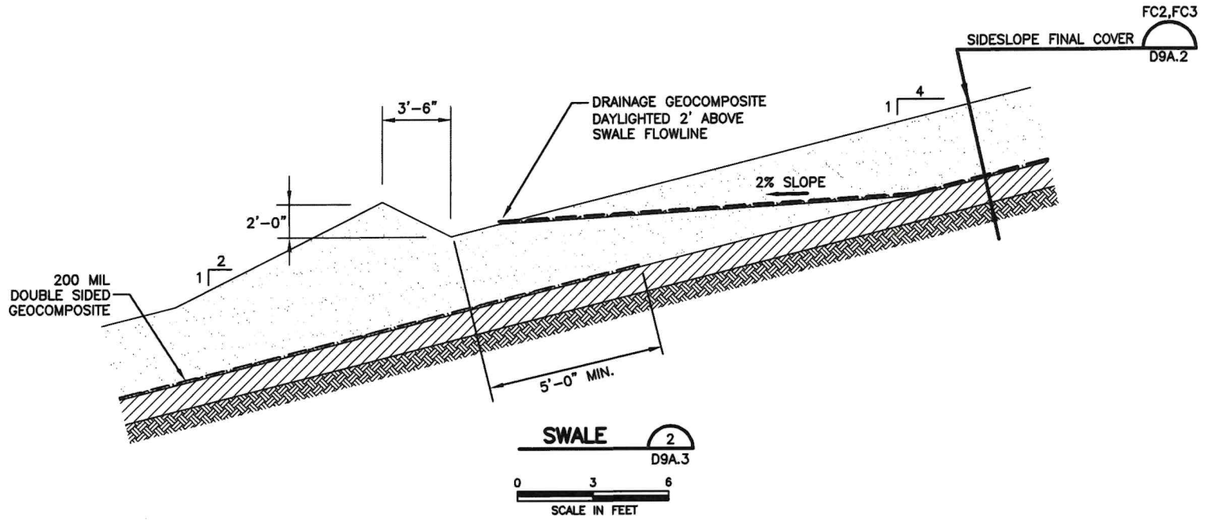


SWALE/CHUTE CONFLUENCE 1 D9A.3

NTS



SWALE 2 D9A.3

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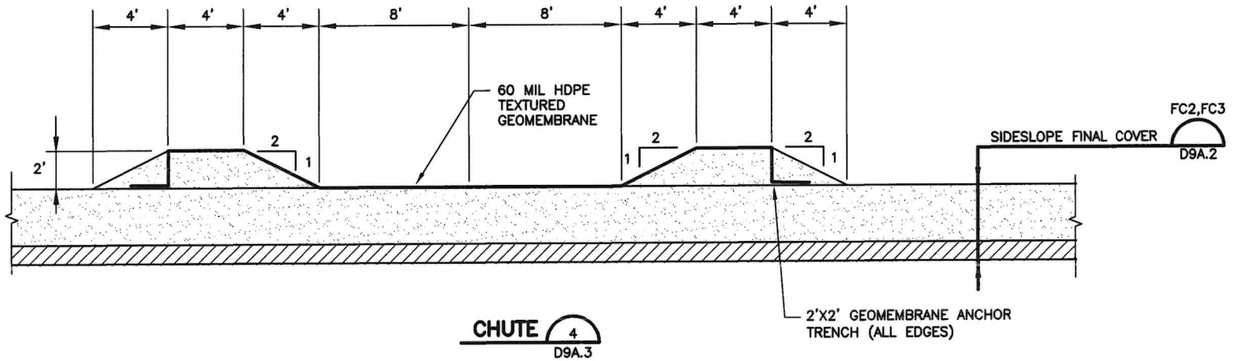
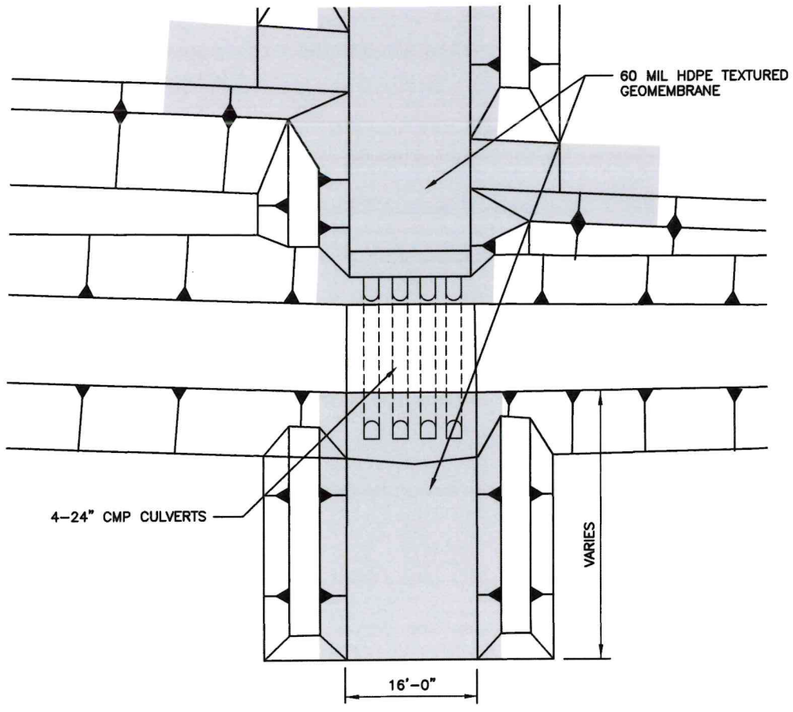
SCALE IN FEET



CHUTE 4 D9A.3

0 2 4

SCALE IN FEET



CHUTE OUTLET 3 D9A.3

NTS

STATE OF TEXAS
GREGORY W. ADAMS
73356
LICENSED
PROFESSIONAL ENGINEER

3/31/2026

REVISIONS			
REV	DATE	DESCRIPTION	DWN BY

ALTERNATE DRAINAGE DETAILS

WASTE MANAGEMENT OF TEXAS, INC. SKYLINE LANDFILL

BIGGS & MATHEWS ENVIRONMENTAL
1700 ROBERT ROAD, STE. 100
MANSFIELD, TEXAS 76063
817-563-1144

TBPELS FIRM NO. F-256 AND NO. 10194895

TBPG FIRM NO. 50222

DRAWING D9A.3

O:\Waste Management\Skyline\Solid Waste\P\Drawings\Part III\Att. D\D3.10-DrainDets.dwg Layout: D9A.3 User: awhite

APPENDIX D9B
HELP INPUT DATA

HELP INPUT

Daily precipitation, temperature, and solar radiation data was generated stochastically using the HELP model synthetic weather generator (WGEN). Weather parameter values for the 30-year evaluation period were generated based on a routine developed by the USDA Agricultural Research Service and are based on the latitude and longitude coordinates provided to the program (Lat 32.54, Long -96.62). The average annual precipitation generated for the Skyline Landfill is approximately 35.43 inches per year with an anticipated minimum of 21.07 inches per year and a maximum of 45.19 inches per year. Typical WGEN data for the 30-year evaluation period is included in Appendix D9B.

Average annual wind speed and quarterly relative humidity data were downloaded from the National Solar Radiation Database website and contains average wind speed and quarterly relative humidity data sets from 1998-2022. The average annual wind speed for the Skyline Landfill is 2.96 mph and the average quarterly humidity ranges from 61%-74%. A summary of the NSRDB data for the 30-year evaluation period is included in Appendix D9B.

The growing season is based largely on mean daily temperatures for the evaluated area. Typically, the start of the growing season is the date that the average daily temperature rises above 50-55 degrees, and the end of the season is the date that the average daily temperature falls below 50-55 degrees. The National Gardening Association estimates that the growing season for Ferris, TX starts on March 26 (the 85th day of the year) and ends around November 4 (the 308th day of the year).

The maximum leaf area index is the dimensionless ratio of the leaf area actively transporting vegetation to the surface of the land. Bare soil would have a leaf area index value around zero, where a dense stand of trees will have a value approaching five. Based on the geographic distribution of maximum leaf area index graphic presented in the HELP model manual, a maximum leaf area index value of five was selected.

The evaporative zone depth parameter is an estimate of the anticipated depth from which water may be removed from the system via evapotranspiration. The computer model requires that the value be greater than zero and less than or equal to the depth of the topmost layer. The evaporative zone depth value used for each run is equal to the thickness of the topmost layer for each comparative run.

Design data related to the stormwater runoff potential of the proposed final cover system is also required by the model. HELP models the rainfall-runoff process using the Soil Conservation Services (SCS) curve-number method. The curve number used for the HELP model evaluation is calculated by the model based on the proposed cover system slope, slope length, and anticipated vegetative cover. The proposed final cover system grades are:

- Representative top deck slope and length (5% and 2,000 ft);

- Representative sideslope and length between terraces (25% and 150 ft);
- Runoff curve number: 93.2 for top deck and 94 for sideslope.

The erosion layer was modeled as a vertical percolation layer and will be constructed from uncompacted soils with an assumed saturated hydraulic conductivity of $5x10^{-5}$ cm/sec. The assumed evaporative zone depth of each model is the erosion layer thickness.

The prescribed infiltration layer was modeled as a vertical percolation layer and will consist of compacted clayey soil with a minimum hydraulic conductivity of $1x10^{-5}$ cm/sec.

The alternate infiltration layer was modeled as a barrier soil layer and will consist of compacted clayey soil with a minimum hydraulic conductivity of $1x10^{-7}$ cm/sec.

The geomembrane layer was modeled as a flexible membrane cover with an assumed saturated hydraulic conductivity of $4x10^{-13}$ cm/sec. The FMC will be a 40-mil LLDPE geomembrane with good field placement, a pinhole density of two per acre, and an installation defect rate of three per acre.

The drainage layer was modeled as a lateral drainage layer and will consist of a double sided geocomposite with an assumed hydraulic conductivity of 14.4 cm/sec.

APPENDIX D9C
HELP MODEL RESULTS

HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE
HELP MODEL VERSION 4.0 BETA (2018)
DEVELOPED BY USEPA NATIONAL RISK MANAGEMENT RESEARCH LABORATORY

Title: Skyline Landfill **Simulated On:** 8/22/2025 10:59

Layer 1

Type 1 - Vertical Percolation Layer (Cover Soil)
SiCL - Silty Clay Loam
Material Texture Number 12

Thickness	=	6 inches
Porosity	=	0.471 vol/vol
Field Capacity	=	0.342 vol/vol
Wilting Point	=	0.21 vol/vol
Initial Soil Water Content	=	0.3151 vol/vol
Effective Sat. Hyd. Conductivity	=	4.20E-05 cm/sec

Layer 2

Type 1 - Vertical Percolation Layer
Infiltration Layer
Material Texture Number 44

Thickness	=	18 inches
Porosity	=	0.461 vol/vol
Field Capacity	=	0.36 vol/vol
Wilting Point	=	0.203 vol/vol
Initial Soil Water Content	=	0.2188 vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E-05 cm/sec

Layer 3

Type 4 - Flexible Membrane Liner
LDPE Membrane
Material Texture Number 36

Thickness	=	0.04 inches
Effective Sat. Hyd. Conductivity	=	4.00E-13 cm/sec
FML Pinhole Density	=	2 Holes/Acre
FML Installation Defects	=	3 Holes/Acre
FML Placement Quality	=	3 Good

Note: Initial moisture content of the layers and snow water were computed as nearly steady-state values by HELP.

General Design and Evaporative Zone Data

SCS Runoff Curve Number	=	93.2
Fraction of Area Allowing Runoff	=	100 %
Area projected on a horizontal plane	=	1 acres
Evaporative Zone Depth	=	24 inches
Initial Water in Evaporative Zone	=	5.829 inches
Upper Limit of Evaporative Storage	=	11.124 inches
Lower Limit of Evaporative Storage	=	4.914 inches
Initial Snow Water	=	0 inches
Initial Water in Layer Materials	=	5.829 inches
Total Initial Water	=	5.829 inches
Total Subsurface Inflow	=	0 inches/year

Note: SCS Runoff Curve Number was User-Specified.

Evapotranspiration and Weather Data

Station Latitude	=	32.54 Degrees
Maximum Leaf Area Index	=	4.5
Start of Growing Season (Julian Date)	=	70 days
End of Growing Season (Julian Date)	=	314 days
Average Wind Speed	=	15 mph
Average 1st Quarter Relative Humidity	=	71 %
Average 2nd Quarter Relative Humidity	=	74 %
Average 3rd Quarter Relative Humidity	=	63 %
Average 4th Quarter Relative Humidity	=	68 %

Note: Evapotranspiration data was obtained for Ferris, Texas

Normal Mean Monthly Precipitation (inches)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
2.616586	1.944726	3.711607	3.359808	4.240706	3.770842
2.198988	1.872116	2.607895	3.789102	2.796116	3.385224

Note: Precipitation was simulated based on HELP V4 weather simulation for:
Lat/Long: 32.54/-96.62

Normal Mean Monthly Temperature (Degrees Fahrenheit)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
55.7	56	61.6	74.2	84.3	89.4
94.4	91.5	84	74.5	64.9	58.9

Note: Temperature was simulated based on HELP V4 weather simulation for:
Lat/Long: 32.54/-96.62
Solar radiation was simulated based on HELP V4 weather simulation for:
Lat/Long: 32.54/-96.62

Average Annual Totals Summary

Title: Skyline Landfill
Simulated on: 8/22/2025 11:00

	Average Annual Totals for Years 1 - 30*			
	(inches)	[std dev]	(cubic feet)	(percent)
Precipitation	36.29	[5.56]	131,746.2	100.00
Runoff	5.556	[1.961]	20,166.5	15.31
Evapotranspiration	30.689	[3.791]	111,399.8	84.56
Subprofile1				
Percolation/leakage through Layer 3	0.040751	[0.057698]	147.9	0.11
Average Head on Top of Layer 3	0.9232	[1.5215]	---	---
Water storage				
Change in water storage	0.0088	[2.1276]	31.9	0.02

* Note: Average inches are converted to volume based on the user-specified area.

Peak Values Summary

Title: Skyline Landfill
Simulated on: 8/22/2025 11:00

	Peak Values for Years 1 - 30*	
	(inches)	(cubic feet)
Precipitation	4.82	17,502.4
Runoff	3.364	12,210.5
Subprofile1		
Percolation/leakage through Layer 3	0.002226	8.0801
Average head on Layer 3	22.7643	
Other Parameters		
Snow water	2.9848	10,834.7
Maximum vegetation soil water	0.4582 (vol/vol)	
Minimum vegetation soil water	0.2048 (vol/vol)	

Final Water Storage in Landfill Profile at End of Simulation Period

Title: Skyline Landfill
Simulated on: 8/22/2025 11:00
Simulation period: 30 years

	Final Water Storage	
Layer	(inches)	(vol/vol)
1	1.8872	0.3145
2	4.2060	0.2337
3	0.0000	0.0000
Snow water	0.0000	---

HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE
HELP MODEL VERSION 4.0 BETA (2018)
DEVELOPED BY USEPA NATIONAL RISK MANAGEMENT RESEARCH LABORATORY

Title: Skyline Landfill **Simulated On:** 8/22/2025 11:05

Layer 1

Type 1 - Vertical Percolation Layer (Cover Soil)
SiCL - Silty Clay Loam
Material Texture Number 12

Thickness	=	6 inches
Porosity	=	0.471 vol/vol
Field Capacity	=	0.342 vol/vol
Wilting Point	=	0.21 vol/vol
Initial Soil Water Content	=	0.3148 vol/vol
Effective Sat. Hyd. Conductivity	=	4.20E-05 cm/sec

Layer 2

Type 1 - Vertical Percolation Layer
Infiltration Layer
Material Texture Number 44

Thickness	=	18 inches
Porosity	=	0.461 vol/vol
Field Capacity	=	0.36 vol/vol
Wilting Point	=	0.203 vol/vol
Initial Soil Water Content	=	0.2186 vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E-05 cm/sec

Layer 3

Type 4 - Flexible Membrane Liner
LDPE Membrane
Material Texture Number 36

Thickness	=	0.04 inches
Effective Sat. Hyd. Conductivity	=	4.00E-13 cm/sec
FML Pinhole Density	=	2 Holes/Acre
FML Installation Defects	=	3 Holes/Acre
FML Placement Quality	=	3 Good

Note: Initial moisture content of the layers and snow water were computed as nearly steady-state values by HELP.

General Design and Evaporative Zone Data

SCS Runoff Curve Number	=	94
Fraction of Area Allowing Runoff	=	100 %
Area projected on a horizontal plane	=	1 acres
Evaporative Zone Depth	=	24 inches
Initial Water in Evaporative Zone	=	5.823 inches
Upper Limit of Evaporative Storage	=	11.124 inches
Lower Limit of Evaporative Storage	=	4.914 inches
Initial Snow Water	=	0 inches
Initial Water in Layer Materials	=	5.823 inches
Total Initial Water	=	5.823 inches
Total Subsurface Inflow	=	0 inches/year

Note: SCS Runoff Curve Number was User-Specified.

Evapotranspiration and Weather Data

Station Latitude	=	32.54 Degrees
Maximum Leaf Area Index	=	4.5
Start of Growing Season (Julian Date)	=	70 days
End of Growing Season (Julian Date)	=	314 days
Average Wind Speed	=	15 mph
Average 1st Quarter Relative Humidity	=	71 %
Average 2nd Quarter Relative Humidity	=	74 %
Average 3rd Quarter Relative Humidity	=	63 %
Average 4th Quarter Relative Humidity	=	68 %

Note: Evapotranspiration data was obtained for Ferris, Texas

Normal Mean Monthly Precipitation (inches)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
2.616586	1.944726	3.711607	3.359808	4.240706	3.770842
2.198988	1.872116	2.607895	3.789102	2.796116	3.385224

Note: Precipitation was simulated based on HELP V4 weather simulation for:
Lat/Long: 32.54/-96.62

Normal Mean Monthly Temperature (Degrees Fahrenheit)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
55.7	56	61.6	74.2	84.3	89.4
94.4	91.5	84	74.5	64.9	58.9

Note: Temperature was simulated based on HELP V4 weather simulation for:
Lat/Long: 32.54/-96.62
Solar radiation was simulated based on HELP V4 weather simulation for:
Lat/Long: 32.54/-96.62

Average Annual Totals Summary

Title: Skyline Landfill
Simulated on: 8/22/2025 11:06

	Average Annual Totals for Years 1 - 30*			
	(inches)	[std dev]	(cubic feet)	(percent)
Precipitation	36.29	[5.56]	131,746.2	100.00
Runoff	6.479	[2.124]	23,518.7	17.85
Evapotranspiration	29.774	[3.62]	108,081.2	82.04
Subprofile1				
Percolation/leakage through Layer 3	0.031949	[0.053452]	116.0	0.09
Average Head on Top of Layer 3	0.7423	[1.3712]	---	---
Water storage				
Change in water storage	0.0083	[2.0422]	30.3	0.02

* Note: Average inches are converted to volume based on the user-specified area.

Peak Values Summary

Title: Skyline Landfill
Simulated on: 8/22/2025 11:06

	Peak Values for Years 1 - 30*		
	(inches)		(cubic feet)
Precipitation	4.82		17,502.4
Runoff	3.499		12,699.6
Subprofile1			
Percolation/leakage through Layer 3	0.002086		7.5715
Average head on Layer 3	21.3881		
Other Parameters			
Snow water	2.9848		10,834.7
Maximum vegetation soil water	0.4496	(vol/vol)	
Minimum vegetation soil water	0.2048	(vol/vol)	

Final Water Storage in Landfill Profile at End of Simulation Period

Title: Skyline Landfill
Simulated on: 8/22/2025 11:06
Simulation period: 30 years

	Final Water Storage	
Layer	(inches)	(vol/vol)
1	1.8871	0.3145
2	4.1865	0.2326
3	0.0000	0.0000
Snow water	0.0000	---

HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE
HELP MODEL VERSION 4.0 BETA (2018)
DEVELOPED BY USEPA NATIONAL RISK MANAGEMENT RESEARCH LABORATORY

Title: Skyline Landfill **Simulated On:** 8/22/2025 11:10

Layer 1

Type 1 - Vertical Percolation Layer (Cover Soil)
SiCL - Silty Clay Loam
Material Texture Number 12

Thickness	=	24 inches
Porosity	=	0.471 vol/vol
Field Capacity	=	0.342 vol/vol
Wilting Point	=	0.21 vol/vol
Initial Soil Water Content	=	0.2458 vol/vol
Effective Sat. Hyd. Conductivity	=	4.20E-05 cm/sec

Layer 2

Type 2 - Lateral Drainage Layer
Geocomposite
Material Texture Number 123

Thickness	=	0.248 inches
Porosity	=	0.85 vol/vol
Field Capacity	=	0.1 vol/vol
Wilting Point	=	0.005 vol/vol
Initial Soil Water Content	=	0.0999 vol/vol
Effective Sat. Hyd. Conductivity	=	1.44E+02 cm/sec
Slope	=	2 %
Drainage Length	=	500 ft

Layer 3

Type 4 - Flexible Membrane Liner
LDPE Membrane
Material Texture Number 36

Thickness	=	0.04 inches
Effective Sat. Hyd. Conductivity	=	4.00E-13 cm/sec
FML Pinhole Density	=	2 Holes/Acre
FML Installation Defects	=	3 Holes/Acre
FML Placement Quality	=	3 Good

Layer 4

Type 3 - Barrier Soil Liner

Liner Soil (High)

Material Texture Number 16

Thickness	=	12 inches
Porosity	=	0.427 vol/vol
Field Capacity	=	0.418 vol/vol
Wilting Point	=	0.367 vol/vol
Initial Soil Water Content	=	0.427 vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E-07 cm/sec

Note: Initial moisture content of the layers and snow water were computed as nearly steady-state values by HELP.

General Design and Evaporative Zone Data

SCS Runoff Curve Number	=	93.2
Fraction of Area Allowing Runoff	=	100 %
Area projected on a horizontal plane	=	1 acres
Evaporative Zone Depth	=	24 inches
Initial Water in Evaporative Zone	=	5.898 inches
Upper Limit of Evaporative Storage	=	11.304 inches
Lower Limit of Evaporative Storage	=	5.04 inches
Initial Snow Water	=	0 inches
Initial Water in Layer Materials	=	11.047 inches
Total Initial Water	=	11.047 inches
Total Subsurface Inflow	=	0 inches/year

Note: SCS Runoff Curve Number was User-Specified.

Evapotranspiration and Weather Data

Station Latitude	=	32.54 Degrees
Maximum Leaf Area Index	=	4.5
Start of Growing Season (Julian Date)	=	70 days
End of Growing Season (Julian Date)	=	314 days
Average Wind Speed	=	15 mph
Average 1st Quarter Relative Humidity	=	71 %
Average 2nd Quarter Relative Humidity	=	74 %
Average 3rd Quarter Relative Humidity	=	63 %
Average 4th Quarter Relative Humidity	=	68 %

Note: Evapotranspiration data was obtained for Ferris, Texas

Normal Mean Monthly Precipitation (inches)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
2.616586	1.944726	3.711607	3.359808	4.240706	3.770842
2.198988	1.872116	2.607895	3.789102	2.796116	3.385224

Note: Precipitation was simulated based on HELP V4 weather simulation for:
Lat/Long: 32.54/-96.62

Normal Mean Monthly Temperature (Degrees Fahrenheit)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
55.7	56	61.6	74.2	84.3	89.4
94.4	91.5	84	74.5	64.9	58.9

Note: Temperature was simulated based on HELP V4 weather simulation for:
Lat/Long: 32.54/-96.62
Solar radiation was simulated based on HELP V4 weather simulation for:
Lat/Long: 32.54/-96.62

Average Annual Totals Summary

Title: Skyline Landfill
Simulated on: 8/22/2025 11:12

	Average Annual Totals for Years 1 - 30*			
	(inches)	[std dev]	(cubic feet)	(percent)
Precipitation	36.29	[5.56]	131,746.2	100.00
Runoff	5.556	[1.952]	20,167.0	15.31
Evapotranspiration	30.176	[3.723]	109,538.9	83.14
Subprofile1				
Lateral drainage collected from Layer 2	0.5548	[0.6806]	2,013.9	1.53
Percolation/leakage through Layer 4	0.000000	[0]	0.0012	0.00
Average Head on Top of Layer 3	0.0000	[0.0001]	---	---
Water storage				
Change in water storage	0.0073	[1.6373]	26.4	0.02

* Note: Average inches are converted to volume based on the user-specified area.

Peak Values Summary

Title: Skyline Landfill
Simulated on: 8/22/2025 11:12

	Peak Values for Years 1 - 30*		
	(inches)		(cubic feet)
Precipitation	4.82		17,502.4
Runoff	3.351		12,165.1
Subprofile1			
Drainage collected from Layer 2	0.3204		1,163.0
Percolation/leakage through Layer 4	0.000000		0.0002
Average head on Layer 3	0.0098		---
Maximum head on Layer 3	0.0196		---
Location of maximum head in Layer 2	0.43	(feet from drain)	
Other Parameters			
Snow water	2.9848		10,834.7
Maximum vegetation soil water	0.4019	(vol/vol)	
Minimum vegetation soil water	0.2100	(vol/vol)	

Final Water Storage in Landfill Profile at End of Simulation Period

Title: Skyline Landfill
Simulated on: 8/22/2025 11:12
Simulation period: 30 years

	Final Water Storage	
Layer	(inches)	(vol/vol)
1	6.1162	0.2548
2	0.0248	0.0999
3	0.0000	0.0000
4	5.1240	0.4270
Snow water	0.0000	---

HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE
HELP MODEL VERSION 4.0 BETA (2018)
DEVELOPED BY USEPA NATIONAL RISK MANAGEMENT RESEARCH LABORATORY

Title: Skyline Landfill **Simulated On:** 8/22/2025 10:46

Layer 1

Type 1 - Vertical Percolation Layer (Cover Soil)
SiCL - Silty Clay Loam
Material Texture Number 12

Thickness	=	36 inches
Porosity	=	0.471 vol/vol
Field Capacity	=	0.342 vol/vol
Wilting Point	=	0.21 vol/vol
Initial Soil Water Content	=	0.2174 vol/vol
Effective Sat. Hyd. Conductivity	=	4.20E-05 cm/sec

Layer 2

Type 2 - Lateral Drainage Layer
Geocomposite
Material Texture Number 123

Thickness	=	0.248 inches
Porosity	=	0.85 vol/vol
Field Capacity	=	0.1 vol/vol
Wilting Point	=	0.005 vol/vol
Initial Soil Water Content	=	0.0999 vol/vol
Effective Sat. Hyd. Conductivity	=	1.44E+02 cm/sec
Slope	=	25 %
Drainage Length	=	125 ft

Layer 3

Type 3 - Barrier Soil Liner
Liner Soil (High)
Material Texture Number 16

Thickness	=	12 inches
Porosity	=	0.427 vol/vol
Field Capacity	=	0.418 vol/vol
Wilting Point	=	0.367 vol/vol
Initial Soil Water Content	=	0.427 vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E-07 cm/sec

Note: Initial moisture content of the layers and snow water were computed as nearly steady-state values by HELP.

General Design and Evaporative Zone Data

SCS Runoff Curve Number	=	94	
Fraction of Area Allowing Runoff	=	100	%
Area projected on a horizontal plane	=	1	acres
Evaporative Zone Depth	=	36	inches
Initial Water in Evaporative Zone	=	7.826	inches
Upper Limit of Evaporative Storage	=	16.956	inches
Lower Limit of Evaporative Storage	=	7.56	inches
Initial Snow Water	=	0	inches
Initial Water in Layer Materials	=	12.975	inches
Total Initial Water	=	12.975	inches
Total Subsurface Inflow	=	0	inches/year

Note: SCS Runoff Curve Number was User-Specified.

Evapotranspiration and Weather Data

Station Latitude	=	32.54	Degrees
Maximum Leaf Area Index	=	4.5	
Start of Growing Season (Julian Date)	=	70	days
End of Growing Season (Julian Date)	=	314	days
Average Wind Speed	=	15	mph
Average 1st Quarter Relative Humidity	=	71	%
Average 2nd Quarter Relative Humidity	=	74	%
Average 3rd Quarter Relative Humidity	=	63	%
Average 4th Quarter Relative Humidity	=	68	%

Note: Evapotranspiration data was obtained for Ferris, Texas

Normal Mean Monthly Precipitation (inches)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
2.616586	1.944726	3.711607	3.359808	4.240706	3.770842
2.198988	1.872116	2.607895	3.789102	2.796116	3.385224

Note: Precipitation was simulated based on HELP V4 weather simulation for:
Lat/Long: 32.54/-96.62

Normal Mean Monthly Temperature (Degrees Fahrenheit)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
55.7	56	61.6	74.2	84.3	89.4
94.4	91.5	84	74.5	64.9	58.9

Note: Temperature was simulated based on HELP V4 weather simulation for:
Lat/Long: 32.54/-96.62
Solar radiation was simulated based on HELP V4 weather simulation for:
Lat/Long: 32.54/-96.62

Average Annual Totals Summary

Title: Skyline Landfill
Simulated on: 8/22/2025 10:48

	Average Annual Totals for Years 1 - 30*			
	(inches)	[std dev]	(cubic feet)	(percent)
Precipitation	36.29	[5.56]	131,746.2	100.00
Runoff	6.221	[2.119]	22,583.5	17.14
Evapotranspiration	29.773	[3.297]	108,077.6	82.03
Subprofile1				
Lateral drainage collected from Layer 2	0.3021	[0.5873]	1,096.4	0.83
Percolation/leakage through Layer 3	0.002407	[0.004958]	8.7375	0.01
Average Head on Top of Layer 3	0.0000	[0]	---	---
Water storage				
Change in water storage	-0.0055	[2.5143]	-20.1	-0.02

* Note: Average inches are converted to volume based on the user-specified area.

Peak Values Summary

Title: Skyline Landfill
Simulated on: 8/22/2025 10:48

	Peak Values for Years 1 - 30*		
	(inches)		(cubic feet)
Precipitation	4.82		17,502.4
Runoff	3.498		12,696.3
Subprofile1			
Drainage collected from Layer 2	0.1627		590.6
Percolation/leakage through Layer 3	0.001759		6.3852
Average head on Layer 3	0.0034		---
Maximum head on Layer 3	0.0002		---
Location of maximum head in Layer 2	0.00	(feet from drain)	
Other Parameters			
Snow water	2.9848		10,834.7
Maximum vegetation soil water	0.3847	(vol/vol)	
Minimum vegetation soil water	0.2100	(vol/vol)	

Final Water Storage in Landfill Profile at End of Simulation Period

Title: Skyline Landfill
Simulated on: 8/22/2025 10:48
Simulation period: 30 years

	Final Water Storage	
Layer	(inches)	(vol/vol)
1	7.6600	0.2128
2	0.0248	0.0999
3	5.1240	0.4270
Snow water	0.0000	---

APPENDIX D9D
SIDESLOPE OPTION B
ALTERNATIVE FINAL COVER DEMONSTRATION
(FROM PERMIT MSW 42D)

Robert J. Huston, *Chairman*
R. B. "Ralph" Marquez, *Commissioner*
John M. Baker, *Commissioner*
Jeffrey A. Saitas, *Executive Director*

TEXAS NATURAL RESOURCE CONSERVATION COMMISSION

Protecting Texas by Reducing and Preventing Pollution

March 21, 2000

Mr. Jack Steele
Area Manager
Waste Management
P.O. Box 141968
Austin, Texas 78714-1968

Re: Municipal Solid Waste, Dallas and Ellis Counties
Skyline Landfill and Recycling Center, MSW Permit No. 42-C
Class I Permit Modification for Alternate Final Cover System
Tracking Number 1431

Dear Mr. Steele:

Enclosed is a copy of the above-referenced permit modification for a municipal solid waste facility issued pursuant to Chapter 361, Texas Health & Safety Code. The documentation, including the application, prepared and submitted to support the modification request shall be considered a part of this permit and shall be considered as operational requirements of this permit. Please contact Mr. George P. Hartmann, P.E. at (512) 239-3419 if you have any questions concerning this matter.

Sincerely,

Dorca Zaragoza-Stone, Manager
MSW Permits Section
Waste Permits Division

DZS/gph

enclosure

cc: Ms. Beth A. Gross, P.E., GeoSyntech Consultants, Austin

TEXAS NATURAL RESOURCE CONSERVATION COMMISSION

MODIFICATION TO

MUNICIPAL SOLID WASTE PERMIT Nº MSW 42-C

Waste Management of Texas, Inc. - Skyline Landfill and Recycling Center

Municipal Solid Waste Permit No. MSW 42-C is hereby modified as follows:

Description of Changes: Revision to Final Cover System Design to allow alternate and previously permitted final cover designs.

Permit Sections Revised: Part III, Site Development Plan

This modification is a part of Permit No. MSW 42-C and should be attached thereto.

APPROVED, ISSUED, AND EFFECTIVE in accordance with 30 Texas Administrative Code Section 305.70(i).

ISSUED DATE:

MAR 2 1 2000

For the Commission

WASTE MANAGEMENT

WASTE MANAGEMENT

P.O. Box 141968
Austin, Texas 78714-1968
(512) 272-6225 (office)
(512) 272-9370 (fax)

December 27,1999

Ms. Dorca Zaragoza-Stone
Manager, MSW Permits Section
Texas Natural Resource Conservation Commission
P.O. Box 13087 (MC-124)
Austin, Texas 78711-3087

RE: Municipal Solid Waste - Ferris, Texas
Skyline Landfill and Recycling Center - Permit No. MSW 42-C
Request for Class I Permit Modification

Dear Ms. Zaragoza-Stone:

Waste Management of Texas, Inc. (WMTX) hereby requests a Class I permit modification for the referenced facility pursuant to 30 TAC § 305.70 (g)(15). The modification consists of including an alternate final cover system (i.e., either the currently permitted final cover system or the alternate will be used). Attached for your review please find three copies of the permit modification document.

In accordance with the requirements of 30 TAC § 305.44, I 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.

If you have any questions regarding this submittal, please do not hesitate to contact me at (512) 272-6225.

Sincerely,
Waste Management of Texas, Inc.

Jack Steele
Area Manager

GEOSYNTEC CONSULTANTS

106 East 6th Street, Suite 800
Austin, TX 78701
Tel. (512) 322-3951 • Fax (512) 322-3953

27 December 1999

Mr. Jack Steele
Area Manager
Waste Management of Texas, Inc.
9900 Giles Road
Austin, Texas 78754

Subject: Permit Modification, Permit No. MSW 42-C
WMTX Skyline Landfill and Recycling Center
Ferris, Texas

Dear Mr. Steele:

As you requested, GeoSyntec Consultants (GeoSyntec) has prepared a Class I permit modification for the Skyline Landfill and Recycling Center (Skyline Landfill). The permit modification consists of including an alternate final cover system (i.e., either the currently permitted final cover system or the alternate will be used). The alternate final cover system utilizes excess site soils and consists of the following components, from top to bottom:

- 3-ft thick (minimum) erosion layer consisting of on-site clay soil;
- geocomposite drainage layer: and
- 18-in. thick soil infiltration layer ($k \leq 1 \times 10^{-7}$ cm/s).

The upper 6-in. of the erosion layer supports vegetation and has no compaction criteria. It is only required to receive the minimal compaction needed for stability (typically incident to the placement and spreading process). Below the upper 6 in., the erosion layer soil must be compacted with pad-foot or prong-foot rollers to at least 95% of the soil's maximum dry unit weight and at or up to five percentage points greater than the soil's optimum moisture content as determined by ASTM D 698. During construction, field moisture/density tests should be conducted on the erosion layer at a minimum frequency of 1 test per 8,000 ft^2 per lift to verify that these compaction criteria are met.

GT0936-01/TX990029

In support of this modification, the following documentation has been prepared:

- A detail of the alternate final cover system is shown on Attachment 7L-a, which is presented in Appendix A to this letter.
- A performance evaluation of the alternative final cover system is presented in Appendix B. The hydraulic performance of the cover system was analyzed using the U.S. Environmental Protection Agency's Hydrologic Evaluation of Landfill Performance (HELP) computer model. The results of the analysis demonstrate that the alternate final cover system should perform better than the prescriptive minimum criteria final cover system defined in 30 TAC § 330.253 (b) and essentially equivalent to the currently permitted final cover system.

If you have any questions regarding the information presented in this permit modification, please do not hesitate to contact me.

Sincerely,

Beth A. Gross

Beth A. Gross, P.E.
Senior Project Engineer

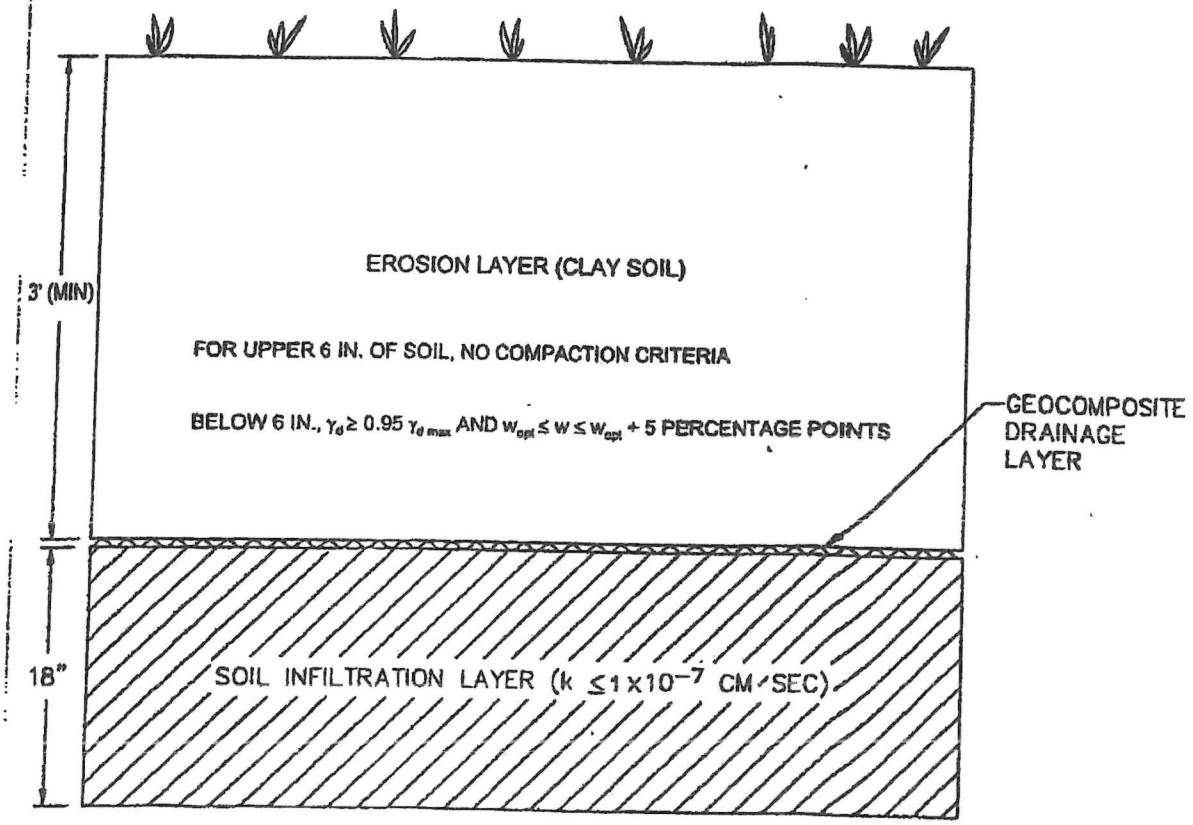
Appendicies

12/27/99
STATE OF TEXAS
BETH ANN GROSS
79864
REGISTERED
PROFESSIONAL ENGINEER

GT0936-01/TX990029

APPENDIX A

ATTACHMENT 7L-a



DETAIL
ALTERNATE FINAL COVER SYSTEM

SCALE: NTS

STATE OF TEXAS
BETH ANN GROSS
79864
REGISTERED PROFESSIONAL ENGINEER
12/27/99

GeoSyntec Consultants
AUSTIN, TEXAS

ATTACHMENT NO.	7L-8
PROJECT NO.	GT0936-01
DOCUMENT NO.	TX990029
FILE NO.	0936F001

APPENDIX B

ALTERNATE FINAL COVER SYSTEM PERFORMANCE EVALUATION

Written By: M. Christman Date: 10/12/99 Reviewed by: B. Gross Date: 12/21/99

Client: WMTX Project: Skyline Landfill Permit Mod. Project/Proposal No.: GT0936 Task No.: 01

ALTERNATE FINAL COVER SYSTEM PERFORMANCE EVALUATION

12/27/99

STATE OF TEXAS
BETH ANN GROSS
79864
REGISTERED
PROFESSIONAL ENGINEER

Beth Ann Gross

46 pages

INTRODUCTION

The purpose of this calculation package is to assess the performance of the alternate final cover system for the Skyline Landfill and Recycling Center (Skyline Landfill). In accordance with 30 TAC § 330.253 (c), an alternate final cover system for a municipal solid waste landfill (MSWLF) must provide reduction in infiltration and protection from wind and water erosion equivalent to that of the prescriptive minimum criteria final cover system defined in 30 TAC § 330.253 (b). In addition, for the Skyline Landfill, an alternate final cover system must perform equivalently to the currently permitted final cover system.

The prescriptive minimum criteria final cover system (prescriptive cover system) for modern MSWLFs is defined in 30 TAC § 330.253 (b)(1) and (3) to consist of the following components, from top to bottom:

- 6-in. thick soil erosion layer;
- geomembrane barrier; and
- 18-in. thick soil infiltration layer ($k \leq 1 \times 10^{-5}$ cm/s).

The currently permitted final cover system (permitted cover system) for the Skyline Landfill consists of the following components, from top to bottom:

- 28-in. thick clayey soil erosion layer;
- geocomposite (i.e., geotextile/geonet/geotextile) drainage layer on sideslopes steeper than 6H:1V;
- polyethylene geomembrane barrier; and
- 18-in. thick soil infiltration layer ($k \leq 1 \times 10^{-7}$ cm/s).

The proposed alternate final cover system (alternate cover system) consists of the following components, from top to bottom:

- 3-ft thick clayey soil erosion layer;
- geocomposite drainage layer on the top deck and the sideslopes; and
- 18-in. thick soil infiltration layer ($k \leq 1 \times 10^{-7}$ cm/s).

Like the erosion layer for the permitted cover system, the erosion layer for the alternate cover system will consist of clayey soil vegetated with grass. However, the erosion layer for the alternate cover system is thicker than those for the prescriptive and permitted cover systems. Therefore, the proposed alternate cover system is considered to provide protection from wind and water erosion at leas equivalent to that provided by the prescriptive and permitted cover systems.

The ability of the alternate cover system to provide equivalent reduction in infiltration as the prescriptive and permitted cover systems is analyzed below.

METHOD OF ANALYSIS

The most common method used to evaluate the hydraulic performance of landfill cover systems is the U.S. EPA Hydrologic Evaluation of Landfill Performance (HELP) computer model. The HELP model simulates hydrologic processes for a landfill by performing daily, sequential water budget analyses using a quasi-two-dimensional, deterministic approach (Schroeder et al., 1994a, 1994b). The hydrologic processes considered in the HELP model include precipitation, surface-water storage (i.e., storage as snow), interception of precipitation by foliage, surface-water evaporation, runoff, snow melt, infiltration, plant transpiration, soil water evaporation, soil water storage, vertical drainage (saturated and unsaturated), lateral drainage (saturated), vertical percolation (saturated) through compacted soil liners and geosynthetic clay liners, and leakage through geomembranes.



The HELP model requires the input of daily and general climatic data, material properties data for the landfill components being modeled, and landfill design data. The input data used for the Skyline Landfill site and the considered final cover systems are described below.

Thirty years of climatic data for the Skyline Landfill site were synthetically generated by HELP using default climatic parameters for Dallas, Texas. The average annual precipitation during these thirty years ranged from 16.70 to 39.60 in.

The erosion layer was modeled as a vertical percolation layer with a good stand of grass. The geocomposite drainage layer was modeled as a lateral drainage layer. The geomembrane was modeled as a flexible membrane liner. The soil infiltration layer was modeled as a barrier soil liner. The erosion layer and soil infiltration layer will primarily be constructed of on-site clayey soils. From the results of laboratory tests conducted previously on site soil samples (see Table 1 1-1 in facility permit and the Soil and Liner Evaluation Reports), the site soils are predominantly classified as CH materials and generally have liquid limits in the range of 65 to 90% and plastic indices in the range of 40 to 65%.

The material properties used for the layers were generally taken from the HELP model database and are shown on the attached HELP model output. The material properties of the layers are summarized below:

- Erosion layer: material texture number 10 for upper 6 in. of layer and material texture number 15 for soil below 6 in. depth; evaporative zone depth = erosion layer thickness; default hydraulic conductivity of 1.7×10^{-5} cm/s for the soil below 6 in. depth in the permitted cover and modified hydraulic conductivity of 1×10^{-6} cm/s for the for the soil below 6 in. depth in the alternate cover.

- Geocomposite drainage layer: material texture number 20 with default hydraulic conductivity of 10 cm/s (transmissivity of 5×10^{-4} m^2/s).

- Geomembrane: material texture number 35 (0.06-in. thick) with one pinhole and two installation defects/acre; good placement quality.

- Soil infiltration layer: material texture number 16 with modified hydraulic conductivity of 1×10^{-5} cm/s for the prescriptive cover and default hydraulic conductivity of 1×10^{-7} cm/s for the permitted and alternate covers.

The design data required by the HELP model consists of the cover system surface slope and slope length, the drainage layer slope and slope length, and the runoff curve number. The final cover system grades are shown on Attachment 9, which is included in this calculation package and taken from the facility permit application. The cover system surface slope and slope length were assumed to equal the drainage layer slope and slope length. The design data used for the Skyline Landfill were as follows:

- representative top deck slope and slope length (from peak to elevation 650 ft msl) = 8.5% and 450 ft;
- representative sideslope slope and slope length (between drainage terraces; the geocomposite outlets on these terraces) = 20% and 150 ft; and
- HELP model computed runoff curve number = 80.60 for top deck and 82.20 for sideslope.

Six HELP model simulations were performed to calculate percolation through the three cover systems with the representative top deck and sideslope geometries. The results of the simulations are described below.

RESULTS

The results of the analysis are tabulated below. HELP model output files for the six simulations are attached. The simulations demonstrate that the permitted and alternate cover systems should provide enhanced reduction in infiltration over the prescriptive cover system and that the alternate cover system provides an essentially equivalent reduction in infiltration as the permitted cover system. The relatively high performance of the alternate cover system is primarily due to: (i) the ability of the thick erosion layer to store infiltration until it is removed by evapotranspiration; and (ii) the ability of the geocomposite drainage layer beneath the erosion layer to rapidly remove rainwater that infiltrates through the erosion layer.

Written By: M. Christman Date: 10/12/99 Reviewed by: B. Gross Date: 12/21/99

Client: WMTX Project: Skyline Landfill Permit Mod. Project/Proposal No.: GT0936 Task No.: 01

Cover System Configuration	Location	Avg. Annual Percolation	
		(in.)	(gal/acre/day)
Prescriptive	Top Deck	0.02	1.3
	Side Slope	0.02	1.3
Permitted	Top Deck	0.002	0.1
	Side Slope	0.00000	<0.00001
Alternate	Top Deck	0.004	0.3
	Side Slope	0.002	0.1

CONCLUSIONS

The alternate cover system should perform better than the prescriptive cover system and essentially equivalent to the currently permitted cover system.

REFERENCES

Schroeder, P.R., Lloyd, C.M., and Zappi, P.A., "*The Hydrologic Evaluation of Landfill Performance (HELP) Model, User's Guide for Version 3*", U.S. Environmental Protection Agency, Office of Research and Development, Washington, D.C., Report No. EPA/600/R-94/168a, 1994a.

Schroeder, P.R., Dozier, T.S., Zappi, P.A., McEnroe, B.M., Sjostrom, J.W., and Peyton, R.L., "*The Hydrologic Evaluation of Landfill Performance (HELP) Model Engineering Documentation for Version 3*", U.S. Environmental Protection Agency, Office of Research and Development, Washington, D.C., Report No. EPA/600/R-94/168b, 116 p., 1994b.

For Permit Purposes Only
TOP DECK
L = 450'
S = 8.5%
SIDE SLOPE
L = 150'
S = 20%
LEGEND
NOTES
SKYLINE LANDFILL
AND RECYCLING CENTER
LANDFILL COMPLETION
PLAN
HDR
TOP
DECK

6/46

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

PRECIPITATION DATA FILE:     c:\help3\DALLAS.D4
TEMPERATURE DATA FILE:       C:\HELP3\DALLAS.D7
SOLAR RADIATION DATA FILE:   C:\HELP3\DALLAS.D13
EVAPOTRANSPIRATION DATA:     C:\HELP3\DAL28.D11
SOIL AND DESIGN DATA FILE:   C:\HELP3\EPAT.D10
OUTPUT DATA FILE:            C:\HELP3\EPAT.OUT

TIME:   6:21     DATE:  10/25/1999

**********************************************************************

     TITLE:  WMTX SKYLINE LANDFILL -- PRESCRIPTIVE COVER SYSTEM (TOP DECK)

**********************************************************************

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


                              LAYER  1
                              --------

                  TYPE 1 - VERTICAL PERCOLATION LAYER
                       MATERIAL TEXTURE NUMBER  10
          THICKNESS                     =      6.00   INCHES
          POROSITY                      =      0.3980 VOL/VOL
          FIELD CAPACITY                =      0.2440 VOL/VOL
          WILTING POINT                 =      0.1360 VOL/VOL
          INITIAL SOIL WATER CONTENT    =      0.2605 VOL/VOL
          EFFECTIVE SAT. HYD. COND.     = 0.119999997000E-03 CM/SEC
        NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  4.63
               FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.
```

LAYER 2

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35

THICKNESS	= 0.06	INCHES
POROSITY	= 0.0000	VOL/VOL
FIELD CAPACITY	= 0.0000	VOL/VOL
WILTING POINT	= 0.0000	VOL/VOL
INITIAL SOIL WATER CONTENT	= 0 0000	VOL/VOL
EFFECTIVE SAT. HYD. COND.	= 0.199999996000E-12	CM/SEC
FML PINHOLE DENSITY	= 1.00	HOLES/ACRE
FML INSTALLATION DEFECTS	= 2.00	HOLES/ACRE
FML PLACEMENT QUALITY	= 3 - GOOD	

LAYER 3

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 3

THICKNESS	= 18.00	INCHES
POROSITY	= 0.4270	VOL/VOL
FIELD CAPACITY	= 0.4180	VOL/VOL
WILTING POINT	= 0.3670	VOL/VOL
INITIAL SOIL WATER CONTENT	= 0.4270	VOL/VOL
EFFECTIVE SAT. HYD. COND.	= 0.999999975000E-05	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE #10 WITH A GOOD STAND OF GRASS, A SURFACE SLOPE OF 8.% AND A SLOPE LENGTH OF 450. FEET.

SCS RUNOFF CURVE NUMBER	= 80.60	
FRACTION OF AREA ALLOWING RUNOFF	= 100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	= 1.000	ACRES
EVAPORATIVE ZONE DEPTH	= 6.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	= 1.563	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	= 2.388	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	= 0.816	INCHES
INITIAL SNOW WATER	= 0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	= 9.249	INCHES
TOTAL INITIAL WATER	= 9.249	INCHES
TOTAL SUBSURFACE INFLOW	= 0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
DALLAS TEXAS

STATION LATITUDE	=	32.85 DEGREES
MAXIMUM LEAF AREA INDEX	=	3.50
START OF GROWING SEASON (JULIAN DATE)	=	63
END OF GROWING SEASON (JULIAN DATE)	=	329
EVAPORATIVE ZONE DEPTH	=	6.0 INCHES
AVERAGE ANNUAL WIND SPEED	=	10.80 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	66.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	68.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	63.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	66.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR DALLAS TEXAS

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
1.65	1.93	2.42	3.63	4.27	2.59
2.00	1.76	3.31	2.47	1.76	1.67

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR DALLAS TEXAS

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
44.00	48.50	56.10	65.90	73.70	82.00
86.30	85.50	78.60	67.90	55.60	47.80

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR DALLAS TEXAS
AND STATION LATITUDE = 32.85 DEGREES

10/46

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 30

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	1.29	1.79	2.22	3.48	3.85	2.64
	2.76	1.67	3.70	2.52	1.61	1.76
STD. DEVIATIONS	0.88	1.03	1.32	2.14	1.79	1.71
	2.20	1.24	2.03	2.07	1.21	1.26
RUNOFF						
TOTALS	0.197	0.185	0.338	0.785	0.589	0.352
	0.457	0.049	0.671	0.687	0.231	0.382
STD. DEVIATIONS	0.362	0.330	0.666	1.216	1.029	0.549
	1.004	0.122	0.861	1.201	0.596	0.635
EVAPOTRANSPIRATION						
TOTALS	1.291	1.516	2.015	2.713	3.335	2.537
	2.304	1.603	2.675	1.908	1.152	1.323
STD. DEVIATIONS	0.621	0.713	1.011	1.270	1.111	1.353
	1.401	1.200	1.210	1.100	0.574	0.593
PERCOLATION/LEAKAGE THROUGH LAYER 3						
TOTALS	0.0023	0.0021	0.0018	0.0015	0.0011	0.0006
	0.0004	0.0002	0.0010	0.0018	0.0016	0.0027
STD. DEVIATIONS	0.0019	0.0014	0.0013	0.0011	0.0006	0.0005
	0.0005	0.0004	0.0008	0.0017	0.0018	0.0021

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 2						
AVERAGES	1.7779	1.8023	1.3804	1.1968	0.8251	0.5249
	0.3287	0.1704	0.7975	1.4116	1.3058	2.1338
STD. DEVIATIONS	1.5821	1.2761	1.0676	0.9301	0.5031	0.4275
	0.3870	0.2789	0.6993	1.3725	1.4665	1.6982

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 30

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	1.29	1.79	2.22	3.48	3.85	2.64
	2.76	1.67	3.70	2.52	1.61	1.76
STD. DEVIATIONS	0.88	1.03	1.32	2.14	1.79	1.71
	2.20	1.24	2.03	2.07	1.21	1.26
RUNOFF						
TOTALS	0.197	0.185	0.338	0.785	0.589	0.352
	0.457	0.049	0.671	0.687	0.231	0.382
STD. DEVIATIONS	0.362	0.330	0.666	1.216	1.029	0.549
	1.004	0.122	0.861	1.201	0.596	0.635
EVAPOTRANSPIRATION						
TOTALS	1.291	1.516	2.015	2.713	3.335	2.537
	2.304	1.603	2.675	1.908	1.152	1.323
STD. DEVIATIONS	0.621	0.713	1.011	1.270	1.111	1.353
	1.401	1.200	1.210	1.100	0.574	0.593
PERCOLATION/LEAKAGE THROUGH LAYER 3						
TOTALS	0.0023	0.0021	0.0018	0.0015	0.0011	0.0006
	0.0004	0.0002	0.0010	0.0018	0.0016	0.0027
STD. DEVIATIONS	0.0019	0.0014	0.0013	0.0011	0.0006	0.0005
	0.0005	0.0004	0.0008	0.0017	0.0018	0.0021

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 2						
AVERAGES	1.7779	1.8023	1.3804	1.1968	0.8251	0.5249
	0.3287	0.1704	0.7975	1.4116	1.3058	2.1338
STD. DEVIATIONS	1.5821	1.2761	1.0676	0.9301	0.5031	0.4275
	0.3870	0.2789	0.6993	1.3725	1.4665	1.6982

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 30

	INCHES	CU. FEET	PERCENT
PRECIPITATION	29.29 (5.380)	106304.6	100.00
RUNOFF	4.921 (2.5803)	17863.14	16.804
EVAPOTRANSPIRATION	24.372 (3.5640)	88470.19	83.223
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.01697 (0.00568)	61.609	0.05796
AVERAGE HEAD ON TOP OF LAYER 2	1.138 (0.391)		
CHANGE IN WATER STORAGE	-0.025 (0.5740)	-90.39	-0.085

= 460.8 gallons/acre/year
= 1.3 gallons/acre/day

PEAK DAILY VALUES FOR YEARS 1 THROUGH 30

	(INCHES)	(CU. FT.)
PRECIPITATION	4.98	18077.400
RUNOFF	3.347	12150.0088
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.000234	0.85078
AVERAGE HEAD ON TOP OF LAYER 2	6.000	
SNOW WATER	1.00	3631.1433
MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.3980	
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.1360	

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FINAL WATER STORAGE AT END OF YEAR 30

LAYER	(INCHES)	(VOL/VOL)
1	0.8160	0.1360
2	0.0000	0.0000
3	7.6860	0.4270
SNOW WATER	0.000	

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**                                                                  **
**                                                                  **
**                HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE     **
**                  HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)      **
**                    DEVELOPED BY ENVIRONMENTAL LABORATORY         **
**                      USAE WATERWAYS EXPERIMENT STATION           **
**                  FOR USEPA RISK REDUCTION ENGINEERING LABORATORY  **
**                                                                  **
**                                                                  **
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PRECIPITATION DATA FILE:     c:\help3\DALLAS.D4
TEMPERATURE DATA FILE:       C:\HELP3\DALLAS.D7
SOLAR RADIATION DATA FILE:   C:\HELP3\DALLAS.D13
EVAPOTRANSPIRATION DATA:     C:\HELP3\DAL28.D11
SOIL AND DESIGN DATA FILE:   C:\HELP3\EPAS.D10
OUTPUT DATA FILE:            C:\HELP3\EPAS.OUT

TIME:   6:26     DATE:  10/25/1999

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     TITLE:  WMTX SKYLINE LANDFILL -- PRESCRIPTIVE COVER SYSTEM (SIDESLOPE)

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


                                LAYER  1
                                --------

                TYPE 1 - VERTICAL PERCOLATION LAYER
                    MATERIAL TEXTURE NUMBER  10
          THICKNESS                     =      6.00   INCHES
          POROSITY                      =      0.3980 VOL/VOL
          FIELD CAPACITY                =      0.2440 VOL/VOL
          WILTING POINT                 =      0.1360 VOL/VOL
          INITIAL SOIL WATER CONTENT    =      0.2605 VOL/VOL
          EFFECTIVE SAT. HYD. COND.     =  0.119999997000E-03 CM/SEC
        NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  4.63
                 FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.
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LAYER 2

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35

THICKNESS	=	0.06	INCHES
POROSITY	=	0.0000	VOL/VOL
FIELD CAPACITY	=	0.0000	VOL/VOL
WILTING POINT	=	0.0000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.199999996000E-12	CM/SEC
FML PINHOLE DENSITY	=	1.00	HOLES/ACRE
FML INSTALLATION DEFECTS	=	2.00	HOLES/ACRE
FML PLACEMENT QUALITY	=	3 - GOOD	

LAYER 3

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	18.00	INCHES
POROSITY	=	0.4270	VOL/VOL
FIELD CAPACITY	=	0.4180	VOL/VOL
WILTING POINT	=	0.3670	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4270	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.999999975000E-05	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE #10 WITH A GOOD STAND OF GRASS, A SURFACE SLOPE OF 20.% AND A SLOPE LENGTH OF 150. FEET.

SCS RUNOFF CURVE NUMBER	=	82.20	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	6.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	1.563	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	2.388	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	0.816	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	9.249	INCHES
TOTAL INITIAL WATER	=	9.249	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
DALLAS TEXAS

STATION LATITUDE	=	32.85	DEGREES
MAXIMUM LEAF AREA INDEX	=	3.50	
START OF GROWING SEASON (JULIAN DATE)	=	63	
END OF GROWING SEASON (JULIAN DATE)	=	329	
EVAPORATIVE ZONE DEPTH	=	6.0	INCHES
AVERAGE ANNUAL WIND SPEED	=	10.80	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	66.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	68.00	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	63.00	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	66.00	%

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR DALLAS TEXAS

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
1.65	1.93	2.42	3.63	4.27	2.59
2.00	1.76	3.31	2.47	1.76	1.67

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR DALLAS TEXAS

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
44.00	48.50	56.10	65.90	73.70	82.00
86.30	85.50	78.60	67.90	55.60	47.80

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR DALLAS TEXAS
AND STATION LATITUDE = 32.85 DEGREES

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 30

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	1.29	1.79	2.22	3.48	3.85	2.64
	2.76	1.67	3.70	2.52	1.61	1.76
STD. DEVIATIONS	0.88	1.03	1.32	2.14	1.79	1.71
	2.20	1.24	2.03	2.07	1.21	1.26
RUNOFF						
TOTALS	0.196	0.187	0.338	0.791	0.592	0.353
	0.456	0.050	0.673	0.672	0.231	0.382
STD. DEVIATIONS	0.362	0.330	0.666	1.212	1.028	0.548
	0.989	0.122	0.861	1.204	0.596	0.635
EVAPOTRANSPIRATION						
TOTALS	1.293	1.513	2.011	2.713	3.333	2.533
	2.305	1.602	2.672	1.926	1.149	1.322
STD. DEVIATIONS	0.624	0.716	1.016	1.274	1.109	1.354
	1.407	1.199	1.207	1.091	0.573	0.593
PERCOLATION/LEAKAGE THROUGH LAYER 3						
TOTALS	0.0023	0.0021	0.0018	0.0015	0.0010	0.0006
	0.0004	0.0002	0.0010	0.0018	0.0016	0.0027
STD. DEVIATIONS	0.0019	0.0014	0.0013	0.0011	0.0006	0.0005
	0.0005	0.0004	0.0008	0.0017	0.0018	0.0021

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 2						
AVERAGES	1.7828	1.8087	1.3782	1.2119	0.8220	0.5207
	0.3303	0.1694	0.7953	1.3950	1.3028	2.1372
STD. DEVIATIONS	1.5759	1.2853	1.0687	0.9263	0.5015	0.4244
	0.3948	0.2782	0.7001	1.3679	1.4636	1.7003

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 30

	INCHES	CU. FEET	PERCENT
PRECIPITATION	29.29 (5.380)	106304.6	100.00
RUNOFF	4.923 (2.6023)	17871.05	16.811
EVAPOTRANSPIRATION	24.370 (3.5527)	88462.27	83.216
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.01697 (0.00568)	61.618	0.05796
AVERAGE HEAD ON TOP OF LAYER 2	1.138 (0.392)		
CHANGE IN WATER STORAGE	-0.025 (0.5770)	-90.39	-0.085

= 460.9 gallons/acre/yr
= 1.3 gallons/acre/day

PEAK DAILY VALUES FOR YEARS 1 THROUGH 30

	(INCHES)	(CU. FT.)
PRECIPITATION	4.98	18077.400
RUNOFF	3.347	12149.8057
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.000234	0.85078
AVERAGE HEAD ON TOP OF LAYER 2	6.000	
SNOW WATER	1.00	3631.1433
MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.3980	
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.1360	

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FINAL WATER STORAGE AT END OF YEAR 30

LAYER	(INCHES)	(VOL/VOL)
1	0.8160	0.1360
2	0.0000	0.0000
3	7.6860	0.4270
SNOW WATER	0.000	

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**          HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE           **
**            HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)            **
**             DEVELOPED BY ENVIRONMENTAL LABORATORY                **
**               USAE WATERWAYS EXPERIMENT STATION                  **
**          FOR USEPA RISK REDUCTION ENGINEERING LABORATORY         **
**                                                                  **
**                                                                  **
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PRECIPITATION DATA FILE:     c:\help3\DALLAS.D4
TEMPERATURE DATA FILE:       C:\HELP3\DALLAS.D7
SOLAR RADIATION DATA FILE:   C:\HELP3\DALLAS.D13
EVAPOTRANSPIRATION DATA:     C:\HELP3\DAL28.D11
SOIL AND DESIGN DATA FILE:   C:\HELP3\EXIST.D10
OUTPUT DATA FILE:            C:\HELP3\EXIST.OUT

TIME:   5:51     DATE:  10/25/1999

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     TITLE:  WMTX SKYLINE LANDFILL -- PERMITTED COVER SYSTEM (TOP DECK)

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


                              LAYER  1
                              --------

                  TYPE 1 - VERTICAL PERCOLATION LAYER
                      MATERIAL TEXTURE NUMBER  10
          THICKNESS                     =      6.00   INCHES
          POROSITY                      =      0.3980 VOL/VOL
          FIELD CAPACITY                =      0.2440 VOL/VOL
          WILTING POINT                 =      0.1360 VOL/VOL
          INITIAL SOIL WATER CONTENT    =      0.2119 VOL/VOL
          EFFECTIVE SAT. HYD. COND.     =  0.119999997000E-03 CM/SEC
        NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  4.63
               FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.
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LAYER 2

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 15

THICKNESS	=	22.00 INCHES
POROSITY	=	0.4750 VOL/VOL
FIELD CAPACITY	=	0.3780 VOL/VOL
WILTING POINT	=	0.2650 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3045 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.170000003000E-04 CM/SEC

LAYER 3

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35

THICKNESS	=	0.06 INCHES
POROSITY	=	0.0000 VOL/VOL
FIELD CAPACITY	=	0.0000 VOL/VOL
WILTING POINT	=	0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY	=	1.00 HOLES/ACRE
FML INSTALLATION DEFECTS	=	2.00 HOLES/ACRE
FML PLACEMENT QUALITY	=	3 - GOOD

LAYER 4

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 16

THICKNESS	=	18.00 INCHES
POROSITY	=	0.4270 VOL/VOL
FIELD CAPACITY	=	0.4180 VOL/VOL
WILTING POINT	=	0.3670 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4270 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000001000E-06 CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE #10 WITH A GOOD STAND OF GRASS, A SURFACE SLOPE OF 8.% AND A SLOPE LENGTH OF 450. FEET.

SCS RUNOFF CURVE NUMBER	=	80.60	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	28.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	7.971	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	12.838	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	6.646	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	15.657	INCHES
TOTAL INITIAL WATER	=	15.657	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
DALLAS TEXAS .

STATION LATITUDE	=	32.85	DEGREES
MAXIMUM LEAF AREA INDEX	=	3.50	
START OF GROWING SEASON (JULIAN DATE)	=	63	
END OF GROWING SEASON (JULIAN DATE)	=	329	
EVAPORATIVE ZONE DEPTH	=	28.0	INCHES
AVERAGE ANNUAL WIND SPEED	=	10.80	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	66.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	68.00	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	63.00	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	66.00	%

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR DALLAS TEXAS

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
1.65	1.93	2.42	3.63	4.27	2.59
2.00	1.76	3.31	2.47	1.76	1.67

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR DALLAS TEXAS

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
44.00	48.50	56.10	65.90	73.70	82.00
86.30	85.50	78.60	67.90	55.60	47.80

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR DALLAS TEXAS
AND STATION LATITUDE = 32.85 DEGREES

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 30

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	1.29 2.76	1.79 1.67	2.22 3.70	3.48 2.52	3.85 1.61	2.64 1.76
STD. DEVIATIONS	0.88 2.20	1.03 1.24	1.32 2.03	2.14 2.07	1.79 1.21	1.71 1.26
RUNOFF						
TOTALS	0.018 0.109	0.051 0.008	0.035 0.098	0.250 0.093	0.222 0.043	0.048 0.070
STD. DEVIATIONS	0.075 0.262	0.207 0.022	0.075 0.164	0.476 0.223	0.533 0.168	0.111 0.190
EVAPOTRANSPIRATION						
TOTALS	1.346 2.665	1.534 1.705	2.057 2.814	3.935 1.713	5.280 0.981	2.985 1.240
STD. DEVIATIONS	0.551 1.784	0.572 1.370	0.817 1.440	1.061 0.793	1.761 0.398	1.545 0.508
PERCOLATION/LEAKAGE THROUGH LAYER 4						
TOTALS	0.0003 0.0000	0.0003 0.0000	0.0003 0.0000	0.0004 0.0001	0.0001 0.0001	0.0000 0.0003
STD. DEVIATIONS	0.0004 0.0000	0.0003 0.0000	0.0003 0.0000	0.0003 0.0002	0.0002 0.0002	0.0000 0.0004

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AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 3

AVERAGES	7.4356	7.4137	8.2696	8.9732	3.2549	0.0249
	0.0914	0.0275	0.0177	1.5709	3.3367	6.2163
STD. DEVIATIONS	9.5376	8.7396	7.4393	7.5339	4.9528	0.1224
	0.3497	0.1505	0.0725	3.8277	6.0361	8.8041

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 30

	INCHES		CU. FEET	PERCENT
PRECIPITATION	29.29	(5.380)	106304.6	100.00
RUNOFF	1.045	(0.9460)	3793.39	3.568
EVAPOTRANSPIRATION	28.255	(4.4927)	102565.26	96.482
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.00189	(0.00147)	6.869	0.00646
			= 51.4 gallons/acre/year	
AVERAGE HEAD ON TOP OF LAYER 3	3.886	(3.077)	= 0.14 gallons/acre/day	
CHANGE IN WATER STORAGE	-0.017	(2.6386)	-60.98	-0.057

PEAK DAILY VALUES FOR YEARS 1 THROUGH 30

	(INCHES)	(CU. FT.)
PRECIPITATION	4.98	18077.400
RUNOFF	2.220	8059.9077
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.000037	0.13367
AVERAGE HEAD ON TOP OF LAYER 3	28.000	
SNOW WATER	1.00	3631.1433

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.4585

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.2374

FINAL WATER STORAGE AT END OF YEAR 30

LAYER	(INCHES)	(VOL/VOL)
1	1.2981	0.2163
2	6.1684	0.2804
3	0.0000	0.0000
4	7.6860	0.4270
SNOW WATER	0.000	

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**                                                                  **
**                                                                  **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE       **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)        **
**                   DEVELOPED BY ENVIRONMENTAL LABORATORY          **
**                     USAE WATERWAYS EXPERIMENT STATION            **
**                FOR USEPA RISK REDUCTION ENGINEERING LABORATORY    **
**                                                                  **
**                                                                  **
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PRECIPITATION DATA FILE:     c:\help3\DALLAS.D4
TEMPERATURE DATA FILE:       C:\HELP3\DALLAS.D7
SOLAR RADIATION DATA FILE:   C:\HELP3\DALLAS.D13
EVAPOTRANSPIRATION DATA:     C:\HELP3\DAL28.D11
SOIL AND DESIGN DATA FILE:   C:\HELP3\EXISTS.D10
OUTPUT DATA FILE:            C:\HELP3\EXISTS.OUT

TIME:   6:12     DATE:  10/25/1999

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     TITLE:  WMTX SKYLINE LANDFILL -- PERMITTED COVER SYSTEM (SIDESLOPE)

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


                                LAYER  1
                                --------

                    TYPE 1 - VERTICAL PERCOLATION LAYER
                        MATERIAL TEXTURE NUMBER  10
          THICKNESS                    =      6.00   INCHES
          POROSITY                     =      0.3980 VOL/VOL
          FIELD CAPACITY               =      0.2440 VOL/VOL
          WILTING POINT                =      0.1360 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.2114 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.119999997000E-03 CM/SEC
        NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  4.63
                 FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.
```

LAYER 2

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 15

THICKNESS	=	22.00	INCHES
POROSITY	=	0.4750	VOL/VOL
FIELD CAPACITY	=	0.3780	VOL/VOL
WILTING POINT	=	0.2650	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3053	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.170000003000E-04	CM/SEC

LAYER 3

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 20

THICKNESS	=	0.20	INCHES
POROSITY	=	0.8500	VOL/VOL
FIELD CAPACITY	=	0.0100	VOL/VOL
WILTING POINT	=	0.0050	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0100	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	10.0000000000	CM/SEC
SLOPE	=	20.00	PERCENT
DRAINAGE LENGTH	=	150.0	FEET

LAYER 4

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35

THICKNESS	=	0.06	INCHES
POROSITY	=	0.0000	VOL/VOL
FIELD CAPACITY	=	0.0000	VOL/VOL
WILTING POINT	=	0.0000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.199999996000E-12	CM/SEC
FML PINHOLE DENSITY	=	1.00	HOLES/ACRE
FML INSTALLATION DEFECTS	=	1.00	HOLES/ACRE
FML PLACEMENT QUALITY	=	3 - GOOD	

LAYER 5

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 16

THICKNESS	=	18.00	INCHES
POROSITY	=	0.4270	VOL/VOL
FIELD CAPACITY	=	0.4180	VOL/VOL
WILTING POINT	=	0.3670	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4270	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000001000E-06	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE #10 WITH A GOOD STAND OF GRASS, A SURFACE SLOPE OF 20.% AND A SLOPE LENGTH OF 150. FEET.

SCS RUNOFF CURVE NUMBER	=	82.20	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	28.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	7.985	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	12.838	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	6.646	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	15.673	INCHES
TOTAL INITIAL WATER	=	15.673	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
DALLAS TEXAS

STATION LATITUDE	=	32.85	DEGREES
MAXIMUM LEAF AREA INDEX	=	3.50	
START OF GROWING SEASON (JULIAN DATE)	=	63	
END OF GROWING SEASON (JULIAN DATE)	=	329	
EVAPORATIVE ZONE DEPTH	=	28.0	INCHES
AVERAGE ANNUAL WIND SPEED	=	10.80	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	66.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	68.00	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	63.00	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	66.00	%

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR DALLAS TEXAS

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
1.65	1.93	2.42	3.63	4.27	2.59
2.00	1.76	3.31	2.47	1.76	1.67

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR DALLAS TEXAS

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
44.00	48.50	56.10	65.90	73.70	82.00
86.30	85.50	78.60	67.90	55.60	47.80

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR DALLAS TEXAS
AND STATION LATITUDE = 32.85 DEGREES

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 30

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	1.29	1.79	2.22	3.48	3.85	2.64
	2.76	1.67	3.70	2.52	1.61	1.76
STD. DEVIATIONS	0.88	1.03	1.32	2.14	1.79	1.71
	2.20	1.24	2.03	2.07	1.21	1.26
RUNOFF						
TOTALS	0.002	0.013	0.037	0.203	0.182	0.068
	0.160	0.013	0.142	0.127	0.035	0.017
STD. DEVIATIONS	0.004	0.036	0.093	0.434	0.444	0.141
	0.374	0.033	0.207	0.291	0.117	0.054

EVAPOTRANSPIRATION

TOTALS	1.351	1.504	2.090	3.774	4.166	2.838
	2.616	1.695	2.803	1.741	1.021	1.247
STD. DEVIATIONS	0.551	0.561	0.794	1.096	1.641	1.639
	1.713	1.350	1.430	0.829	0.431	0.511

LATERAL DRAINAGE COLLECTED FROM LAYER 3

TOTALS	0.2229	0.1028	0.2042	0.1676	0.1661	0.0012
	0.0006	0.0004	0.0002	0.1788	0.1067	0.3143
STD. DEVIATIONS	0.3960	0.2390	0.4244	0.3269	0.4093	0.0026
	0.0016	0.0012	0.0003	0.4952	0.2380	0.5450

PERCOLATION/LEAKAGE THROUGH LAYER 5

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 4

AVERAGES	0.0003	0.0002	0.0003	0.0002	0.0002	0.0000
	0.0000	0.0000	0.0000	0.0002	0.0002	0.0004
STD. DEVIATIONS	0.0005	0.0004	0.0006	0.0005	0.0006	0.0000
	0.0000	0.0000	0.0000	0.0007	0.0003	0.0007

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 30

	INCHES	CU. FEET	PERCENT
PRECIPITATION	29.29 (5.380)	106304.6	100.00
RUNOFF	0.995 (0.8099)	3611.35	3.397
EVAPOTRANSPIRATION	26.846 (4.1025)	97451.73	91.672
LATERAL DRAINAGE COLLECTED FROM LAYER 3	1.46578 (1.30760)	5320.791	5.00523
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.00000 (0.00000)	0.000	0.00000
AVERAGE HEAD ON TOP OF LAYER 4	0.000 (0.000)		
CHANGE IN WATER STORAGE	-0.022 (1.7187)	-79.33	-0.075

< 0.0037 gallons/acre/year
< 0.00001 gallons/acre/day

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 30

	(INCHES)	(CU. FT.)
PRECIPITATION	4.98	18077.400
RUNOFF	2.081	7555.4185
DRAINAGE COLLECTED FROM LAYER 3	0.55779	2024.79541
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.000000	0.00004
AVERAGE HEAD ON TOP OF LAYER 4	0.024	
MAXIMUM HEAD ON TOP OF LAYER 4	0.038	
LOCATION OF MAXIMUM HEAD IN LAYER 3 (DISTANCE FROM DRAIN)	0.0 FEET	
SNOW WATER	1.00	3631.1433

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.4481

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.2374

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

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

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FINAL WATER STORAGE AT END OF YEAR 30

LAYER	(INCHES)	(VOL/VOL)
1	1.2370	0.2062
2	6.0925	0.2769
3	0.0020	0.0100
4	0.0000	0.0000
5	7.6860	0.4270
SNOW WATER	0.000	

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**                                                                  **
**                                                                  **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE       **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)        **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY           **
**                    USAE WATERWAYS EXPERIMENT STATION             **
**              FOR USEPA RISK REDUCTION ENGINEERING LABORATORY     **
**                                                                  **
**                                                                  **
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PRECIPITATION DATA FILE:     C:\FLOWMO~1\HELP3\DALLAS.D4
TEMPERATURE DATA FILE:       C:\FLOWMO~1\HELP3\DALLAS.D7
SOLAR RADIATION DATA FILE:   C:\FLOWMO~1\HELP3\DALLAS.D13
EVAPOTRANSPIRATION DATA:     C:\FLOWMO~1\HELP3\DAL48.D11
SOIL AND DESIGN DATA FILE:   C:\FLOWMO~1\HELP3\ALT1T.D10
OUTPUT DATA FILE:            C:\FLOWMO~1\HELP3\ALT1T.OUT

TIME:  7:10       DATE:  10/25/1999

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     TITLE:  WMTX SKYLINE LANDFILL -- ALTERNATE COVER SYSTEM (TOP DECK)

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


                                LAYER  1
                                --------

                    TYPE 1 - VERTICAL PERCOLATION LAYER
                        MATERIAL TEXTURE NUMBER  10
        THICKNESS                     =      6.00   INCHES
        POROSITY                      =      0.3980 VOL/VOL
        FIELD CAPACITY                =      0.2440 VOL/VOL
        WILTING POINT                 =      0.1360 VOL/VOL
        INITIAL SOIL WATER CONTENT    =      0.2309 VOL/VOL
        EFFECTIVE SAT. HYD. COND.     = 0.119999997000E-03 CM/SEC
      NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  4.63
               FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.
```

LAYER 2

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	30.00	INCHES
POROSITY	=	0.4750	VOL/VOL
FIELD CAPACITY	=	0.3780	VOL/VOL
WILTING POINT	=	0.2650	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2863	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.999999997000E-06	CM/SEC

LAYER 3

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 20

THICKNESS	=	0.20	INCHES
POROSITY	=	0.8500	VOL/VOL
FIELD CAPACITY	=	0.0100	VOL/VOL
WILTING POINT	=	0.0050	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2564	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	10.0000000000	CM/SEC
SLOPE	=	8.50	PERCENT
DRAINAGE LENGTH	=	450.0	FEET

LAYER 4

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 16

THICKNESS	=	18.00	INCHES
POROSITY	=	0.4270	VOL/VOL
FIELD CAPACITY	=	0.4180	VOL/VOL
WILTING POINT	=	0.3670	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4270	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000001000E-06	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE #10 WITH A GOOD STAND OF GRASS, A SURFACE SLOPE OF 8.% AND A SLOPE LENGTH OF 450. FEET.

SCS RUNOFF CURVE NUMBER	=	80.60	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	36.2	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	10.025	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	16.808	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	8.767	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	17.711	INCHES
TOTAL INITIAL WATER	=	17.711	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
DALLAS TEXAS

STATION LATITUDE	=	32.85	DEGREES
MAXIMUM LEAF AREA INDEX	=	3.50	
START OF GROWING SEASON (JULIAN DATE)	=	63	
END OF GROWING SEASON (JULIAN DATE)	=	329	
EVAPORATIVE ZONE DEPTH	=	36.2	INCHES
AVERAGE ANNUAL WIND SPEED	=	10.80	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	66.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	68.00	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	63.00	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	66.00	%

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR DALLAS TEXAS

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
1.65	1.93	2.42	3.63	4.27	2.59
2.00	1.76	3.31	2.47	1.76	1.67

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR DALLAS TEXAS

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
44.00	48.50	56.10	65.90	73.70	82.00
86.30	85.50	78.60	67.90	55.60	47.80

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR DALLAS TEXAS
AND STATION LATITUDE = 32.85 DEGREES

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 30

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	1.29 2.76	1.79 1.67	2.22 3.70	3.48 2.52	3.85 1.61	2.64 1.76
STD. DEVIATIONS	0.88 2.20	1.03 1.24	1.32 2.03	2.14 2.07	1.79 1.21	1.71 1.26
RUNOFF						
TOTALS	0.180 0.521	0.224 0.072	0.372 0.819	0.882 0.704	0.651 0.232	0.406 0.353
STD. DEVIATIONS	0.344 1.078	0.384 0.162	0.670 0.991	1.254 1.238	1.065 0.542	0.601 0.649
EVAPOTRANSPIRATION						
TOTALS	0.723 2.276	0.969 1.587	1.652 2.413	3.611 1.418	5.226 0.778	2.583 0.618
STD. DEVIATIONS	0.141 1.303	0.143 1.152	0.235 1.034	0.829 0.567	1.271 0.245	1.185 0.177
LATERAL DRAINAGE COLLECTED FROM LAYER 3						
TOTALS	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0077 0.0000	0.0110 0.0000	0.0000 0.0000
STD. DEVIATIONS	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0401 0.0000	0.0330 0.0000	0.0000 0.0000
PERCOLATION/LEAKAGE THROUGH LAYER 4						
TOTALS	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0019 0.0000	0.0023 0.0000	0.0000 0.0000
STD. DEVIATIONS	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	0.0098 0.0000	0.0071 0.0000	0.0000 0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 4

AVERAGES	0.0000	0.0000	0.0000	0.0007	0.0010	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0038	0.0031	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS). FOR YEARS 1 THROUGH 30

	INCHES		CU. FEET	PERCENT
PRECIPITATION	29.29	(5.380)	106304.6	100.00
RUNOFF	5.417	(2.8201)	19662.00	18.496
EVAPOTRANSPIRATION	23.854	(3.1470)	86591.05	81.456
LATERAL DRAINAGE COLLECTED FROM LAYER 3	0.01868	(0.06945)	67.822	0.06380
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.00419	(0.01609)	15.214	0.01431
			= 113.8 gallons/acre/year	
AVERAGE HEAD ON TOP OF LAYER 4	0.000	(0.001)	= 0.31 gallons/acre/day	
CHANGE IN WATER STORAGE	-0.009	(1.9008)	-31.55	-0.030

PEAK DAILY VALUES FOR YEARS 1 THROUGH 30

	(INCHES)	(CU. FT.)
PRECIPITATION	4.98	18077.400
RUNOFF	3.727	13527.6777
DRAINAGE COLLECTED FROM LAYER 3	0.02680	97.27611
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.003416	12.39968
AVERAGE HEAD ON TOP OF LAYER 4	0.076	
MAXIMUM HEAD ON TOP OF LAYER 4	0.157	
LOCATION OF MAXIMUM HEAD IN LAYER 3 (DISTANCE FROM DRAIN)	0.0 FEET	
SNOW WATER	1.00	3631.1433

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.4232
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.2422

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

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

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FINAL WATER STORAGE AT END OF YEAR 30

LAYER	(INCHES)	(VOL/VOL)
1	1.2229	0.2038
2	8.4901	0.2830
3	0.0513	0.2564
4	7.6860	0.4270
SNOW WATER	0.000	

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**                                                                  **
**          HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE           **
**            HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)            **
**              DEVELOPED BY ENVIRONMENTAL LABORATORY               **
**                USAE WATERWAYS EXPERIMENT STATION                 **
**          FOR USEPA RISK REDUCTION ENGINEERING LABORATORY         **
**                                                                  **
**                                                                  **
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PRECIPITATION DATA FILE: C:\FLOWMO~1\HELP3\DALLAS.D4
TEMPERATURE DATA FILE: C:\FLOWMO~1\HELP3\DALLAS.D7
SOLAR RADIATION DATA FILE: C:\FLOWMO~1\HELP3\DALLAS.D13
EVAPOTRANSPIRATION DATA: C:\FLOWMO~1\HELP3\DAL48.D11
SOIL AND DESIGN DATA FILE: C:\FLOWMO~1\HELP3\ALT1S.D10
OUTPUT DATA FILE: C:\FLOWMO~1\HELP3\ALT1S.OUT

TIME: 15:44 DATE: 12/27/1999

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TITLE: WMTX SKYLINE LANDFILL -- ALTERNATE COVER SYSTEM (SIDE SLOPE)

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

LAYER 1

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 10

THICKNESS	= 6.00	INCHES
POROSITY	= 0.3980	VOL/VOL
FIELD CAPACITY	= 0.2440	VOL/VOL
WILTING POINT	= 0.1360	VOL/VOL
INITIAL SOIL WATER CONTENT	= 0.2309	VOL/VOL
EFFECTIVE SAT. HYD. COND.	= 0.119999997000E-03	CM/SEC

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

LAYER 2

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	30.00	INCHES
POROSITY	=	0.4750	VOL/VOL
FIELD CAPACITY	=	0.3780	VOL/VOL
WILTING POINT	=	0.2650	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2863	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.999999997000E-06	CM/SEC

LAYER 3

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 20

THICKNESS	=	0.20	INCHES
POROSITY	=	0.8500	VOL/VOL
FIELD CAPACITY	=	0.0100	VOL/VOL
WILTING POINT	=	0.0050	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2564	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	10.000000000	CM/SEC
SLOPE	=	20.00	PERCENT
DRAINAGE LENGTH	=	150.0	FEET

LAYER 4

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 16

THICKNESS	=	18.00	INCHES
POROSITY	=	0.4270	VOL/VOL
FIELD CAPACITY	=	0.4180	VOL/VOL
WILTING POINT	=	0.3670	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4270	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000001000E-06	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE #10 WITH A GOOD STAND OF GRASS, A SURFACE SLOPE OF 20.% AND A SLOPE LENGTH OF 150. FEET.

SCS RUNOFF CURVE NUMBER	=	82.20	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	36.2	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	10.025	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	16.808	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	8.767	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	17.711	INCHES
TOTAL INITIAL WATER	=	17.711	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
DALLAS TEXAS

STATION LATITUDE	=	32.85	DEGREES
MAXIMUM LEAF AREA INDEX	=	3.50	
START OF GROWING SEASON (JULIAN DATE)	=	63	
END OF GROWING SEASON (JULIAN DATE)	=	329	
EVAPORATIVE ZONE DEPTH	=	36.2	INCHES
AVERAGE ANNUAL WIND SPEED	=	10.80	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	66.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	68.00	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	63.00	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	66.00	%

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR DALLAS TEXAS

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
1.65	1.93	2.42	3.63	4.27	2.59
2.00	1.76	3.31	2.47	1.76	1.67

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR DALLAS TEXAS

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
44.00	48.50	56.10	65.90	73.70	82.00
86.30	85.50	78.60	67.90	55.60	47.80

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR DALLAS TEXAS
AND STATION LATITUDE = 32.85 DEGREES

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 30

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	1.29	1.79	2.22	3.48	3.85	2.64
	2.76	1.67	3.70	2.52	1.61	1.76
STD. DEVIATIONS	0.88	1.03	1.32	2.14	1.79	1.71
	2.20	1.24	2.03	2.07	1.21	1.26
RUNOFF						
TOTALS	0.181	0.225	0.377	0.887	0.653	0.407
	0.525	0.073	0.820	0.704	0.232	0.353
STD. DEVIATIONS	0.344	0.384	0.669	1.252	1.064	0.600
	1.076	0.163	0.990	1.239	0.542	0.649
EVAPOTRANSPIRATION						
TOTALS	0.723	0.969	1.652	3.611	5.214	2.580
	2.272	1.586	2.412	1.419	0.778	0.618
STD. DEVIATIONS	0.141	0.243	0.235	0.830	1.270	1.183
	1.300	1.251	1.034	0.568	0.245	0.177
LATERAL DRAINAGE COLLECTED FROM LAYER 3						
TOTALS	0.0000	0.0000	0.0000	0.0086	0.0118	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0453	0.0353	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH LAYER 4						
TOTALS	0.0000	0.0000	0.0000	0.0009	0.0011	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0049	0.0035	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 4

AVERAGES	0.0000	0.0000	0.0000	0.0003	0.0004	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0015	0.0012	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 30

	INCHES	CU. FEET	PERCENT
PRECIPITATION	29.29 (5.380)	106304.6	100.00
RUNOFF	5.437 (2.8173)	19736.09	18.566
EVAPOTRANSPIRATION	23.834 (3.1445)	86518.88	81.388
LATERAL DRAINAGE COLLECTED FROM LAYER 3	0.02036 (0.07595)	73.892	0.06951
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.00199 (0.00818)	7.227	0.00680
		= 54.1 gallons/acre/year	
AVERAGE HEAD ON TOP OF LAYER 4	0.000 (0.000)	= 0.15 gallons/acre/day	
CHANGE IN WATER STORAGE	-0.009 (1.8994)	-31.55	-0.030

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 30

	(INCHES)	(CU. FT.)
PRECIPITATION	4.98	18077.400
RUNOFF	3.727	13528.2090
DRAINAGE COLLECTED FROM LAYER 3	0.02900	105.28500
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.002906	10.54977
AVERAGE HEAD ON TOP OF LAYER 4	0.030	
MAXIMUM HEAD ON TOP OF LAYER 4	0.023	
LOCATION OF MAXIMUM HEAD IN LAYER 3 (DISTANCE FROM DRAIN)	0.0 FEET	
SNOW WATER	1.00	3631.1433

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.4231
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.2422

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

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

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FINAL WATER STORAGE AT END OF YEAR 30

LAYER	(INCHES)	(VOL/VOL)
1	1.2229	0.2038
2	8.4901	0.2830
3	0.0513	0.2564
4	7.6860	0.4270
SNOW WATER	0.000	

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