RESPONSE TO TECHNICAL NOTICE OF DEFICIENCY
PERMIT MODIFICATION REQUEST
Reconfiguration of Block O

City of Nacogdoches Landfill
Nacogdoches, Texas
TCEQ Permit No. MSW-720

Prepared for:
City of Nacogdoches
4602 NW Stallings Drive
Nacogdoches, Texas 75964

Nacogdoches
the oldest town in Texas

Prepared by:
SCS ENGINEERS

File No. 16209006.26 | May 2024

Texas Board of Professional Engineers Registration No. F-3407
12651 Briar Forest Drive, Suite 205
Houston, TX 77077
(281) 293-8494

May 14, 2024

Mr. Gordon Shields
MC-124
Municipal Solid Waste Permits
Waste Permits Division
Texas Commission on Environmental Quality
12100 Park 35 Circle
Austin, Texas 78753

VIA EMAIL/FEDEX

Subject: City of Nacogdoches Landfill – Nacogdoches County
Municipal Solid Waste (MSW) – MSW Permit No. 720
Response to Technical Notice of Deficiency (NOD)
Permit Modification Request – Reconfiguration of Block O
Tracking No. 29534833; RN102217395/CN600134076

Dear Mr. Shields:

On behalf of the City of Nacogdoches (City), SCS Engineers (SCS) is pleased to submit this response to your April 25, 2024 email regarding deficiencies in the Permit Modification Request to permit MSW – 720 for the City of Nacogdoches Landfill in Nacogdoches County, Texas.

Specifically, the following comments were offered accompanied by our written response in ***bold and italic***.

<u>TCEQ Comment #1</u>

On Form TCEQ-20650, Part 8, correct the longitude of the facility from 86" to 36".

<u>SCS Response to #1</u>

Form TCEQ-20650, Part 8 is revised to read 36" instead of 86".

<u>TCEQ Comment #2</u>

On Form TCEQ-20650, Part 10, provide additional explanation of why the modification is needed, e.g. to compensate for an over-excavated area of the future cell.

<u>SCS Response to #2</u>

Form TCEQ-20650, Part 10 is revised accordingly.

<u>TCEQ Comment #3</u>

In PDF Volume I Part 1 (PDF-I-1), pages 53-59 have no changes to the text positions, or to the page numbers, or to the revision (submittal) dates. Please provide revised pages, or mark them in the red-line volume as no changes, or remove these pages from both the replacement volume and the red-line volume.

SCS Response to #3

PDF-I-1, pages 53-59 or permit pages III-A6.A-8 to III-A6.A-14 are confirmed to have no changes, with pages removed from replacement and redline versions. Part III, Attachment 6, Appendix A is resubmitted with updated seal, date and signature.

TCEQ Comment #4

In PDF-I-1, page 113 is missing the professional engineer seal. Please add the P.E. seal to the Drawing No. 7A.

SCS Response to #4

PDF-I-1, page 113 or permit drawing 7A – III.1.1.G Attachment 7 – Final Contour Map is resubmitted with seal, date and signature.

TCEQ Comment #5

In PDF-I-1 page 131, please update the value for initial moisture content for closed data (column three) for leachate collection, noting that it is crossed out in redline copy.

SCS Response to #5

PDF-I-1, page 131 or permit page 10E-2-2 is confirmed to have no change to the value for initial moisture content for closed data for leachate collection. The redline version has been revised to indicate no change to the value. Additionally, the Cover was revised with an updated header and seal, date and signature. For clarity purposes, pages 10E-2-11 to 10E-2-27 of redline version and pages 10E-2-11 to 10E-2-23 of the clean version are included in this submittal.

TCEQ Comment #6

In PDF Volume I Part 2 (PDF-I-2) page 14, correct the second scenario 8 to scenario 9 in the liner stability analysis table.

SCS Response to #6

PDF-I-2, page 14 or permit page C-1-6 is revised to correct the second scenario 8 to scenario 9 in Table 2 – Mass Waste Final Slope Stability Analysis.

TCEQ Comment #7

In PDF-I-2 page 16, plot the locations for both AA' and CC' on this plan map, and change the figure title to "for Section AA' & CC'" to be consistent with PDF-I-2 page 17.

SCS Response to #7

PDF-I-2, page 16 or permit page C-1-8 is revised to show both AA' and CC' on the plan map and changed the Figure 1 title to "Section Location Plan for Section AA' and CC'".

TCEQ Comment #8

In PDF-I-2 page 20, confirm this page has no changes other than the page number, add the revision date, and note this change in the redline volume.

SCS Response to #8

PDF-I-2, page 20 or permit page C-1-12 is confirmed to have to change. This and other pages without changes mistakenly included in the Initial Submittal have been removed with this NOD response.

TCEQ Comment #9

In PDF-I-2 pages 21 through 80 for stability analysis sections, i.e. C-1-13 through C-1-72, is 60 pages in total. This is less than C-1-18 through C-1-117 which is 100 pages in total in the redline volume. Please indicate which pages were removed in the redline volume by using full page strike-out so we know which ones to remove from the current permit.

SCS Response to #9

The entire redline in the Initial Submittal for this section has been removed. That redline version had formatting error that contributed additional pages. PDF-I-2, pages 9 through 80 or permit pages C-1-1 through C-1-72 clean and redline are resubmitted to include only revised pages with appropriate footer page numbers, revision numbers and revision dates.

TCEQ Comment #10

In PDF-I-2 page 118, correct an inconsistency with the Tmin and/or Tman for active fill condition so that Tmin >= Tman, or provide an explanation.

SCS Response to #10

PDF-I-2, pages 116 through 118 or permit pages G2-1 through G2-4 were revised to correct inconsistencies in the appendix. The relationship should be Tmin <= Tman, i.e. manufacturer's transmissivity should be greater than required transmissivity. Additionally, the entire appendix is resubmitted to include the corrections and supporting calculations (G2-5 to G2-23).

TCEQ Comment #11

In PDF-I-2 page 124, on DWG 15-2, please add narrative to explain the grade break in the NW corner of the block, in reference to this figure. Include further details beyond the brief entry of "to compensate for over excavated area of future cell" on the application form. Provide a summary of the history (e.g. add details of the footprint reduction, the subsequent changes to Blocks P and O, etc.).

SCS Response to #11

PDF-I-2, page 124 or permit drawing 15-2 – Base Grades – Block O is revised to include a note providing additional information regarding the grade break in the NW corner of the block, as well as a brief history. Additionally, a detail was added to permit drawing 15-5 – Liner System Details for the grade break.

TCEQ Comment #12

In PDF-I-2 page 124, DWG 15-2, please clarify the meaning of "Trench" as used in the figure. Alternatively, a note could be added to the figure next to each use of "Trench" to indicate the meaning of the references, e.g., future blocks, closed blocks or closed trench fills, etc.

SCS Response to #12

PDF-I-2, page 124 or permit drawing 15-2 – Base Grades – Block O is revised to include a note that indicates the "Trenches" reference may also be referred to as "Cell" or "Phase".

TCEQ Comment #13

In PDF-I-2 page 124, DWG 15-2, please change "Unusable" to "Removed From Plan".

SCS Response to #13

PDF-I-2, page 124 or permit drawing 15-2 – Base Grades – Block O revised to clarify that "Unusable Trenches" have been removed from plan.

TCEQ Comment #14

For all the replacement pages ensure that each has "Rev." or "Revision" with a date and a page number.

SCS Response to #14

All replacement pages have been revised to include page numbers, revision numbers and revision dates. Changes are also reflected in the redline version.

TCEQ Comment #15

Ensure that all the redline pages and replacement pages are in the correct volumes, in both the digital PDF volumes and printed volumes.

SCS Response to #15

All appropriate pages have been included in replacement and redline versions as wells as paper and PDF versions. All redlines are included in Attachment 3 of this NOD response.

Additional revisions included in this NOD response as a result of the above changes:

Resubmitted Master Table of Contents (TOC) with updated seal, date and signature.

Resubmitted Part III, Attachment 10 Cover and TOC with updated seal, date and signature.

Part III, Attachment 10, Appendix 10D, pages 10D-1 to 10D-9 were mistakenly omitted from the Initial Submittal and has been submitted with this NOD response. Sample Underdrain Calculations and drawing 10D-1 – Underdrain Layout Plan is revised to incorporate the base grades changes.

Resubmitted Part III, Attachment 10, Appendix 10E Cover and TOC with updated seal, date and signature.

Resubmitted Part III, Attachment 12 Cover with updated seal, date and signature.

Resubmitted Part III, Attachment 12, Appendix C Cover and TOC with updated seal, date and signature.

Resubmitted Part III, Attachment 15 Cover and TOC with updated seal, date and signature.

Resubmitted Part III, Attachment 15, Appendix G Cover and TOC with updated seal, date and signature.

The following items are being submitted with this response:

Table 1. SUBMITTED WITH THIS PERMIT MODIFICATION REQUEST TECHNICAL NOD RESPONSE ARE THE FOLLOWING:

Section	Title	Description
TCEQ-20650 Form	Permit/Registration Modification and Temporary Authorization Application Form	Revised Parts 8 and 10, included complete form.
Volumes	Table of Contents	Revised and replaced TOC.
Part III, Attachment 6, Appendix A	Top Dome Surface and External Embankment Erosion Control Plan	Revised and replaced Divider Page, Cover Sheet, TOC, pages III-A6.A-2, and III-A6.A-4 through III-A6.A-7.
Part III, Attachment 7	Final Contour Map	Resubmitted drawing 7A.
Part III, Attachment 10	Soil and Liner Quality Control Plan	Revised and replaced Cover Sheet, and TOC.
Part III, Attachment 10, Appendix 10D	Sample Underdrain and Ballasting Calculations	Revised and replaced pages 10D-1 to 10D-8, and page 10D-9 or drawing 10D-1.
Part III, Attachment 10, Appendix 10E	Geosynthetic Clay Liner – Alternate Liner Design Demonstration	Revised and replaced Cover Sheet and TOC.
Part III, Attachment 10, Appendix 10E-2	Help Model Analysis	Revised and replaced pages 10E-2-1, 10E-2-2, and 10E-2-11 to 10E-2-27.
Part III, Attachment 12	Final Closure Plan	Revised and replaced Cover Sheet.

Part III, Attachment 12, Appendix C	Liner and Final Cover Stability Calculations	Revised and replaced Cover Sheet, and TOC.
Part III, Attachment 12, Appendix C-1	Waste Slope Stability Calculations and Results	Revised and replaced pages C-1-1 to C-1-6, and select pages of C-1-8 to C-1-72.
Part III, Attachment 15	Site Development Plan	Revised and replaced Cover Sheet, and TOC.
Part III, Attachment 15, Appendix G	Block O – Leachate Generation Model	Revised and replaced Cover Sheet and TOC.
Part III, Attachment 15, Appendix G2	Geocomposite Demonstration	Revised and replaced pages G2-1 to G2-4, and added pages G2-5 to G2-23.
Part III, Attachment 15, Appendix H	Block O – Leachate Pipe Strength and Flow Calculations	Revised and replaced drawings 15-2, and 15-5.

The certification statement required by 30 TAC §305.44 is included as part of the enclosed Part I Form.

As required by 30 TAC §330.125(c) of the TCEQ rules, please be advised that this letter with enclosures is being placed in the operating record for the subject facility in accordance with the requirements of 30 TAC §330.125(a) and/or (b). Also as required, an original, two unmarked copy, and one redline/strikeout of this permit modification request technical review response are being submitted. An additional copy of this response is being submitted directly to the TCEQ Region 10 office and added to the public website.

We trust that this submittal is complete and will lead towards technical approval of this permit modification request. If you have any questions or comments concerning this submittal, please contact Jeff Reed at (281) 293-8494.

Sincerely,

Jeffrey K. Reed, P.E.
Vice President/Business Unit Director
SCS ENGINEERS

Ricardo Espinoza
Staff Professional
SCS ENGINEERS

RJE/JRM

cc: Mr. Case Opperman, PE, City of Nacogdoches
Mr. Cary Walker, City of Nacogdoches
Mr. Jason Vickery, PE, City of Nacogdoches
TCEQ Region 10

Texas Commission on Environmental Quality

Waste Permits Division Correspondence Cover Sheet

Date: 05/09/2024
Facility Name: City of Nacogdoches Landfill
Permit or Registration No.: MSW-720

Nature of Correspondence:
☐ Initial/New
☒ Response/Revision to TCEQ Tracking No.: 29534833 (from subject line of TCEQ letter regarding initial submission)

Affix this cover sheet to the front of your submission to the Waste Permits Division. Check appropriate box for type of correspondence. Contact WPD at (512) 239-2335 if you have questions regarding this form.

Table 1 - Municipal Solid Waste Correspondence

Applications	Reports and Notifications
☐ New Notice of Intent	☐ Alternative Daily Cover Report
☐ Notice of Intent Revision	☐ Closure Report
☐ New Permit (including Subchapter T)	☐ Compost Report
☐ New Registration (including Subchapter T)	☐ Groundwater Alternate Source Demonstration
☐ Major Amendment	☐ Groundwater Corrective Action
☐ Minor Amendment	☐ Groundwater Monitoring Report
☐ Limited Scope Major Amendment	☐ Groundwater Background Evaluation
☒ Notice Modification	☐ Landfill Gas Corrective Action
☐ Non-Notice Modification	☐ Landfill Gas Monitoring
☐ Transfer/Name Change Modification	☐ Liner Evaluation Report
☐ Temporary Authorization	☐ Soil Boring Plan
☐ Voluntary Revocation	☐ Special Waste Request
☐ Subchapter T Disturbance Non-Enclosed Structure	☐ Other:
☐ Other:	

Table 2 - Industrial & Hazardous Waste Correspondence

Applications	Reports and Responses
☐ New	☐ Annual/Biennial Site Activity Report
☐ Renewal	☐ CPT Plan/Result
☐ Post-Closure Order	☐ Closure Certification/Report
☐ Major Amendment	☐ Construction Certification/Report
☐ Minor Amendment	☐ CPT Plan/Result
☐ CCR Registration	☐ Extension Request
☐ CCR Registration Major Amendment	☐ Groundwater Monitoring Report
☐ CCR Registration Minor Amendment	☐ Interim Status Change
☐ Class 3 Modification	☐ Interim Status Closure Plan
☐ Class 2 Modification	☐ Soil Core Monitoring Report
☐ Class 1 ED Modification	☐ Treatability Study
☐ Class 1 Modification	☐ Trial Burn Plan/Result
☐ Endorsement	☐ Unsaturated Zone Monitoring Report
☐ Temporary Authorization	☐ Waste Minimization Report
☐ Voluntary Revocation	☐ Other:
☐ 335.6 Notification	
☐ Other:	

Attachment No. 1

TCEQ Permit Modification Application Form

(Form TCEQ-20650)

Texas Commission on Environmental Quality

Application Form for Municipal Solid Waste Permit or Registration Modification or Temporary Authorization

Application Tracking Information

Facility Name: City of Nacogdoches Landfill

Permittee or Registrant Name: City of Nacogdoches

MSW Authorization Number: MSW-720

Initial Submission Date: 01/24/2024

Revision Date: 05/09/2024

Instructions for completing this form are provided in form TCEQ-20650-instr[1]. If you have questions, contact the Municipal Solid Waste Permits Section by email to mswper@tceq.texas.gov, or by phone at 512-239-2335.

Application Data

1. Submission Type

☐ Initial Submission ☒ Notice of Deficiency (NOD) Response

2. Authorization Type

☒ Permit ☐ Registration

3. Application Type

☒ Modification with Public Notice ☐ Modification without Public Notice

☐ Temporary Authorization (TA) ☐ Modification for Name Change or Transfer

4. Application Fee

Amount

The application fee for a modification or temporary authorization is $150.

Payment Method

☐ Check

☒ Online through ePay portal www3.tceq.texas.gov/epay/

If paid online, enter ePay Trace Number: 683354, 683355

[1] www.tceq.texas.gov/downloads/permitting/waste-permits/msw/forms/20650-instr.pdf

5. Application URL

For modifications that require notice (other than those for arid exempt landfills), provide the URL address of a publicly accessible internet web site where the application and all revisions to the application will be posted:

https://www.scsengineers.com/state/

6. Party Responsible for Mailing Notice

For modifications that require notice, indicate who will be responsible for mailing notice:

☒ Applicant ☐ Agent in Service ☐ Consultant

Contact Name: Case Opperman, PE

Title: Director of Public Works/City Engineer

Email Address: oppermanc@nactx.us

7. Confidential Documents

Does the application contain confidential documents?

☐ Yes ☒ No

If "Yes", reference the confidential documents in the application, but submit the confidential documents as an attachment in a separate binder marked "CONFIDENTIAL."

8. Facility General Information

Facility Name: City of Nacogdoches Landfill

Contact Name: Case Opperman, PE Title: Director of Public Works/City Engineer

MSW Authorization Number (if existing): MSW-720

Regulated Entity Reference Number: **RN** 102217395

Physical or Street Address: 4602 NW Stallings Drive

City: Nacogdoches County: Nacogdoches State: TX Zip Code: 75964

Phone Number: 936/559-2583

Latitude (Degrees, Minutes Seconds): N 31° 38' 57"

Longitude (Degrees, Minutes Seconds): W 94° 40' 36"

9. Facility Types

☒ Type I ☐ Type IV ☐ Type V

☐ Type IAE ☐ Type IVAE ☐ Type VI

10. Description of the Revisions to the Facility

Provide a brief description of revisions to permit or registration conditions and supporting documents referred to by the permit or registration, and a reference to the specific provisions under which the modification or temporary authorization application is being made. Also, provide an explanation of why the modification or temporary authorization is needed:

This modification request is to revise the base and final grades of Block O. This change is being made under 30 TAC §305.70(k)(8) and (9). This modification is to compensate for over excavated areas of future cells in Block O.

11. Facility Contact Information

Site Operator (Permittee or Registrant)

Name: City of Nacogdoches

Customer Reference Number: **CN**600134076

Contact Name: Case Opperman, PE Title: Director of Public Works/City Engineer

Mailing Address: P.O. Box 635030

City: Nacogdoches County: Nacogdoches State: TX Zip Code: 75963

Phone Number: (936) 559-2515

Email Address: oppermanc@nactx.us

Texas Secretary of State (SOS) Filing Number: ______

Operator (if different from *Site Operator*)

Name: ______

Customer Reference Number: **CN**______

Contact Name: ______ Title: ______

Mailing Address: ______

City: ______ County: ______ State: ____ Zip Code: ____

Phone Number: ______

Email Address: ______

Texas Secretary of State (SOS) Filing Number: ______

Consultant (if applicable)

Firm Name: SCS Engineers

Consultant Name: Jeffrey K. Reed, P.E.

Texas Board of Professional Engineers Firm Registration Number: F-3407

Contact Name: Jeffrey K. Reed Title: Vice President

Mailing Address: 12651 Briar Forest Drive, Suite 205

City: Houston County: Harris State: TX Zip Code: 77077

Phone Number: (281) 293-8494

Email Address: jeffreed@scsengineers.com

Agent in Service (required for out-of-state applicants)

Name: ______

Mailing Address: ______

City: ______ County: ______ State: TX Zip Code: ____

Phone Number: ______

Email Address: ______

12. Ownership Status of the Facility

Is this a modification that changes the legal description, the property owner, or the Site Operator (Permittee or Registrant)?

☐ Yes ☒ No

If the answer is "No", skip this section.

Does the Site Operator (Permittee or Registrant) own all the facility units and all the facility property?

☒ Yes ☐ No

If "No", provide the following information for other owners.

Owner Name: ______

Mailing Address: ______

City: ______ County: ______ State: TX Zip Code: ____

Phone Number: ______

Email Address: ______

Signature Page

Site Operator or Authorized Signatory

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.

Name: Richard B. Beverlin, III Title: City Manager

Email Address: beverlinr@nactx.us

Signature: [signature] Date: 05/14/24

Operator or Principal Executive Officer Designation of Authorized Signatory

To be completed by the operator if the application is signed by an authorized representative for the operator.

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

Operator or Principal Executive Officer Name: ______________________

Email Address: ______________________

Signature: ______________________ Date: __________

Notary

SUBSCRIBED AND SWORN to before me by the said Richard B. Beverlin

On this 14th day of May, 2024

My commission expires on the 29th day of September, 2025

Rhonda K. Lewis

Notary Public in and for

Nacogdoches County, Texas

RHONDA K. LEWIS
Notary Public, State of Texas
Comm. Expires 09-29-2025
Notary ID 133360897

Note: Application Must Bear Signature and Seal of Notary Public

Attachments for Permit or Registration Modification with Public Notice

Refer to instruction document **200650-instr** for professional engineer seal requirements.

Attachments Table 1. Required attachments.

Required Attachments	Attachment Number
Land Ownership Map	1
Landowners List	2
Marked (Redline/Strikeout) Pages	3
Unmarked Revised Pages	4

Attachments Table 2. Additional attachments as applicable.

Additional Attachments as Applicable (select all that apply and add others as needed)	Attachment Number
☐ TCEQ Core Data Form(s)	
☐ Signatory Authority Delegation	
■ Fee Payment Receipt	5
☐ Confidential Documents	

Attachments for Permit or Registration Modification without Public Notice, or Temporary Authorization

Refer to instruction document **200650-instr** for professional engineer seal requirements.

Attachments Table 3. Required attachments for modifications.

Required Attachments for Modification	Attachment Number
Marked (Redline/Strikeout) Pages	NA
Unmarked Revised Pages	NA

Attachments Table 4. Additional attachments for modifications and temporary authorizations, as applicable.

Additional Attachments as Applicable (select all that apply and add others as needed)	Attachment Number
☐ TCEQ Core Data Form(s)	NA
☐ Signatory Authority Delegation	NA
☐ Fee Payment Receipt	NA
☐ Confidential Documents	NA

Attachments for Permit or Registration Name Change or Transfer Modification

Refer to instruction document **200650-instr** for professional engineer seal requirements.

Attachments Table 5. Required attachments.

Required Attachments	Attachment Number
TCEQ Core Data Form(s)	
Property Legal Description	
Property Metes and Bounds Description	
Metes and Bounds Drawings	
On-Site Easements Drawing	
Land Ownership Map	
Land Ownership List	
Property Owner Affidavit	
Verification of Legal Status	
Evidence of Competency	

Attachments Table 6. Additional attachments as applicable.

Additional Attachments as Applicable (select all that apply and add others as needed)	Attachment Number
☐ Signatory Authority Delegation	
☒ Fee Payment Receipt	
☐ Confidential Documents	
☐ Final Plat Record of Property	
☐ Assumed Name Certificate	

Attachment No. 2

Replacement Pages

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VOLUME 1

SCS Engineers
TBPE Reg. # F-3407
5/7/24

STATE OF TEXAS
JEFFREY K. REED
80103
LICENSED
PROFESSIONAL ENGINEER

FOR PERMITTING
PURPOSES ONLY

31 TAC 330.54 - .56 PART III SITE DEVELOPMENT PLAN

FOR PERMITTING PURPOSES ONLY

SCS Engineers
TBPE Reg. # F-3407

5/7/24

STATE OF TEXAS
JEFFREY K. REED
80103
LICENSED PROFESSIONAL ENGINEER

VOLUME 2

SCS Engineers
TBPE Reg. # F-3407

FOR PERMITTING PURPOSES ONLY

STATE OF TEXAS
JEFFREY K. REED
80103
LICENSED
PROFESSIONAL ENGINEER
5/7/24

SCS Engineers
TBPE Reg. # F-3407

5/7/24

STATE OF TEXAS
JEFFREY K. REED
80103
LICENSED
PROFESSIONAL ENGINEER

FOR PERMITTING
PURPOSES ONLY

PART III, ATTACHMENT 6, APPENDIX A

Top Dome Surface and External Embankment Erosion Control Plan

CITY OF NACOGDOCHES LANDFILL
TCEQ PERMIT MSW-720
NACOGDOCHES, TEXAS

TOP DOME SURFACE AND EXTERNAL EMBANKMENT EROSION CONTROL PLAN

PART III, ATTACHMENT 6, APPENDIX A

Prepared for:

CITY OF NACOGDOCHES
P.O. Box 635030
Nacogdoches, Texas 75963

Prepared by:

SCS ENGINEERS
Texas Board of Professional Engineers Registration No. F-3407
12651 Briar Forest Dr., Suite 205
Houston, Texas 77077

FEBRUARY 2011
Revision 1 – September 2019
Revision 2 – December 2023
Revision 3 – May 2024

TABLE OF CONTENTS

APPENDICIES

FIGURES

STATE OF TEXAS
JAMES ROY MURRAY III
73860
LICENSED
PROFESSIONAL ENGINEER
5/8/24
SCS Engineers
TBPE Reg. # F-3407

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 designed in accordance with 30 TAC §§330.63(c), 330.303, and 330.305);

b) have received intermediate or final cover; and,

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

For example, after an above grade slope has reached the permitted elevation, the intermediate cover will be provided and structural erosion control features (e.g., diversion dikes, letdown structures, and/or silt fence) will be in-place within 180 days of placement of intermediate cover. If an external slope has received intermediate cover, but is not at the final permitted grade and the area will not receive waste for a period greater than 180 days, erosion control features will be in-place within 180 days of placement of the intermediate cover.

1.0.1 EROSION ANALYSIS RESULTS

Existing vegetated intermediate covered slopes with a minimum of 60 percent vegetated coverage will not require additional structural erosion controls for top dome surfaces with 1,670 feet or less drainage flow lengths, and 25% external embankment side slopes with 780 feet or less drainage flow lengths. All Blocks yet to receive final cover (Blocks O and P) have soil losses well below the TCEQ minimum of 50 tons per acre per year. Block O, with a flow length of 1,890 feet and 60 percent vegetative coverage, has a soil loss of 21.20 tons per acre per year. Block P, with a flow length of 480 feet and 60 percent vegetative coverage, has a soil loss of 22.76 tons per acre per year. These calculations are included in Appendix III-6A-2. For additional discussion, see Section 1.1.1.1, Non-erosive Slopes.

Slopes which drain to ongoing waste placement areas, pre-excavated areas, areas that have received only daily cover or areas under construction which have not received waste are not considered external side slopes.

Site perimeter drainage features such as perimeter drainage channels and toe berms will be constructed adjacent to and downstream of areas to be excavated for waste fill. In some cases, the slopes drain directly into the existing creek. These drainage features will be constructed in accordance with the Part III, Attachment 6, Groundwater and Surface Water Protection Plan and Drainage Plan.

The top dome surfaces will be filled to non-erosive grades, not exceeding 5 percent. Top dome surfaces will be graded to sheet flow with non erosive velocities and acceptable soil losses and therefore will not require any water diversion. The top dome surface will establish a minimum 60 percent vegetative coverage or utilize mulch stabilization or erosion control matting to accomplish the 60 percent coverage within 180 days. Water handling devices; including diversion dikes, let-down structures, and silt fence, as described in Section 1.1.2, will be utilized at the base of the surface.

Top dome surfaces will have a maximum sheetflow length of 1,670 feet (130 feet for 10% slopes and 1,540 feet for 3.2% slopes) and 350 feet for 5% slopes. Top dome surfaces with 3.2% slopes will have velocities of 1.62 feet per second (fps) and a shear stress of 0.14 pounds per square foot (psf). Top dome surfaces with 5% slopes will have velocities of 1.14 feet per second (fps) and a shear stress of 0.08 pounds per square foot (psf). Top dome surfaces with 10% slopes will have velocities of 0.60 feet per second (fps) and a shear stress of 0.18 pounds per square foot (psf). According to the Texas Department of Transportation Hydraulic Design Manual, Revised March 2009 (TxDOT Manual) the values for "Permissible Shear Stresses for Various Linings" for a vegetated lining is 0.35 psf to 3.70 psf. The top dome surface will establish a minimum 60 percent vegetative coverage or equivalent cover with primary grind mulch. Where vegetative cover is utilized, interim top dome and external embankment slopes may be seeded with winter rye or other seed mixture determined to be effective at stabilizing soils. Native grasses are the most likely vegetation to establish and thrive on the top dome and external embankment slopes. The native grasses in the area of the landfill consist primarily of Bermuda, with some Foxtail Millet. Other grasses that are found in the vicinity of the landfill include Little Bluestem, Indian Grass, and Switchgrass. These grasses are similar to the Retardance Class C from the "Retardance Class for Lining Materials" table found in the TxDOT Manual and are reflective of the grasses and cover conditions evident on the existing waste hills at the site. Retardance Class E consists of Burmuda Grass in either good stand, cut to 1.5 inches, or burned stubble. Since this scenario is not reflective of any the grasses or cover conditions seen at the site, Retardance Class E is eliminated. For determining the Permissible Shear Stress, Retardance Class C, with a Permissible Shear Stress of 1.00 would correspond to the conditions evident at the landfill; however, to be conservative, for these calculations, a Permissible Shear Stress for Retardance Class D of 0.60 is used to evaluate top dome and external embankment flows. The 5 percent top dome surface with 350 feet of sheetflow will have a maximum shear stress of 0.08 psf, well below the 0.60 psf permissible shear stress. The 3.2 percent top dome surface with 1,540 feet of sheetflow will have a maximum shear stress of 0.14 psf, also well below the 0.60 psf permissible shear stress. The 10 percent top dome surface with 130 feet of sheetflow will have a maximum shear stress of 0.18 psf, also well below the 0.60 psf permissible shear stress.

Maximum permissible velocities were computed for sheetflow conditions for 10 percent, 3.2 percent and 5 percent slopes based on a permissible shear stress of 0.60 psf. The maximum permissible velocity for 3.2 percent slopes is 4.39 fps, well above the 1.62 fps velocity calculated in the sheetflow condition. For 10 percent slopes, the maximum permissible velocity is 1.92 fps, well above the 0.60 fps velocity calculated in the sheetflow condition. For 5 percent slopes, the maximum permissible velocity is 4.10 fps, also well above the 1.14 fps velocity calculated in the sheetflow condition. Additionally, the calculated velocities are less than the Maximum Velocities from Table 6.7 of the Erosion and Sediment Control Handbook, which lists that the native Bermuda grass has a maximum permissible velocity of 6 fps for 0-5 percent slopes.

The external embankment slopes will be filled to non-erosive grades, typically 25 percent. The external embankment slopes will establish a minimum 60 percent vegetative coverage. The 25 percent slopes will have a maximum flow length of 780 feet without water diversion. Block O is the only block which has not received final cover that will have a flow length requiring diversion. Block P has maximum flow lengths shorter than 780 feet. External embankment slopes will be graded to sheet flow and will have non erosive velocities and acceptable soil losses and therefore will not require any water diversion for distances less than 780 feet for 25 percent slopes. Water handling devices; including diversion dikes, let-down structures, and silt fence, as described in Section 1.1.2, will be utilized as required to maintain these maximum flow lengths.

Recently completed or external embankment slopes that do not have an established vegetative cover of at least 60 percent, will have a maximum sheetflow length of 780 feet. The 25 percent slopes will have velocities of 2.72 feet per second (fps) and a shear stress of 0.58 pounds per square foot (psf). The external embankment slope will establish a minimum 60 percent vegetative coverage or equivalent cover using primary grind mulch. The Permissible Shear Stress for top dome and external embankment flows, as calculated above, is 0.60 psf. The 25 percent external embankment slope with 780 feet of sheetflow will have a maximum shear stress of 0.58 psf, less than the 0.60 psf permissible shear stress.

A maximum permissible velocity was computed for a sheetflow condition on a 25 percent slope based on a permissible shear stress of 0.60 psf. The maximum permissible velocity in this case is 3.00 fps, which is above the 2.72 fps velocity calculated in the sheetflow condition. Additionally, the calculated velocities are less than the Maximum Velocities from Table 6.7 of the Erosion and Sediment Control Handbook, which lists that the native Bermuda grass has a maximum permissible velocity of 4 fps for slopes greater than 10 percent. Therefore, the flows from external embankment slopes with 25percent slopes and a maximum drainage length of 780 feet will have non-erosive velocities. For all velocity and shear stress calculations, see Appendix III-6A-1.

Top dome surfaces and external embankment side slopes will have erosion control structures, including vegetation, established within 180 days of placement of the intermediate cover. Vegetation will be in accordance with Section 1.2.1.

1.1.2 WATER HANDLING PRACTICES

Water handling practices include diversion and flow spreading of water.

Diversion is the use of strategically placed control devices to intercept runoff and divert it to another location. A diversion will be installed to keep clean water from crossing and eroding a disturbed area or to move runoff with silt to a location where it can be treated more effectively.

Diversion structures will be constructed with the construction of intermediate cover and within 180 days of the construction of top dome or external side slopes surfaces.

1.1.2.1 Diversion Dike

A diversion dike intercepts runoff from upland areas and diverts it away from exposed slopes to a let-down structure or a stabilized outlet. Diversion dikes are a ridge of compacted soil located in such a manner as to direct water to a desired location. Diversion dikes will be located above external embankment fill slopes. These diversion dikes have been designed for the 25 year, 24 hour peak flowrate. Diversion dikes will be constructed so that 780 feet is the maximum drainage length to a 4:1 slope. Diversion dikes will be constructed on the top slope so that the maximum drainage area to any one diversion dike is 14.1 acres. The calculated maximum shear stress caused by the 25 year storm event in the diversion dike is 0.99 pounds per square foot for a diversion dike built with a 4% drainage slope. Block O is the only block requiring water diversion.

Diversion dikes will be constructed with a minimum slope of 2 percent and a maximum slope of 4 percent. Diversion dikes will be lined with an erosion protection with a minimum permissible shear stress of greater than 1.0 pounds per square foot. This includes straw mat, curled wood mat (Excelsior), rock (d_{50} = 6"), or other TCEQ approved materials that provide a minimum permissible shear stress greater than 1.0 pounds per square foot.

Diversion dikes will be constructed to direct stormwater to a let-down structure or stabilized outlet such as a stone rip-rap pad or approved alternate. For more information on let-down structures, see 1.1.2.2 Calculations for these diversion dikes are included in Appendix III-6A-1.

1.1.2.2 Let-Down Structure

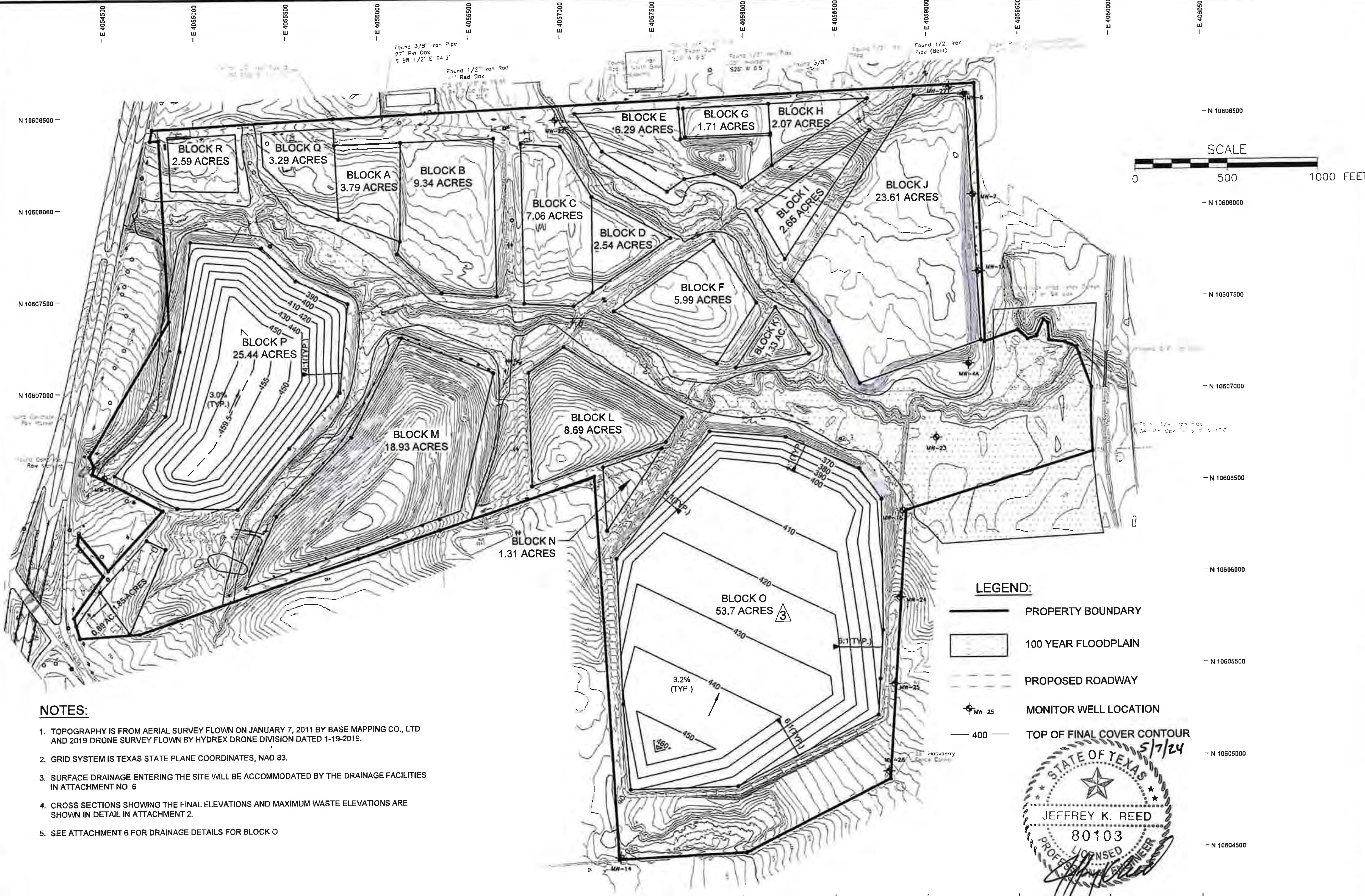
A let-down structure will convey concentrated runoff down steep slopes. The let-down structure will be used on the external embankment side slopes. Runoff will be directed to the let-down structure by means of diversion dikes. The let-down structure will consist of a channel with either a 6 inch gabion, geomembrane, or Reno Mattress (or similar) lining.

These channels have been designed for the 25 year, 24 hour peak flowrate. Block O is the only block that requires installation of a let-down structure. The maximum area to be directed to any one let-down structure is 24.6 acres. Let-down structures will be constructed down the external embankment side slope with a maximum slope of 25 percent. The let-down structure lining will have erosion protection including a 6 inch gabion and geomembrane lining, or other TCEQ approved material with a minimum permissible shear stress greater than 20 lbs/sq. ft. According to TxDOT Manual, Permissible Shear Stresses for Various Linings, 6 inch gabions have a permissible shear stress of 35 psf. The table does not include permissible shear stresses for geomembrane. Geomembrane lining is significantly more resistant to shear forces than gabions, so assuming a permissible shear stress equal to that of gabions, 35 psf, is a conservative assumption. Let down structures will discharge to stone rip-rap pads as detailed on Figure III-6A.3. Calculations for these let-down structures are included in Appendix III-6A-1.

1.1.2.3 Silt Fence

Silt fence is a temporary barrier fence of non-woven textile material which is water permeable but will trap water-borne sediment. The silt fence reduces runoff velocity and allows the deposition of transported sediment to occur. Silt fencing shall consist of posts with pervious synthetic filter fabric (polypropylene, nylon, polyester or other suitable fabric) stretched across the posts. The fabric should contain UV inhibitors and stabilizers for increased product life with a removal capability of approximately 80 percent.

Silt fence will be placed at the base of external embankment slopes that have less than 60 percent vegetative coverage. Additional lines of silt fence will be placed with a maximum spacing of 125 feet up the 4:1 external embankment slopes that do no have 60 percent vegetative coverage.



LEGEND:

- PROPERTY BOUNDARY
- 100 YEAR FLOODPLAIN
- PROPOSED ROADWAY
- MW-25 MONITOR WELL LOCATION
- 400 TOP OF FINAL COVER CONTOUR

NOTES:

1. TOPOGRAPHY IS FROM AERIAL SURVEY FLOWN ON JANUARY 7, 2011 BY BASE MAPPING CO., LTD AND 2019 DRONE SURVEY FLOWN BY HYDREX DRONE DIVISION DATED 1-19-2019.
2. GRID SYSTEM IS TEXAS STATE PLANE COORDINATES, NAD 83.
3. SURFACE DRAINAGE ENTERING THE SITE WILL BE ACCOMMODATED BY THE DRAINAGE FACILITIES IN ATTACHMENT NO. 6
4. CROSS SECTIONS SHOWING THE FINAL ELEVATIONS AND MAXIMUM WASTE ELEVATIONS ARE SHOWN IN DETAIL IN ATTACHMENT 2.
5. SEE ATTACHMENT 6 FOR DRAINAGE DETAILS FOR BLOCK O

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JEFFREY K. REED
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PROFESSIONAL ENGINEER
5/7/24

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REV	DATE	DESCRIPTION	BY
1	6/2011	REVISED BLOCKS P&O GRADES	SCS
2	8/2019	REVISED BLOCKS P&O GRADES	SCS
3	12/2023	REVISED BLOCK O FINAL COVER GRADES.	SCS

TEXAS BOARD OF PROFESSIONAL ENGINEERS REG. NO. F-3407

DRAWING TITLE: III.11.G ATTACHMENT 7 - FINAL CONTOUR MAP

PROJECT TITLE: LANDFILL RECONFIGURATION PERMIT MODIFICATION

CLIENT: CITY OF NACOGDOCHES LANDFILL
PERMIT NO. MSW-720
NACOGDOCHES, NACOGDOCHES COUNTY, TEXAS

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT CONSULTING ENGINEERS
12651 BRIAR FOREST, SUITE 205, HOUSTON, TX 77077
PH (281) 397-6747 FAX NO. (281) 293-7878

PROJ. NO. 16209006.02 | DWN. BY: RLD | Q/A RVW BY: JRM
DSN. BY: RLD | CHK. BY: JKR | APP. BY: JKR

CADD FILE: DWG 7A - FINAL CONTOUR MAP-REV

DATE: 6-2011

SCALE: AS SHOWN

DRAWING NO. 7A

Nacogdoches
the oldest town in Texas

CITY OF NACOGDOCHES LANDFILL
NACOGDOCHES COUNTY, TEXAS
TCEQ PERMIT NO. MSW-720

PART III - SITE DEVELOPMENT PLAN
ATTACHMENT 10
SOIL AND LINER QUALITY CONTROL PLAN

FOR PERMITTING PURPOSES ONLY

5/7/24

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Prepared for:

CITY OF NACOGDOCHES

Prepared by:

SCS ENGINEERS
TBPE Registration No. F-3407
Houston Office
12651 Briar Forest, Suite 205
Houston, Texas 77077
281/293-8494

Revision 0 – July 2013
Revision 1 – January 2014
Revision 2 – January 2020
Revision 3 – January 2024
Revision 4 – May 2024
SCS Project No. 16209006.26

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Appendices

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APPENDIX 10D

SAMPLE UNDERDRAIN AND BALLASTING CALCULATIONS

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inclusive of pgs 10D-1 to 10D-11.

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General Information:

1. Portions of the undeveloped excavation areas for Block O at the City of Nacogdoches Landfill, specifically Phases 3 through 6, will be below the seasonal high groundwater table (SHWT) within the Welches Formation. Based on review of the SHWT map (Attachment 10, Appendix C, Figure 10C-1), portions of the south and western sideslope and floor of Phases 3 through 6 will be constructed below the SHWT. Although, the excavation for these cells will be founded in either Layer 1, which includes sandy clays and clays, and/or Layer 2, which includes a glauconitic clayey silt; for this calculations, it is assumed that the impacted sideslope and/or floor areas of Phases 3 through 6 will be founded in the higher permeable glauconitic clayey silt, which is the water bearing zone at the landfill. Since this water bearing zone will come into contact with the underdrain, the hydraulic conductivity for this layer was used in all calculations for conservativeness.

2. Geologic and hydrogeological characteristics of the site are described in Attachment 4 - Geology Report, as well as Attachment 5 - Groundwater Characterization Report, Appendix III-5-Sup-D, *Preliminary Groundwater Characterization Study at the City of Nacogdoches Landfill* (January 1995, Golder Associates, Inc.), Appendix D. This latter document includes the slug test permeability results for the glauconitic clayey silt. Based on review of the slug test results, four piezometers installed near Block O exhibited a permeability of 9.1×10^{-6} cm/s to 1.5×10^{-4} cm/s, with an average of the three higher values of 2.12×10^{-4} cm/s. Additionally, this calculation assumes that the water bearing unit is a gravity flow aquifer.

3. Based on review of the SHWT map, groundwater flow around Block O is from southwest to northeast, and could exhibit a maximum hydrostatic head of 16 feet in Phase 3, 10 feet in Phase 4, 14 feet in Phase 5, and 14 feet in Phase 6. The calculations presented below are based on a maximum hydrostatic head of 16 feet, and sizing criteria for the floor and sideslope underdrain systems associated with Block O, Phases 3 through 6. As summarized at the end of these calculations, both the floor and sideslope underdrain systems will be installed for Phases 3 through 6.

Method of Analysis:

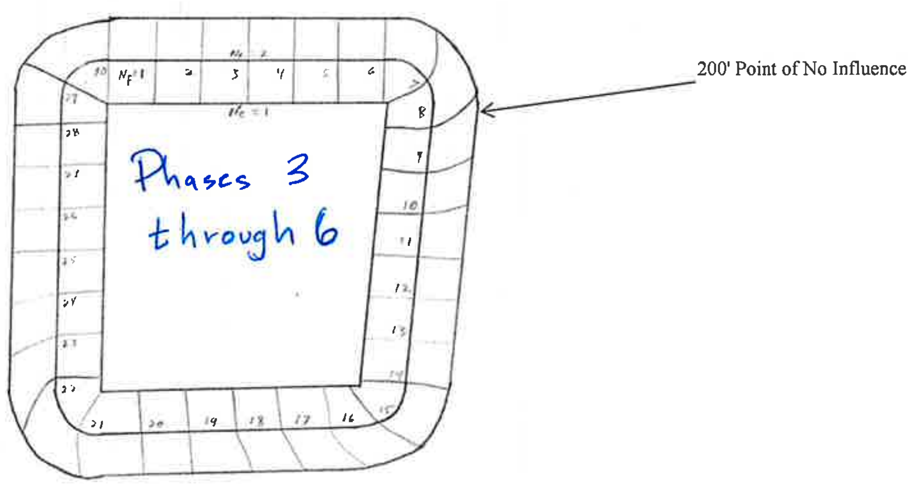
1. Use a flow net to determine underdrain flows at the floor of Phases 3 through 6.
2. Summarize data for Phases 3 through 6 and estimate the hydrostatic uplift based on the revised SHWT map.
3. Use a confined flow analysis assuming a single source slot, fully penetrating the source aquifer to design the sideslope underdrain.
4. Evaluate the required underdrain design (spacing) based on maximum drainage lengths to ensure that the entire system will work as designed.
5. Evaluate that the non-woven geotextiles incorporated into the underdrain meet or exceed the required properties for retention, hydraulic conductivity, and porosity.

References:

1. Cedergren, Harry, *Seepage, Drainage, and Flow Nets, Third edition*, 1989.
2. Departments of the Army, Navy, and Air Force (NAVFAC P-418), *Dewatering and Groundwater Control*, November 1983.
3. Koerner, R.M., *Designing With Geosynthetics, Third Edition*, 1994.
4. GSE Lining Technology Inc., Product Data Sheet "GSE Nonwoven Geotextiles", 2007.
5. GSE Lining Technology Inc., GSE Drainage Design Manual, 3rd Edition, Appendix A, 100-hour Transmissivity Data for Selected Projects.

Solution:

A) **First design the cell floor underdrain** using a plan view flow net to determine inflow. Based upon the updated SHWT map (Attachment 10, Figure 10C-1) the maximum head on the floor of Phases 3 through 6, located in the northwest corner, is approximately 16 feet.



$N_f = 30$, where N_f is the number of flow lines selected. These are equally spaced to define the shape. Lines were added roughly parallel at the corners to allow for final net areas to be more closely square.

$N_e = 2$, where N_e equals the number of equipotential drops from the cell limits to the "point of no influence." In this analysis there are two equipotential drops, including the cell boundary and 100 foot from the cell boundary. Two lines were selected to provide for roughly "square" areas within the flow net (length and width of the sides should be approximately equal). The 200-foot point of no influence was selected because it was assumed that the underdrain would pump at a rate such that drawdown occurs within 200-feet of the cell boundary (see sketch on next page).

To calculate the flow to the excavation, use NAVFAC, Figure 4-27, Equation (5), Page 4-31.

$Q_T = kH''S_f/2$

Q_T = Total flow

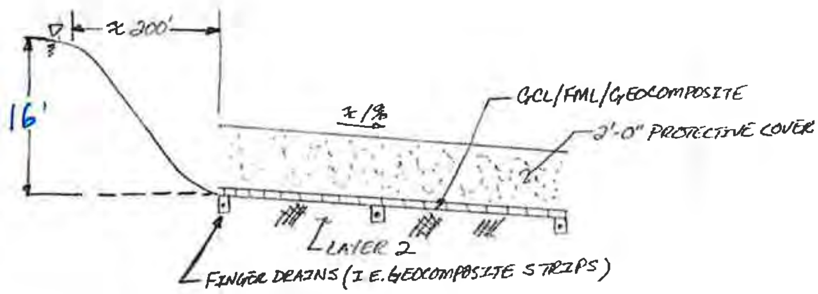
where: k = Permeability of aquifer = 2.12E-04 cm/sec or 4.17E-04 ft/min

$H'' = H^2 - H_o^2$, where H_o is negligible, and therefore is assumed to be zero

H = max. head on Phases 3 to 6 floor = 16 feet

$S_f = N_f/N_e$ = 15

The 16-foot maximum head is representative of the seasonal high groundwater elevation of 392 feet MSL for Phase 3, as shown on Figure 10C-1, and a cell floor elevation of 376 feet MSL, as shown on Drawing 10D-1.

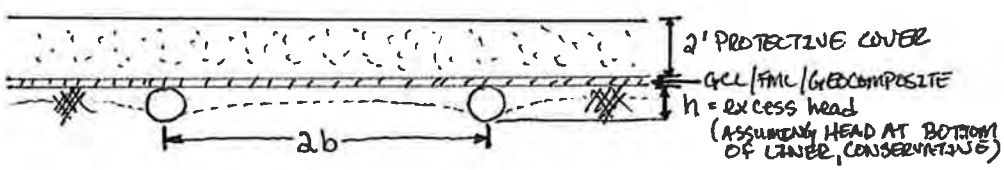


Q_T =	**5.99 gallons/minute**	(this includes a conversion of 7.48 gallons/cubic foot)
	8,630.53 gallons/day	

The overall infiltration rate through the floor area, $q = Q_T/\text{Area}$ Area = 1,370,472 square feet **(Area of Phases 3 thorugh 6 floor)**
31.5 acres

q = 8.42E-04 feet/day

B) **Design floor underdrain** using Equation. 9.2, Page 344 from Cedergren. This analysis will determine the required underdrain spacing to relieve uplift pressure on the bottom of the liner (see drawing below).



From Cedergren: $\frac{q}{k} = \frac{(h)^2}{(b)^2}$

where: q = infiltration rate = 8.42E-04 feet/day

k = permeability = 2.12E-04 cm/sec or 6.01E-01 ft/day

b = 1/2 of underdrain spacing

h = head offset between drains = 2.9 feet (see below for calculation)

to calculate h as follows = h is equal to the weight of the liner and protective cover above the underdrain with a factor of safety of 1.2. Since a GCL will be installed, do not account for liner thickness. Do not provide credit for the minimum 1-foot protective pad over the underdrain (to protect it during liner construction).

h = (2 ft)(110 pcf)/(1.2)(62.4 pcf) = 2.9 feet of water

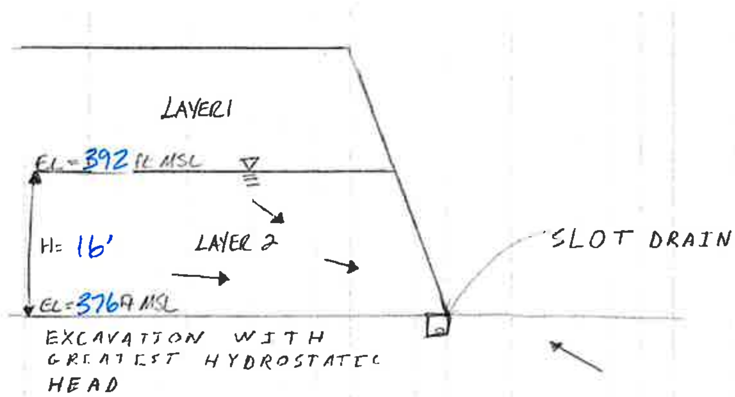
Next, solving for the parameter "b" above to set the spacing: $$(b)^2 = \frac{(h)^2 k}{q}$$

based on the parameters above then: 6,161 feet^2 = b^2
or b = 78.5 feet
and 2b = 157.0 feet

Therefore, an floor underdrain spacing of 157.0 feet or less is needed to meet the design conditions for Phases 3 through 6. For design purposes, an underdrain spacing on the floor of the excavation of 100 feet center to center will be specified.

C) **Design the Sideslope Underdrain**

First, analyze the sideslope seepage.



To calculate the flow to the slot drain, use NAVFAC, Figure 4-1, Equation (3), Page 4-2.

$$Q = \frac{kx}{2L}(H^2 - h_o^2)$$

where: k = permeability = 2.12E-04 cm/sec or 6.01E-01 ft/day
x = slot drain length (we will find a flow per length so no value for this yet)
H = maximum head = 16 feet
h_o is defined on NAVFAC, Figure 4.1, Page 4-2, and calculated using Figure 4.2, Page 4-3.
h_o = 4.8 feet
L = point where drawdown occurs (see calculation below)

To determine "L", the point where drawdown occurs, use NAVFAC, Figure 4-23, equation (1), Page 4-24, where R is shown as L (they are the same value for drawdown radius of influence).

$$R = L = C(H - h_w)\sqrt{k}$$

where: L = radius of influence, equivalent to point where drawdown occurs
C = coefficient of flow = 2 (for a single line of well points)
H = maximum head = 16 feet
$h_w = h_e = H_o + H_S$, and is determined using Figure 4.2, Page 4-3, where H_S equals 0.5,
h_e = 5.3 feet
k = permeability = 2.12E+00 (expressed in units of 10^{-4} cm/sec)

Therefore, L = 31.2 feet

Solving for Q above using L **Q = 2.25 cf/day per foot length**

q = infiltration rate = Q/Area (note that area here is equal to the maximum head multiplied by 3 to compensate for the 3H:1V slope)

therefore; q = 4.68E-02 feet/day

D) Determine the Underdrain Spacing Along the Sideslope

Using the same equation that was used to space the underdrain for the cell floor we will use the following equation:

$$(b)^2 = \frac{(h)^2 k}{q}$$

where: q = infiltration rate = 4.68E-02 feet/day
k = permeability = 2.12E-04 cm/sec or 6.01E-01 ft/day
b = 1/2 of underdrain spacing
h = excess head between drains = 2.9 feet

Based on the parameters above then: 111 feet^2 = b^2
or b = 10.5 feet
and 2b = 21.1 feet

Therefore, an underdrain spacing of 21.1 feet or less is needed to meet the design conditions for Phases 3 through 6. For design purposes, an underdrain spacing on the sideslope of the excavation of 20 feet center to center below the seasonal high water level will be specified for the west and south sideslope of Phase 3, 5, and 6.

E) Next, Size the Underdrain Components on the cell floor (now that the Spacing has been Established Between the Underdrain Elements)

Starting with the bottom underdrain (note, although the sketch in Section B depicts equally spaced pipes, the flow conduit is arbitrary, provided such conduit [i.e., geocomposite strip] has sufficient cross-sectional area to convey the groundwater infiltration rate):

i) Under item B) at the bottom of page 2 of these calculations a spacing of 100 feet center to center was established for the bottom underdrain.
ii) Under item A) at the top of page 2 of these calculations the infiltration rate into the bottom underdrain = 8.42E-04 feet/day
iii) The maximum geocomposite drainage layer length along the bottom underdrain = 310 ft in Phases 3 through 6 (i.e., between floor drains)

Using each of these maximums, the required drain capacity is calculated as follows:

Underdrain Spacing [from B) above] = 100 ft c-c
Q_{REQD} = (q)(Area of infiltration) = (8.42E-04 ft/day)(100 ft c-c)(310 feet)(7.48 gallons/ft^3) = 195.22 gallons/day

Assume the use of a 15-foot wide geocomposite consisting of a geonet with a geotextile heat bonded to each side to transmit this groundwater to floor drains. The east-west running underdrain components have a slope of approximately 0.01 ft/ft. For the double-sided geocomposite assume a transmissivity of 1 x 10^{-3} m^2/sec **(Ref 5, GSE Frabrinet HF)**, based on a gradient of 0.01 and overburden pressure of 1,000 psf.

Compare the geocomposite capacity to the Q_{REQD} 195 gallons/day

For the geocomposite, Q_T = Tiw where: Q_T = Flow in geocomposite under laboratory conditions
T = transmissivity = 1.0E-03 m^2/sec **(Ref. 5 GSE Fabrinet HF)**
i = gradient = 0.01 (ft/ft) (minimum floor slope)
width = 15 ft = 4.572 meters

Q_T = 1,044 gallons/day

$Q_{ALL} = Q_T/FS$ where: Q_T= Flow in geocomposite under laboratory conditions
Q_{ALL}= Allowable flow taking into consideration factors of safety
FS = 2, for intrusion and creep deformation

Therefore Q_{ALL}= 521.81 gallons/day which is > 195.22 gallons/day

Therefore, the geocomposite shall be a 250-mil geonet with 8 oz/sy non-woven geotextiles adhered to both sides with a minimum transmissivity of 1 x 10^{-3} m^2/s at a gradient of 0.01 and overburden pressure of 1,000 psf. Geocomposite strips shall be 15-foot wide at 100 foot c-c spacing along the cell floor of Phases 3 through 6.

F) Next, Size the Sideslope Underdrain Components (now that the Spacing has been Established)

i) Under item D) in the bottom of page 3 of these calculations a spacing of 50 feet center to center was established for the sideslope underdrain
ii) Under item C) at the bottom of page 3 of these calculations the infiltration rate into the sidewall underdrain = 4.68E-02 feet/day
iii) The maximum geocomposite drainage layer length along the sideslope underdrain = 60 feet (horizontal projection in Cell 48)
(It should be noted that only the portion of the sideslope below the seasonal high groundwater table need be considered here)

Using each of these maximums, the required drain capacity is calculated as follows:

Underdrain Spacing [from D) above] = 20 ft c-c
Q_{REQD} = (q)(Area of infiltration) = (4.68E-02 ft/day)(20 ft c-c)(60 feet)(7.48 gallons/ft^3) = 420 gallons/day

For the geocomposite, $Q_T = Tiw$ where: Q_T = Flow in geocomposite under laboratory conditions
T = transmissivity = 5 0E-04 m^2/sec **(Ref. 5 GSE Fabrinet HF)**
i = gradient = 0.33 (3H:1V sideslope)
width = 3 ft = 0.9144 meters

Q_T = 3,479 gallons/day

$Q_{ALL} = Q_T/FS$ where: Q_T= Flow in geocomposite under laboratory conditions
Q_{ALL}= Allowable flow taking into consideration factors of safety
FS = 2, for intrusion and creep deformation

Therefore Q_{ALL}= 1,739.36 gallons/day which is > 420 gallons/day

Therefore, the geocomposite shall be a 250-mil geonet with 8 oz/sy non-woven geotextiles adhered to both sides with a minimum transmissivity of 5 x 10^{-4} m^2/s at a gradient of 0.33 and overburden pressure of 1,000 psf. Geocomposite strips shall be 3-foot wide at 20 foot c-c spacing along the cell sideslope of Phases 3, 5, and 6, below the seasonal high water table.

G) Toe and Floor Drain Design

i) The maximum floor drain length = 640 feet
ii) The minimum slope of toe drain = 0.017 equivalent of 1 7%, where toe or floor drains parallel to the west sideslop of Phase 6
iii) Use 6" perforated HDPE Pipe, Manning's n = 0 009
iv) Infiltration for the floor = 8.42E-04 feet/day from the middle of page 2
v) Infiltration for sideslope = 4.68E-02 feet/day from the bottom of page 3

Flow in floor or toe drains, evaluate maximum Q_{MAX} between floor and sideslope, where $Q_{TD} = q_i A_i$

where: Q_{MAX} = Maximum flow to a floor or toe drain (gallons per minute)
q_{floor} = Infiltration into floor (feet/day) = 8 42E-04
A_{floor} = Floor Area (ft^2) = 1,370,472 (conservatively assume the entire floor drains to a single drain)
$q_{sideslope}$ = Infiltration into sideslope (feet/day) = 4 68E-02
$A_{sideslope}$ = Sideslope Area (ft^2) = 122,000 (conservatively assume the entire west sideslope of Phase 3 and 6 drain to a single toe drain)

Q_{MAX} = 42,710 gallons/day = 29 7 gallons per minute

Next, using the Manning's equation, determine the capacity of a 6", HDPE SDR 11 pipe on a 1 7% grade and compare to Q_{MAX}.

Manning's equation is:

$$V = \frac{(1.486)(r)^{2/3}\ (s)^{1/2}}{n}$$

where: V = velocity in pipe (ft/sec)
n = Manning's number for HDPE = 0 009
s = slope (ft/ft) = 0 017
r = hydraulic radius (ft)= diameter/4 = ((5.373/12)/4) for SDR 11 HDPE Pipe = 0 112

Using the above parameters, V = 5.01 feet per second

$Q_{CAPACITY} = (a)(V)$

where: $Q_{CAPACITY}$ = Flow capacity of pipe in gallons per minute

a =	Pipe cross-sectional area (ft^2) = $\pi D^2/4$ =	0.157	ft^2
	assume half of area for conservativeness =	0.079	ft^2
V =	Velocity from above calculation =	5.01	ft/sec

therefore $Q_{CAPACITY}$ = 176.9 gallons per minute

Since either drain only requires a maximum flow of 29.7 gallons per minute,
but the capacity when flowing half full is 176.9 gallons per minute, therefore, the 6-inch toe drain pipe is acceptable.

H. Evaluate that the non-woven geotextiles incorporated into the underdrain meet or exceed the required properties for retention, hydraulic conductivity, and porosity for the specified design conditions:

i. Non-Woven Geotextile (8 oz/sy) located on the top and bottom of the geocomposite.
ii. Non-Woven Geotextile (8 oz/sy) to be installed around granular drainage aggregate.

Retention:

The apparent opening size (O_{95}) was determined **(Ref 4)**:

8 oz/sy Non-Woven Geotextile: $O_{95} <$ 0.18 mm

AASHTO's Task Force # 25 report as referenced on pp. 101 of Reference 2 recommends that the following criteria be used to check the geotextile retention properties:

- For soil ≤ 50% passing the No. 200 sieve: $O_{95} < 0.59$mm (i.e., AOS of the fabric ≥ No. 30 sieve); and
- For soil > 50% passing the No. 200 sieve: $O_{95} < 0.30$mm (i.e., AOS of the fabric ≥ the No. 50 sieve).

Onsite soils representative of Layer 1 and 2 are classified as clays, sandy clays, clayey silt, sandy silts, and sand seams. Onsite soils are expected to have greater than 50% passing the No. 200 sieve. Therefore, since the O_{95} or AOS of the 8 oz/sy non-woven geotextile is less than 0.30 mm, it meets the retention criteria for the soil formations present at the site.

Hydraulic Conductivity (k):

$q_{allow} = q_{ult} [(1/FS_{SCB} \times FS_{CR} \times FS_{IN} \times FS_{CC} \times FS_{BC})]$ **(Ref. 3, pp. 159)**

Where:

q_{allow} =	allowable flow rate
q_{ult} =	ultimate flow rate
FS_{SCB} =	factor-of-safety for soil clogging and binding
FS_{CR} =	factor-of-safety for creep reduction of void space
FS_{IN} =	factor-of-safety for adjacent materials intruding into the geotextile's void space
FS_{CC} =	factor-of-safety for chemical clogging
FS_{BC} =	factor-of-safety for biological clogging

8 oz/sy Non-Woven Geotextile:

q_{ult} =	0.3	cm/sec	**(Ref. 4)**
FS_{SCB} =	7.50		**(Ref. 3, pp. 160)**
FS_{CR} =	1.25		
FS_{IN} =	1.10		
FS_{CC} =	1.35		
FS_{BC} =	3.00		

These factors-of-safety are averages of the recommended values for underdrain filters.

Calculated factor-of-safety = 41.77 (i.e., for both weights of non-woven geotextile)

8 oz/sy Non-Woven Geotextile: q_{allow} = 7.18E-03 cm/s

The hydraulic conductivity is considered acceptable, since after applying average partial factors-of-safety for underdrain filters, the hydraulic conductivity of the filter is greater than the average hydraulic conductivity of the soil formation, and as such will not impede flow into the underdrain.

Porosity:

The non-woven geotextiles should have enough openings, that the performance of the non-woven geotextiles will not be significantly impaired in the event of blockage of some openings. Giroud recommends a non-woven geotextile porosity of greater than 30%. As per Giroud, the porosity of a non-woven geotextile can be calculated using the following equation.

$$n = 1-[m/\rho t] \times 100$$ **(Ref. 3, pp. 128)**

Where:
- n = geotextile porosity, %
- m = geotextile mass per unit area, lb/sf
- t = geotextile thickness, ft
- ρ = density of filaments, lb/cf

	8 oz/sy	
m =	0.06	
t =	0.007	
ρ =	58.68	
n =	**85.8**	***> 30%, therefore, ok***

SUMMARY OF RESULTS

Calculations were performed for design conditions for Phases 3 through 6 at the City of Nacogdoches Landfill. During design of the construction plans and prior to installation of the underdrain components, manufacturer's product data will be reviewed to confirm that the selected materials meet or exceed the properties of the materials required by this calculation (i.e., thickness, transmissivity, non-woven geotextile properties, etc.).

BOTTOM UNDERDRAIN SYSTEM

The finger drains (geocomposite strips) spaced at 100 ft. c-c were designed for the cell floor of Phases 3 through 6. These drains will consist of minimum 15-foot wide 250-mil double-sided geocomposite strips (with 8 oz/sy non-woven geotextile heat bonded to each side) with a minimum transmissivity of 1×10^{-3} m^2/s at a gradient of 0.01 and overburden pressure of 1,000 psf. These geocomposite strips will be connected to free-flowing floor drains, which drain to an underdrain sump.

SIDESLOPE UNDERDRAIN SYSTEM

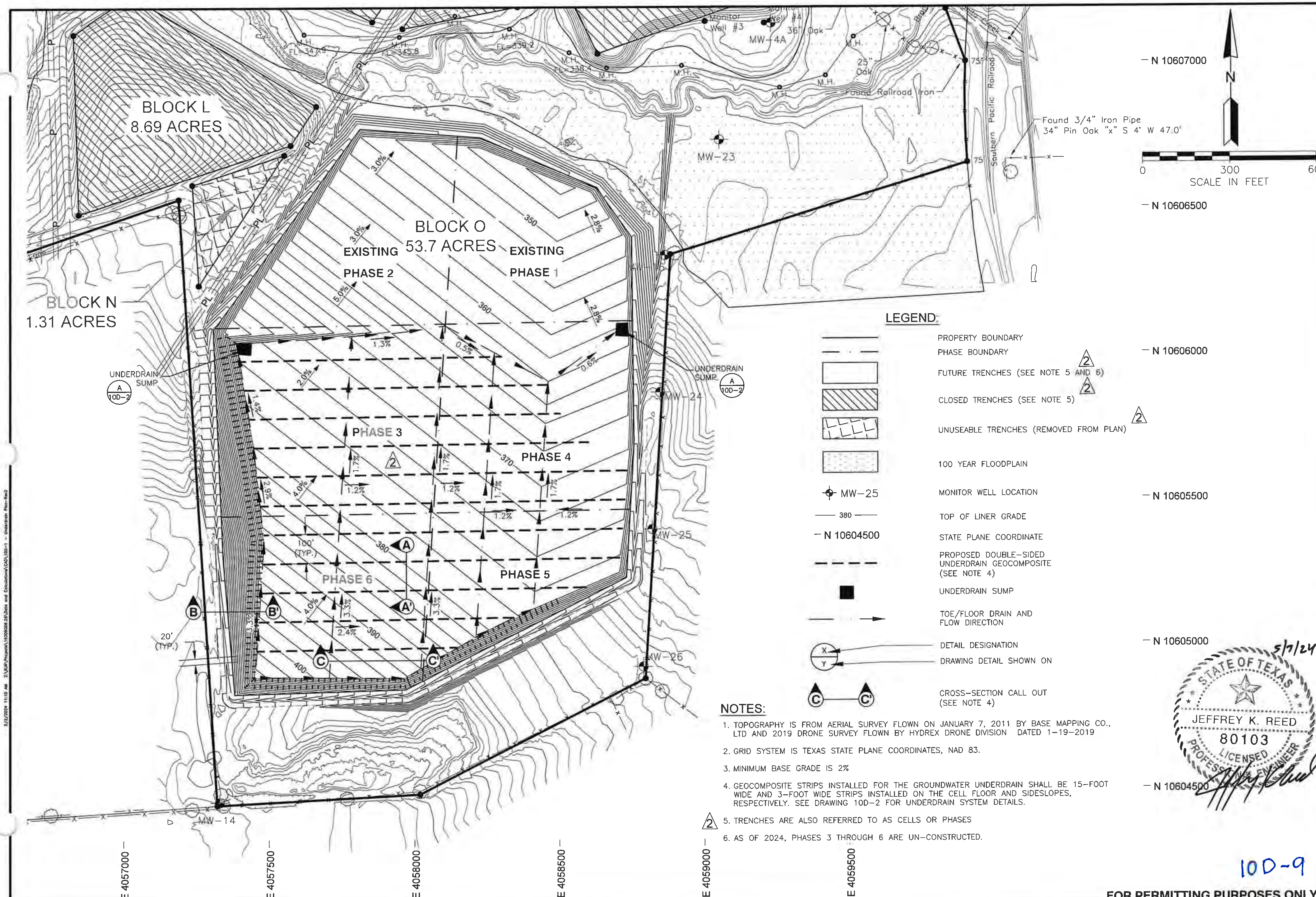
The finger drains (geocomposite strips) spaced at 20 ft. c-c were designed for the cell sideslope of Phases 3 through 6. These drains will consist of minimum 3-foot wide 250-mil double-sided geocomposite strips (with 8 oz/sy non-woven geotextile heat bonded to each side) with a minimum transmissivity of 5×10^{-4} m^2/s at a gradient of 0.33 and overburden pressure of 1,000 psf. It should be noted that in Phases 3 through 6, geocomposite strips will only be necessary on the sideslopes of Phases 3, 5, and 6, and will be installed on sideslopes that have greater than 6 feet of hydrostatic head. For areas of the sideslopes with less than 6 feet of head, groundwater will be controlled by the toe drain installed in Phases 3 throguh 6, as shown on Drawing 10D-1. The geocomposite strips installed on the sideslope of Phases 3, 5, and 6 will be connected to a free-flowing toe drain located at the toe of the west sideslope of Phases 3 and 6 that will drain to an sump located in Phase 4.

TOE AND FLOOR DRAIN

Toe and floor drains a minimum of 1-foot wide and 1.5-feet deep with a minimum 1.7% grade will be built in Phase 3 and 6 leading to underdrain sumps. The trench will contain a minimum 6-inch SDR 11 perforated pipe surrounded by gravel (1/2 to 2-inch). The toe drains, floor drain, and underdrain sump aggregate will be wrapped with a 8 oz/sy non-woven geotextile.

UNDERDRAIN SUMP PUMP AND CONTROLS

The underdrain sump will be equipped with a 10 gpm (minimum) permanent submersible pump and controls. This pump size will be consistent with the maximum infiltration rate into the cell, as calculated in Section A of these calculations. The pump will be equipped with a pressure transducer or equivalent water level sensor to the pump "on" and "off" based on groundwater levels with the sump. The pump "on" level will be set to 24 inches above the bottom of the sump, and the pump "off" level will be set at a depth of 6 inches above the bottom of the sump or the manufactures recommended minimum depth to prevent damage to the pump. The pump control panel will also be equipped with a high-level indicator light, which will indicate when the groundwater depth in the sump exceeds 24 inches. See Drawing 10D-2 for underdrain sizing criteria.



LEGEND:

———	PROPERTY BOUNDARY
— · —	PHASE BOUNDARY
(blank box)	FUTURE TRENCHES (SEE NOTE 5 AND 6)
(hatched box)	CLOSED TRENCHES (SEE NOTE 5)
(patterned box)	UNUSEABLE TRENCHES (REMOVED FROM PLAN)
(dotted box)	100 YEAR FLOODPLAIN
MW-25	MONITOR WELL LOCATION
— 380 —	TOP OF LINER GRADE
— N 10604500	STATE PLANE COORDINATE
— — — —	PROPOSED DOUBLE-SIDED UNDERDRAIN GEOCOMPOSITE (SEE NOTE 4)
■	UNDERDRAIN SUMP
— · →	TOE/FLOOR DRAIN AND FLOW DIRECTION
X / Y	DETAIL DESIGNATION / DRAWING DETAIL SHOWN ON
C — C'	CROSS-SECTION CALL OUT (SEE NOTE 4)

NOTES:

1. TOPOGRAPHY IS FROM AERIAL SURVEY FLOWN ON JANUARY 7, 2011 BY BASE MAPPING CO., LTD AND 2019 DRONE SURVEY FLOWN BY HYDREX DRONE DIVISION DATED 1-19-2019
2. GRID SYSTEM IS TEXAS STATE PLANE COORDINATES, NAD 83.
3. MINIMUM BASE GRADE IS 2%
4. GEOCOMPOSITE STRIPS INSTALLED FOR THE GROUNDWATER UNDERDRAIN SHALL BE 15-FOOT WIDE AND 3-FOOT WIDE STRIPS INSTALLED ON THE CELL FLOOR AND SIDESLOPES, RESPECTIVELY. SEE DRAWING 10D-2 FOR UNDERDRAIN SYSTEM DETAILS.
5. TRENCHES ARE ALSO REFERRED TO AS CELLS OR PHASES
6. AS OF 2024, PHASES 3 THROUGH 6 ARE UN-CONSTRUCTED.

JEFFREY K. REED 80103 LICENSED PROFESSIONAL ENGINEER — STATE OF TEXAS

5/7/24

10D-9

FOR PERMITTING PURPOSES ONLY

REV	DATE	DESCRIPTION	BY
2	05/2024	REVISE BLOCK O BASE GRADES, UCS, LEGEND, AND NOTES.	SCS
1	8/2019	REVISE BLOCK O	SCS

TEXAS BOARD OF PROFESSIONAL ENGINEERS REG. NO. F-3407

DRAWING TITLE: UNDERDRAIN LAYOUT PLAN

PROJECT TITLE: LANDFILL RECONFIGURATION PERMIT MODIFICATION

CLIENT: CITY OF NACOGDOCHES LANDFILL
PERMIT NO. MSW-720
NACOGDOCHES, NACOGDOCHES COUNTY, TEXAS

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT CONSULTING ENGINEERS
12651 BRIAR FOREST, SUITE 205, HOUSTON, TX 77077
PH (281) 397-6747 FAX NO. (281) 293-7878

PROJ. NO. 16209006.02 | DSN. BY: RRK | DWN. BY: JJJ | CHK. BY: JKR | Q/A RVW BY: RRK | APP. BY: JKR

CADD FILE: 10D-1 - UNDERDRAIN PLAN-REV2

DATE: 08/2013

SCALE: AS SHOWN

DRAWING NO. 10D-1

CITY OF NACOGDOCHES LANDFILL
NACOGDOCHES COUNTY, TEXAS
TCEQ PERMIT NO. MSW-720

PART III - SITE DEVELOPMENT PLAN
ATTACHMENT 10, APPENDIX 10E
GEOSYNTHETIC CLAY LINER -
ALTERNATE LINER DESIGN DEMONSTRATION

Prepared for:

CITY OF NACOGDOCHES
4602 NW Stallings Drive
Nacogdoches, TX 75964

Prepared By:

SCS ENGINEERS
TBPE Registration No. F-3407
Houston Office
12651 Briar Forrest Drive
Houston, Texas 77077
281/293-8494

5/7/24
STATE OF TEXAS
JEFFREY K. REED
80103
LICENSED
PROFESSIONAL ENGINEER

Revision 0 - July 2013
Revision 1 – September 2019
Revision 2 – January 2024
Revision 3 – May 2024
SCS Project No. 16209006.26

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APPENDIX 10E-2

HELP MODEL ANALYSIS

(Includes Pages 10E-2-1 through 10E-2-23)

SCS Engineers
TBPE Reg. # F-3407

5/7/24

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inclusive of pgs. 10E-2-1 to 10E-2-23

FOR PERMITTING PURPOSES ONLY

CITY OF NACOGDOCHES LANDFILL
BLOCK O - HELP MODEL SUMMARY SHEET
GCL ALTERNATE LINER DEMONSTRATION

Prep'd By:RJE
Chkd By JKR
Date: 01/19/2024

		ACTIVE	INTERIM	CLOSED
GENERAL INFORMATION	Model Duration (Years)	30	30	30
	Ground Cover	BARE	FAIR	GOOD
	SCS Runoff Curve No.	85	85	85
	Model Area (acre)	1	1	1
	Runoff Area (%)	0	100	100
	Maximum Leaf Area Index	0.0	2.0	3.5
	Evaporative Zone Depth (inch)	6	12	6
EROSION LAYER (Texture = 11)	Thickness (in)			6
	Porosity (vol/vol)			0.4640
	Field Capacity (vol/vol)			0.3100
	Wilting Point (vol/vol)			0.1870
	Init. Moisture Content (vol/vol)			0.4536
	Hyd. Conductivity (cm/s)			6.4E-05
FLEXIBLE MEMBRANE LINER (Texture = 36)	Thickness (in)			0.04
	Hyd. Conductivity (cm/s)			4.0E-13
	Pinhole Density (holes/acre)			1
	Install. Defects (holes/acre)			4
	Placement Quality			GOOD
INFILTRATION LAYER (Texture = 0)	Thickness (in)			18
	Porosity (vol/vol)			0.4270
	Field Capacity (vol/vol)			0.4180
	Wilting Point (vol/vol)			0.3670
	Init. Moisture Content (vol/vol)			0.4094
	Hyd. Conductivity (cm/s)			1.0E-05
INTERMEDIATE / DAILY COVER (Texture = 11)	Thickness (in)	6	12	6
	Porosity (vol/vol)	0.4640	0.4640	0.4640
	Field Capacity (vol/vol)	0.3100	0.3100	0.3100
	Wilting Point (vol/vol)	0.1870	0.1870	0.1870
	Init. Moisture Content (vol/vol)	0.3709	0.3419	0.3100
	Hyd. Conductivity (cm/s)	6.4E-05	6.4E-05	6.4E-05
WASTE (Texture = 18)	Thickness (in)	120	720	720
	Porosity (vol/vol)	0.6710	0.6710	0.6710
	Field Capacity (vol/vol)	0.2920	0.2920	0.2920
	Wilting Point (vol/vol)	0.0770	0.0770	0.0770
	Init. Moisture Content (vol/vol)	0.3054	0.2945	0.2920
	Hyd. Conductivity (cm/s)	1.0E-03	1.0E-03	1.0E-03
PROTECTIVE COVER (Texture = 11)	Thickness (in)	24	24	24
	Porosity (vol/vol)	0.4640	0.4640	0.4640
	Field Capacity (vol/vol)	0.3100	0.3100	0.3100
	Wilting Point (vol/vol)	0.1870	0.1870	0.1870
	Init. Moisture Content (vol/vol)	0.3466	0.3431	0.3100
	Hyd. Conductivity (cm/s)	6.4E-05	6.4E-05	6.4E-05
LEACHATE COLLECTION (Texture = 0)	Thickness (in)	0.20	0.19	0.19
	Porosity (vol/vol)	0.8500	0.8500	0.8500
	Field Capacity (vol/vol)	0.0100	0.0100	0.0100
	Wilting Point (vol/vol)	0.0050	0.0050	0.0050
	Init. Moisture Content (vol/vol)	0.0255	0.0555	0.0107
	Hyd. Conductivity (cm/s)	16.00	5.00	5.00
	Slope (%)	2.8	2.8	2.8
	Slope Length (ft)	325	325	325
FLEXIBLE MEMBRANE LINER (Texture = 35)	Thickness (in)	0.06	0.06	0.6
	Hyd. Conductivity (cm/s)	2.0E-13	2.0E-13	2.0E-13
	Pinhole Density (holes/acre)	1	1	1
	Install. Defects (holes/acre)	4	4	4
	Placement Quality	GOOD	GOOD	GOOD
GEOSYNTHETIC CLAY LINER (Texture = 0)	Thickness (in)	0.24	0.24	0.24
	Porosity (vol/vol)	0.7500	0.7500	0.7500
	Field Capacity (vol/vol)	0.7470	0.7470	0.7470
	Wilting Point (vol/vol)	0.4000	0.4000	0.4000
	Init. Moisture Content (vol/vol)	0.7500	0.7500	0.7500
	Hyd. Conductivity (cm/s)	5.0E-09	5.0E-09	5.0E-09
PRECIPITATION	Average Annual (in)	45.1	45.1	45.1
RUNOFF	Average Annual (in)	0.0	3.5	14.0
EVAPOTRANSPIRATION	Average Annual (in)	26.7	31.2	31.1
PERCOLATION	Average Annual (in)	3.31E-06	3.77E-06	1.39E-06

HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE
HELP MODEL VERSION 4.0 BETA (2018)
DEVELOPED BY USEPA NATIONAL RISK MANAGEMENT RESEARCH LABORATORY

Title: Interim, 60' Waste, 2.8% Slope... **Simulated On:** 12/1/2023 15:30

Layer 1
Type 1 - Vertical Percolation Layer (Cover Soil)
CL - Clay Loam
Material Texture Number 11

Thickness	=	12 inches
Porosity	=	0.464 vol/vol
Field Capacity	=	0.31 vol/vol
Wilting Point	=	0.187 vol/vol
Initial Soil Water Content	=	0.3419 vol/vol
Effective Sat. Hyd. Conductivity	=	6.40E-05 cm/sec

Layer 2
Type 1 - Vertical Percolation Layer (Waste)
Municipal Solid Waste (MSW) (900 pcy)
Material Texture Number 18

Thickness	=	720 inches
Porosity	=	0.671 vol/vol
Field Capacity	=	0.292 vol/vol
Wilting Point	=	0.077 vol/vol
Initial Soil Water Content	=	0.2945 vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E-03 cm/sec

Layer 3
Type 1 - Vertical Percolation Layer
CL - Clay Loam
Material Texture Number 11

Thickness	=	24 inches
Porosity	=	0.464 vol/vol
Field Capacity	=	0.31 vol/vol
Wilting Point	=	0.187 vol/vol
Initial Soil Water Content	=	0.3431 vol/vol
Effective Sat. Hyd. Conductivity	=	6.40E-05 cm/sec

Layer 4
Type 2 - Lateral Drainage Layer
Custom Geonet 2
Material Texture Number 44

Thickness	=	0.19 inches
Porosity	=	0.85 vol/vol
Field Capacity	=	0.01 vol/vol
Wilting Point	=	0.005 vol/vol
Initial Soil Water Content	=	0.0555 vol/vol
Effective Sat. Hyd. Conductivity	=	5.00E+00 cm/sec
Slope	=	2.8 %
Drainage Length	=	325 ft

Layer 5

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	=	1 Holes/Acre
FML Installation Defects	=	4 Holes/Acre
FML Placement Quality	=	3 Good

Layer 6

Type 3 - Barrier Soil Liner

GCL

Material Texture Number 45

Thickness	=	0.24 inches
Porosity	=	0.75 vol/vol
Field Capacity	=	0.747 vol/vol
Wilting Point	=	0.4 vol/vol
Initial Soil Water Content	=	0.75 vol/vol
Effective Sat. Hyd. Conductivity	=	5.00E-09 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	=	85
Fraction of Area Allowing Runoff	=	100 %
Area projected on a horizontal plane	=	1 acres
Evaporative Zone Depth	=	12 inches
Initial Water in Evaporative Zone	=	4.103 inches
Upper Limit of Evaporative Storage	=	5.568 inches
Lower Limit of Evaporative Storage	=	2.244 inches
Initial Snow Water	=	0 inches
Initial Water in Layer Materials	=	224.559 inches
Total Initial Water	=	224.559 inches

Total Subsurface Inflow	=	0 inches/year

Note: SCS Runoff Curve Number was User-Specified.

Evapotranspiration and Weather Data

Station Latitude	=	31.37 Degrees
Maximum Leaf Area Index	=	2
Start of Growing Season (Julian Date)	=	55 days
End of Growing Season (Julian Date)	=	336 days
Average Wind Speed	=	11.3 mph
Average 1st Quarter Relative Humidity	=	69 %
Average 2nd Quarter Relative Humidity	=	69 %
Average 3rd Quarter Relative Humidity	=	62 %
Average 4th Quarter Relative Humidity	=	69 %

Note: Evapotranspiration data was obtained for NACOGDOCHES, TEXAS

Normal Mean Monthly Precipitation (inches)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
4.45	3.17	3.53	3.13	5.29	4.18
2.6	3.08	4.08	4.13	4.54	4.44

Note: Precipitation was simulated using HELP v3.07 data files for the following location: HOUSTON, TEXAS

Normal Mean Monthly Temperature (Degrees Fahrenheit)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
51.4	54.5	61	68.7	74.9	80.6
83.1	82.6	78.4	69.7	60.1	54

Note: Temperature was simulated using HELP v3.07 data files for the following location: HOUSTON, TEXAS
Solar radiation was simulated using HELP v3.07 data files for the following location: HOUSTON, TEXAS (Latitude: 31.37)

Average Annual Totals Summary

Title: Interim, 60' Waste, 2.8% Slope, 325' Length w/ GCL
Simulated on: 12/1/2023 15:31

	Average Annual Totals for Years 1 - 30*			
	(inches)	[std dev]	(cubic feet)	(percent)
Precipitation	45.09	[6.73]	163,658.6	100.00
Runoff	3.516	[1.61]	12,763.0	7.80
Evapotranspiration	31.213	[2.692]	113,304.1	69.23
Subprofile1				
Lateral drainage collected from Layer 4	10.2139	[3.9156]	37,076.4	22.65
Percolation/leakage through Layer 6	0.000004	[0.000001]	0.0137	0.00
Average Head on Top of Layer 5	0.0115	[0.0044]	---	---
Water storage				
Change in water storage	0.1419	[3.4512]	515.1	0.31

* Note: Average inches are converted to volume based on the user-specified area.

Peak Values Summary

Title: Interim, 60' Waste, 2.8% Slope, 325' Length w/ GCL
Simulated on: 12/1/2023 15:31

	Peak Values for Years 1 - 30*	
	(inches)	(cubic feet)
Precipitation	4.62	16,770.6
Runoff	2.340	8,495.8
Subprofile1		
Drainage collected from Layer 4	0.1943	705.2
Percolation/leakage through Layer 6	0.000000	0.0001
Average head on Layer 5	0.0796	---
Maximum head on Layer 5	0.1579	---
Location of maximum head in Layer 4	2.37 (feet from drain)	
Other Parameters		
Snow water	0.7003	2,542.1
Maximum vegetation soil water	0.4516 (vol/vol)	
Minimum vegetation soil water	0.1870 (vol/vol)	

Final Water Storage in Landfill Profile at End of Simulation Period

Title: Interim, 60' Waste, 2.8% Slope, 325' Length w/ GCL
Simulated on: 12/1/2023 15:31
Simulation period: 30 years

	Final Water Storage	
Layer	(inches)	(vol/vol)
1	3.7279	0.3107
2	215.5460	0.2994
3	9.3178	0.3882
4	0.0437	0.2299
5	0.0000	0.0000
6	0.1800	0.7500
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: Closed, 2.8% Slope, 325' Lengt... **Simulated On:** 12/1/2023 15:45

Layer 1
Type 1 - Vertical Percolation Layer (Cover Soil)
CL - Clay Loam
Material Texture Number 11

Thickness	=	6 inches
Porosity	=	0.464 vol/vol
Field Capacity	=	0.31 vol/vol
Wilting Point	=	0.187 vol/vol
Initial Soil Water Content	=	0.4536 vol/vol
Effective Sat. Hyd. Conductivity	=	6.40E-05 cm/sec

Layer 2
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	=	1 Holes/Acre
FML Installation Defects	=	4 Holes/Acre
FML Placement Quality	=	3 Good

Layer 3
Type 1 - Vertical Percolation Layer
Custom Soil 1
Material Texture Number 43

Thickness	=	18 inches
Porosity	=	0.427 vol/vol
Field Capacity	=	0.418 vol/vol
Wilting Point	=	0.367 vol/vol
Initial Soil Water Content	=	0.4094 vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E-05 cm/sec

Layer 4
Type 1 - Vertical Percolation Layer
CL - Clay Loam
Material Texture Number 11

Thickness	=	6 inches

Porosity	=	0.464 vol/vol
Field Capacity	=	0.31 vol/vol
Wilting Point	=	0.187 vol/vol
Initial Soil Water Content	=	0.31 vol/vol
Effective Sat. Hyd. Conductivity	=	6.40E-05 cm/sec

Layer 5

Type 1 - Vertical Percolation Layer (Waste)
Municipal Solid Waste (MSW) (900 pcy)
Material Texture Number 18

Thickness	=	720 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 6

Type 1 - Vertical Percolation Layer
CL - Clay Loam
Material Texture Number 11

Thickness	=	24 inches
Porosity	=	0.464 vol/vol
Field Capacity	=	0.31 vol/vol
Wilting Point	=	0.187 vol/vol
Initial Soil Water Content	=	0.31 vol/vol
Effective Sat. Hyd. Conductivity	=	6.40E-05 cm/sec

Layer 7

Type 2 - Lateral Drainage Layer
Custom Geonet 1
Material Texture Number 123

Thickness	=	0.19 inches
Porosity	=	0.85 vol/vol
Field Capacity	=	0.01 vol/vol
Wilting Point	=	0.005 vol/vol
Initial Soil Water Content	=	0.0107 vol/vol
Effective Sat. Hyd. Conductivity	=	5.00E+00 cm/sec
Slope	=	2.8 %
Drainage Length	=	325 ft

Layer 8

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	=	1 Holes/Acre
FML Installation Defects	=	4 Holes/Acre
FML Placement Quality	=	3 Good

Layer 9

Type 3 - Barrier Soil Liner

Custom Soil 2

Material Texture Number 44

Thickness	=	0.24 inches
Porosity	=	0.75 vol/vol
Field Capacity	=	0.747 vol/vol
Wilting Point	=	0.4 vol/vol
Initial Soil Water Content	=	0.75 vol/vol
Effective Sat. Hyd. Conductivity	=	5.00E-09 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	=	85
Fraction of Area Allowing Runoff	=	100 %
Area projected on a horizontal plane	=	1 acres
Evaporative Zone Depth	=	6 inches
Initial Water in Evaporative Zone	=	2.721 inches
Upper Limit of Evaporative Storage	=	2.784 inches
Lower Limit of Evaporative Storage	=	1.122 inches
Initial Snow Water	=	0 inches
Initial Water in Layer Materials	=	229.812 inches
Total Initial Water	=	229.812 inches
Total Subsurface Inflow	=	0 inches/year

Note: SCS Runoff Curve Number was User-Specified.

Evapotranspiration and Weather Data

Station Latitude	=	31.37 Degrees
Maximum Leaf Area Index	=	3.5
Start of Growing Season (Julian Date)	=	55 days
End of Growing Season (Julian Date)	=	336 days
Average Wind Speed	=	11.3 mph
Average 1st Quarter Relative Humidity	=	69 %
Average 2nd Quarter Relative Humidity	=	69 %

Average 3rd Quarter Relative Humidity	=	62 %
Average 4th Quarter Relative Humidity	=	69 %

Note: Evapotranspiration data was obtained for NACOGDOCHES, TEXAS

Normal Mean Monthly Precipitation (inches)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
4.45	3.17	3.53	3.13	5.29	4.18
2.6	3.08	4.08	4.13	4.54	4.44

Note: Precipitation was simulated using HELP v3.07 data files for the following location: HOUSTON, TEXAS

Normal Mean Monthly Temperature (Degrees Fahrenheit)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
51.4	54.5	61	68.7	74.9	80.6
83.1	82.6	78.4	69.7	60.1	54

Note: Temperature was simulated using HELP v3.07 data files for the following location: HOUSTON, TEXAS
Solar radiation was simulated using HELP v3.07 data files for the following location: HOUSTON, TEXAS (Latitude: 31.37)

Average Annual Totals Summary

Title: Closed, 2.8% Slope, 325' Length w/ GCL
Simulated on: 12/1/2023 15:46

	Average Annual Totals for Years 1 - 30*			
	(inches)	[std dev]	(cubic feet)	(percent)
Precipitation	45.09	[6.73]	163,658.6	100.00
Runoff	13.984	[5.121]	50,761.5	31.02
Evapotranspiration	31.053	[2.761]	112,722.7	68.88
Subprofile1				
Percolation/leakage through Layer 2	0.045954	[0.006734]	166.8	0.10
Average Head on Top of Layer 2	1.7634	[0.2677]	---	---
Subprofile2				
Lateral drainage collected from Layer 7	0.0460	[0.0067]	166.8	0.10
Percolation/leakage through Layer 9	0.000001	[0]	0.0050	0.00
Average Head on Top of Layer 8	0.0001	[0]	---	---
Water storage				
Change in water storage	0.0021	[0.568]	7.5756	0.00

* Note: Average inches are converted to volume based on the user-specified area.

Peak Values Summary

Title: Closed, 2.8% Slope, 325' Length w/ GCL
Simulated on: 12/1/2023 15:46

	Peak Values for Years 1 - 30*	
	(inches)	(cubic feet)
Precipitation	4.62	16,770.6
Runoff	4.085	14,827.1
Subprofile1		
Percolation/leakage through Layer 2	0.000415	1.5059
Average head on Layer 2	6.0000	
Subprofile2		
Drainage collected from Layer 7	0.0004	1.4978
Percolation/leakage through Layer 9	0.000000	0.0000
Average head on Layer 8	0.0002	---
Maximum head on Layer 8	0.0003	---
Location of maximum head in Layer 7	0.00 (feet from drain)	
Other Parameters		
Snow water	0.7003	2,542.1
Maximum vegetation soil water	0.4640 (vol/vol)	
Minimum vegetation soil water	0.1870 (vol/vol)	

Final Water Storage in Landfill Profile at End of Simulation Period

Title: Closed, 2.8% Slope, 325' Length w/ GCL
Simulated on: 12/1/2023 15:46
Simulation period: 30 years

	Final Water Storage	
Layer	(inches)	(vol/vol)
1	2.7840	0.4640
2	0.0000	0.0000
3	7.3688	0.4094
4	1.8600	0.3100
5	210.2400	0.2920
6	7.4400	0.3100
7	0.0020	0.0104
8	0.0000	0.0000
9	0.1800	0.7500
Snow water	0.0000	---

CITY OF NACOGDOCHES LANDFILL
NACOGDOCHES COUNTY, TEXAS
TCEQ PERMIT NO. MSW 720

SITE DEVELOPMENT PLAN PART III

ATTACHMENT 12
FINAL CLOSURE PLAN

Prepared for:

City of Nacogdoches
P.O.Box 635030
Nacogdoches, Texas 75963

Prepared by:

CAS Engineering Services, Inc.
December 4, 2006

Revised by:

SCS ENGINEERS
TEXAS REGISTRATION NUMBER F-3407
Revision 1, December 2014
Revision 2, September 2019
Revision 3, January 2024
Revision 4, May 2024

5/7/24

STATE OF TEXAS
JEFFREY K. REED
80103
LICENSED
PROFESSIONAL ENGINEER

FOR PERMITTING
PURPOSES ONLY

CITY OF NACOGDOCHES LANDFILL
NACOGDOCHES COUNTY, TEXAS

PART III, SITE DEVELOPMENT PLAN
ATTACHMENT 12, APPENDIX C

LINER AND FINAL COVER STABILITY ANALYSIS

Prepared for:

Nacogdoches
the oldest town in Texas

CITY OF NACOGDOCHES
P.O. Box 635030
Nacogdoches, Texas 75963
(936) 559-2502

Prepared By:

SCS ENGINEERS
TBPE Registration No. F-3407
12651 Briar Forest Drive, Suite 205
Houston, Texas 77077
281-293-8494

5/7/24

STATE OF TEXAS
JEFFREY K. REED
80103
LICENSED
PROFESSIONAL ENGINEER

Revision 0 – June 2011
Revision 1 – July 2013
Revision 2 – September 2019/January 2020
Revision 3 – January 2024
Revision 4 – May 2024
SCS Project No. 16209006.26

Table of Contents

SCS Engineers
TBPE Reg. # F-3407

5/7/24

STATE OF TEXAS
JEFFREY K. REED
80103
LICENSED
PROFESSIONAL ENGINEER

APPENDIX C-1
WASTE SLOPE STABILITY CALCULATIONS AND RESULTS

SCS Engineers
TBPE Reg. # F-3407

5/7/24

STATE OF TEXAS
JEFFREY K. REED
80103
LICENSED
PROFESSIONAL ENGINEER

inclusive of pgs.
C-1-1 to C-1-98.

SCS Engineers	WASTE SLOPE STABILITY-GM/CCL		
	Proj. No. 16209006.26	Made By: JKR	Date: 6/16/2011 rev 12/23
	Project: City of Nacogdoches Landfill	Checked By: JRM	Sheet 1 of 2

OBJECTIVE: Estimate the factor of safety against sliding for interior and exterior waste slopes.

GIVEN: Based on a review of the designed grades, the following worst-case conditions were identified:

Floor Grade	2.0% - 5%	
Maximum Interior Waste Slopes	33.0%	18.4 degrees
Maximum Waste Height		57.5 feet (Block O), 77 feet (Block P)
Liner System Evaluated (from top to bottom):	24" Protective Cover consisting of on-site soils Geocomposite Drainage Layer 60-mil HDPE Geomembrane 24" Compacted Clay Liner (CCL) [Block P and Block O, Cell 1 and 2 liner system. Alternate Liner for Block O, Cells 3-6]	

Based on a review of available data, the following parameters were assigned to the referenced materials.

Material	Strength Parameters		Unit Weight (pcf)		Reference
	Φ (deg)	**C (psf)**	**moist**	**saturated**	
Waste	33	500	65	75	Eid, et al. (2000)
Protective Cover	20	200	100	115	Est. for clay
Protective Cover/Geocomposite Interface	26	0	---	---	*
SS Geocomposite/Smooth Geomembrane Interface	8	0	---	---	*
DS Geocomposite/Textured Geomembrane Interface	28	0	---	---	*
Smooth Geomembrane/ CCL Interface	11	300	---	---	**
Textured Geomembrane/ CCL Interface	20	50	---	---	*
CCL/Subgrade Interface	20	200	100	115	Est. for clay

Notes:

* Unpublished testing data by Golder Associates, Inc. (attached)

** Based on shear strength parameters, the critical interface will be the SS geocomposite (geonet side) and smooth geomembrane.

METHOD: PCStabl5M3, Purdue University, 1985
Analyze the critical condition for block and circular failure surfaces.

RESULTS: See Tables 1 and 2, Appendix C-1

CONCLUSIONS: Using the estimated strength parameters and worst-case slopes, the analysis indicates that the interim and final waste slopes will remain stable under the configurations presented in Tables 1 and 2 for a FML/CCL liner.

SCS Engineers	WASTE SLOPE STABILITY-GM/GCL		
	Proj. No. 16209006.26	Made By: JKR	Date: 7/15/13 rev 12/23
	Project: City of Nacogdoches Landfill	Checked By: JRM	Sheet 2 of 2

OBJECTIVE: Estimate the factor of safety against sliding for interior and exterior waste slopes.

GIVEN: Based on a review of the designed grades, the following worst-case conditions were identified:

Floor Grade	2.0% - 5%	
Maximum Interior Waste Slopes	33.0%	18.4 degrees
Maximum Waste Height		57.5 feet (Block O)
Liner System Evaluated (from top to bottom):	24" Protective Cover consisting of on-site soils Geocomposite Drainage Layer 60-mil HDPE Geomembrane Reinforced Geosynthetic Clay Liner (GCL) [Alternate Block O, Cells 3-6 Liner system]	

Based on a review of available data, the following parameters were assigned to the referenced materials.

Material	Strength Parameters		Unit Weight (pcf)		Reference
	Φ (deg)	C (psf)	moist	saturated	
Waste	33	500	65	75	Eid, et al. (2000)
Protective Cover	20	200	100	115	Est. for clay
Protective Cover/Geocomposite Interface	26	0	---	---	*
SS Geocomposite/Smooth Geomembrane Interface	8	0	---	---	*
DS Geocomposite/Textured Geomembrane Interface	28	0	---	---	*
Smooth Geomembrane/ GCL Interface	10	60	---	---	**
Textured Geomembrane/ GCL Interface	20	140	---	---	**
GCL/Subgrade Interface	24	140	---	---	**

Notes:

* Unpublished testing data by Golder Associates, Inc. (attached)

** Direct shear testing data by CETCO Lining Technologies Group. (attached)

** Based on shear strength parameters, the critical interface will be the SS geocomposite (geonet side) and smooth geomembrane.

METHOD: PCStabl5M3, Purdue University, 1985
Analyze the critical condition for block and circular failure surfaces.

RESULTS: See Tables 1 and 2, Appendix C-1

CONCLUSIONS: Using the estimated strength parameters and worst-case slopes, and given the worst case friction interface remains unchanged for either a FML/CCL or a FML/GCL liner, the analysis indicates that the interim and final waste slopes will remain stable under the configurations presented in Tables 1 and 2 for a FML/GCL liner.

Table 1.
Waste Interim Slope Stability Analysis

Scenario	Section	File name	Failure Mode	Loading Condition	Factor of Safety
1 Single-sided GC, FML-Smooth on base floor, FML-Tex on sideslope	Section CC': 3:1 slope with no benches; waste height 46.2'	CCS2310	Circle	Static	2.95
		CBS2310	Block		2.73
2 Single-sided GC, FML-Smooth on base floor, FML-Tex on sideslope	Section CC': 3:1 slope with no benches; waste height 46.2'	CCE2320	Circle	Seismic = 0.04g	2.54
		CBE2320	Block		2.34
3 Single-sided GC, FML-Smooth on base floor, FML-Tex on sideslope	Section CC': 4:1 slope with no benches; waste height 46.2	CCS2330	Circle	Static	3.54
		CBS2330	Block		3.36
4 Single-sided GC, FML-Smooth on base floor, FML-Tex on sideslope	Section CC': 4:1 slope with no benches; waste height 46.2	CCE2340	Circle	Seismic = 0.04g	2.92
		CBE2340	Block		2.76

Table 2.
Mass Waste Final Slope Stability Analysis

Scenario	Section	File name	Failure Mode	Slope Modeled/Loading Condition	Factor of Safety
1 Single-sided GC, FML-Smooth on base floor, FML-Tex on sideslope	Section AA': 4:1 final slope with no benches; waste height 57.5'	ACS2310	Circle	Localized exterior waste slope / Static	3.68
		ABS2310	Block		3.35
2 Single-sided GC, FML-Smooth on base floor, FML-Tex on sideslope	Section AA': 4:1 final slope with no benches; waste height 57.5'	ACE2320	Circle	Localized exterior waste slope / Seismic = 0.04g	3.10
		ABE2320	Block		2.83
3 Single-sided GC, FML-Smooth on base floor, FML-Tex on sideslope	Section AA': 4:1 final slope with no benches; waste height 57.5'	ABS2330	Block	Global exterior waste slope / Static	13.39
		ABE2330	Block	Global exterior waste slope / Seismic = 0.04g	5.76
4 Single-sided GC, FML-Smooth on base floor, FML-Tex on sideslope	Section BB': 4:1 final slope with no benches; waste height 56.3'	BCS2340	Circle	Localized exterior waste slope / Static	4.74
		BBS2340	Block		3.79
5 Single-sided GC, FML-Smooth on base floor, FML-Tex on sideslope	Section BB': 4:1 final slope with no benches; waste height 56.3'	BCE2350	Circle	Localized exterior waste slope / Seismic = 0.04g	3.78
		BBE2350	Block		2.99
6 Single-sided GC, FML-Smooth on base floor, FML-Tex on sideslope	Section BB': 4:1 final slope with no benches; waste height 56.3'	BBS2360	Block	Global exterior waste slope / Static	9.43
		BBE2360	Block	Global exterior waste slope / Seismic = 0.04g	5.00

Scenario	Section	File name	Failure Mode	Slope Modeled/Loading Condition	Factor of Safety
7 Single-sided GC, FML-Smooth on base floor, FML-Tex on sideslope	Section DD': 4:1 final slope with no benches; waste height 77'	DCS100	Circle	Localized exterior waste slope / Static	3.85
		DBS100	Block		3.48
8 Single-sided GC, FML-Smooth on base floor, FML-Tex on sideslope	Section DD': 4:1 final slope with no benches; waste height 77'	DCE100	Circle	Localized exterior waste slope / Seismic = 0.04g	3.12
		DBE100	Block		2.82
9 Single-sided GC, FML-Smooth on base floor, FML-Tex on sideslope	Section DD': 4:1 final slope with no benches; waste height 77'	DBS200	Block	Global exterior waste slope / Static	3.93
		DBE200	Block	Global exterior waste slope / Seismic = 0.04g	3.02

Figure 1. Section Location Plan for Section AA' and CC'

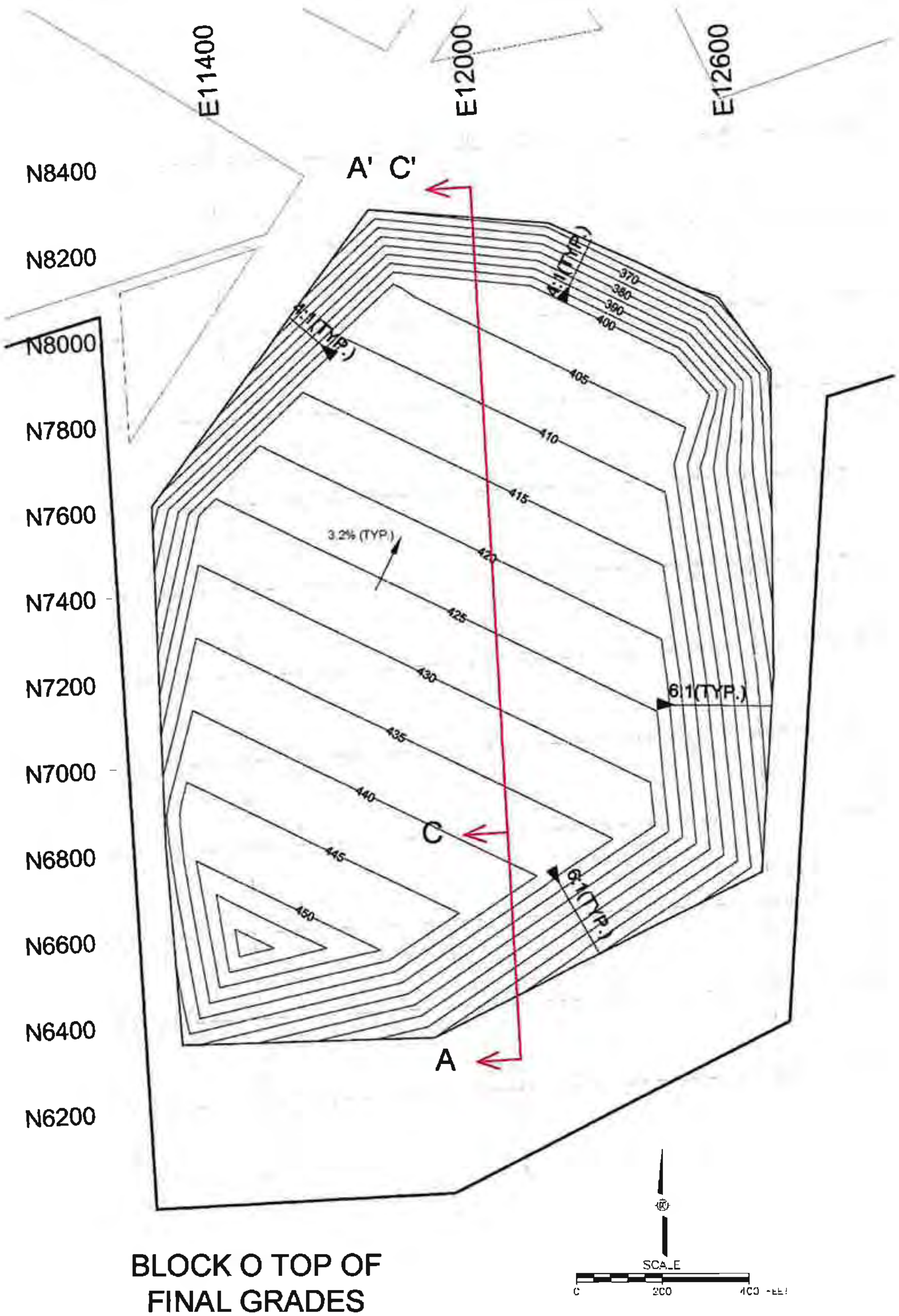


Figure 2. Section Profiles for Section AA' & CC'

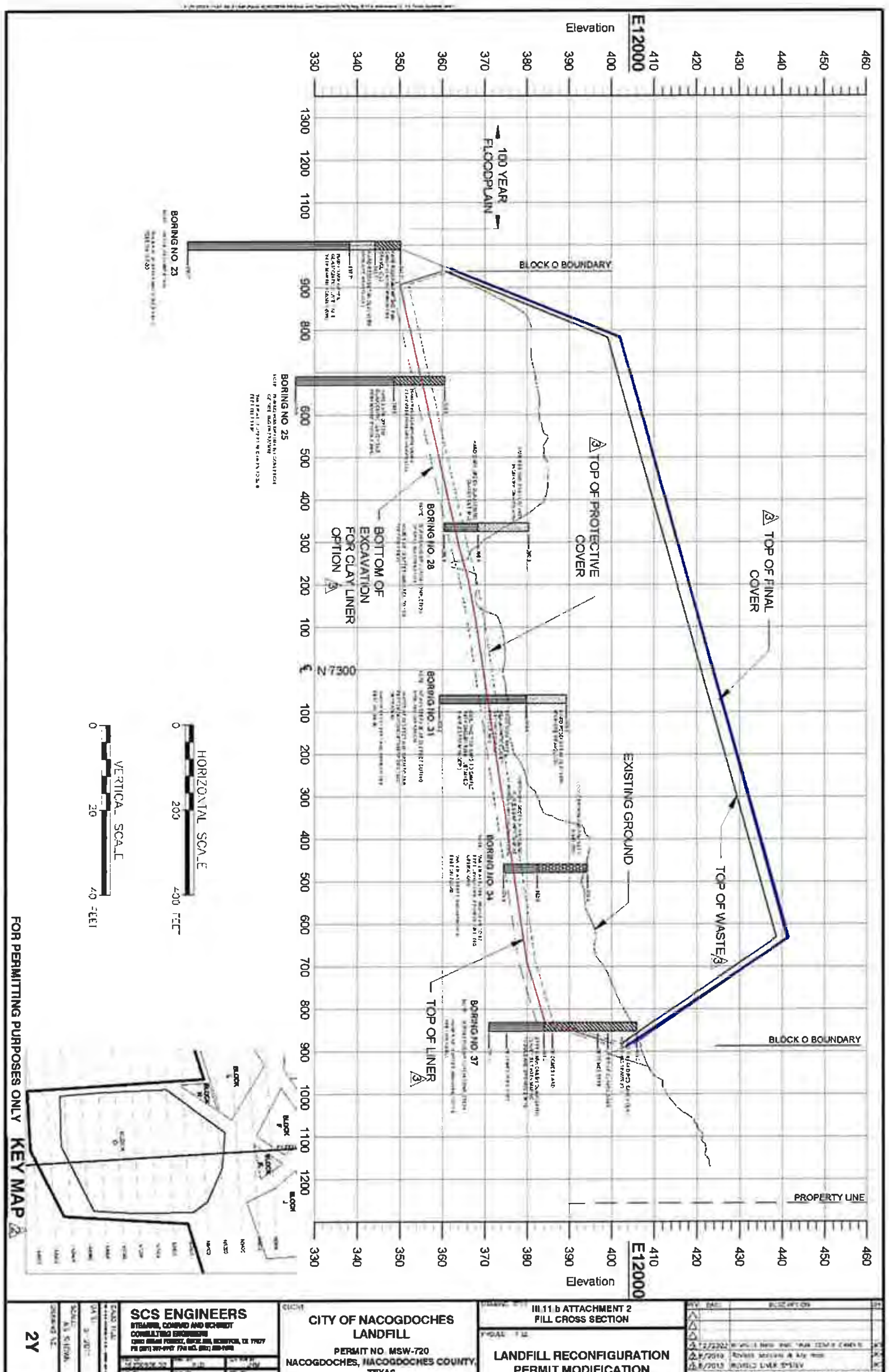


Figure 3. Section Location Plan (section AA' & BB')

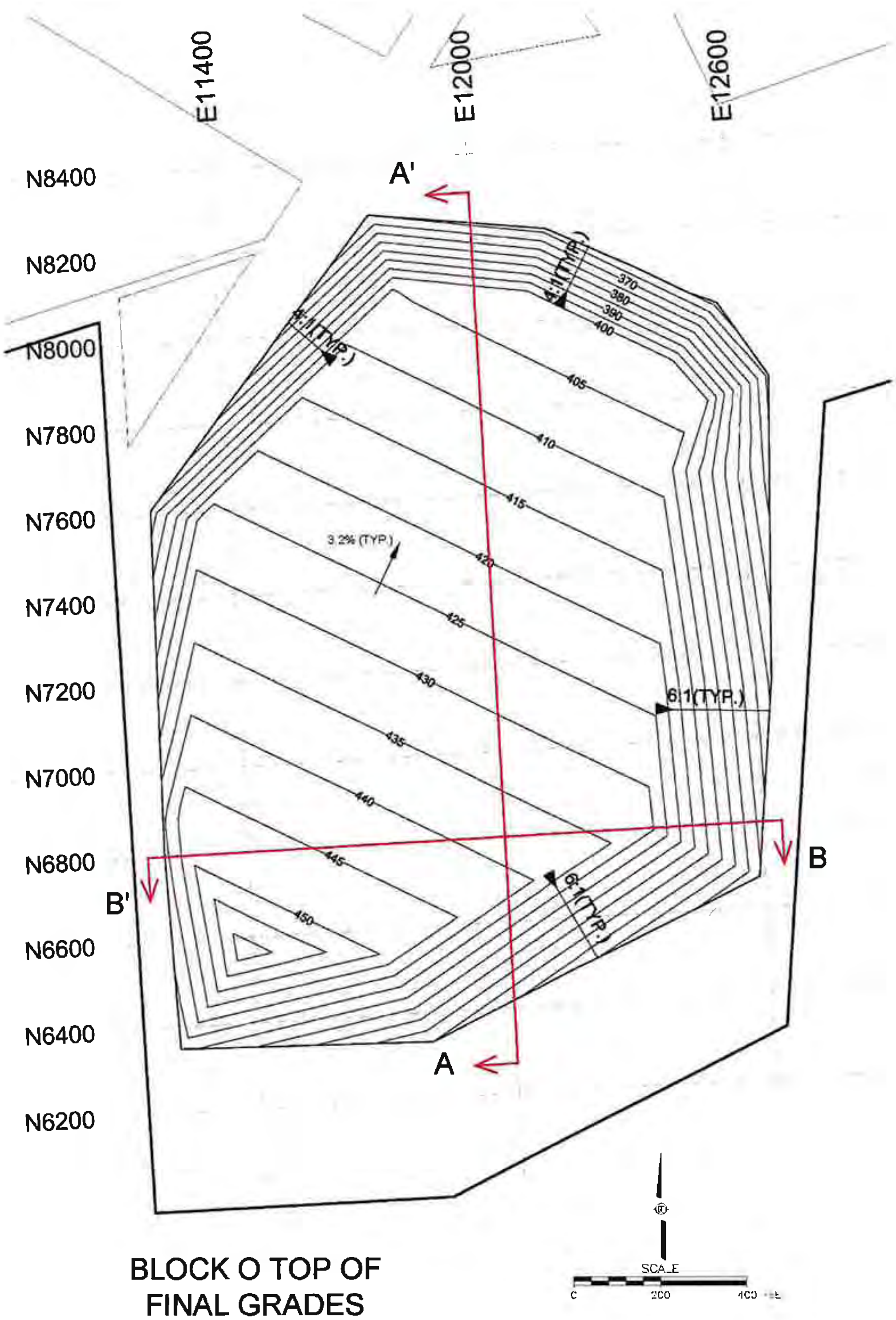
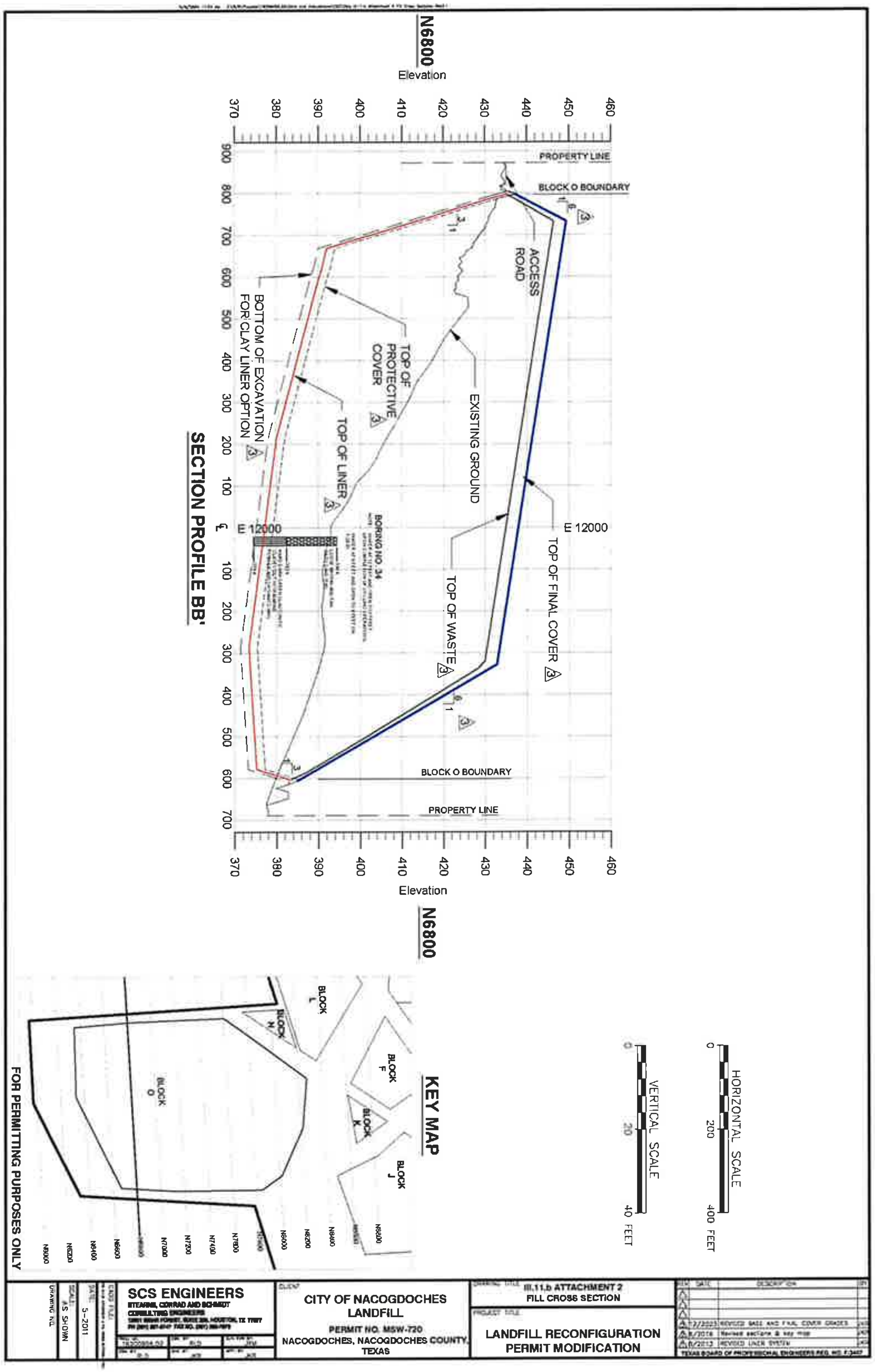
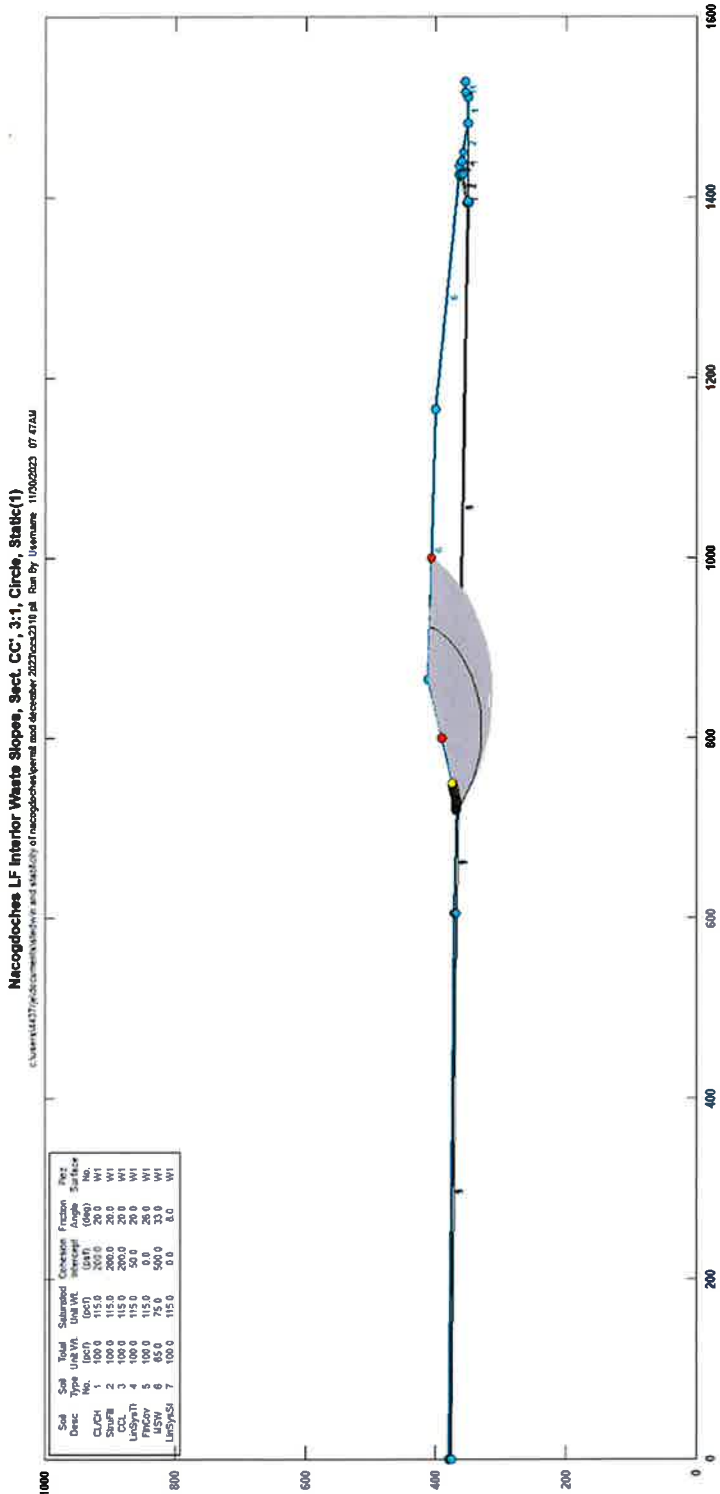
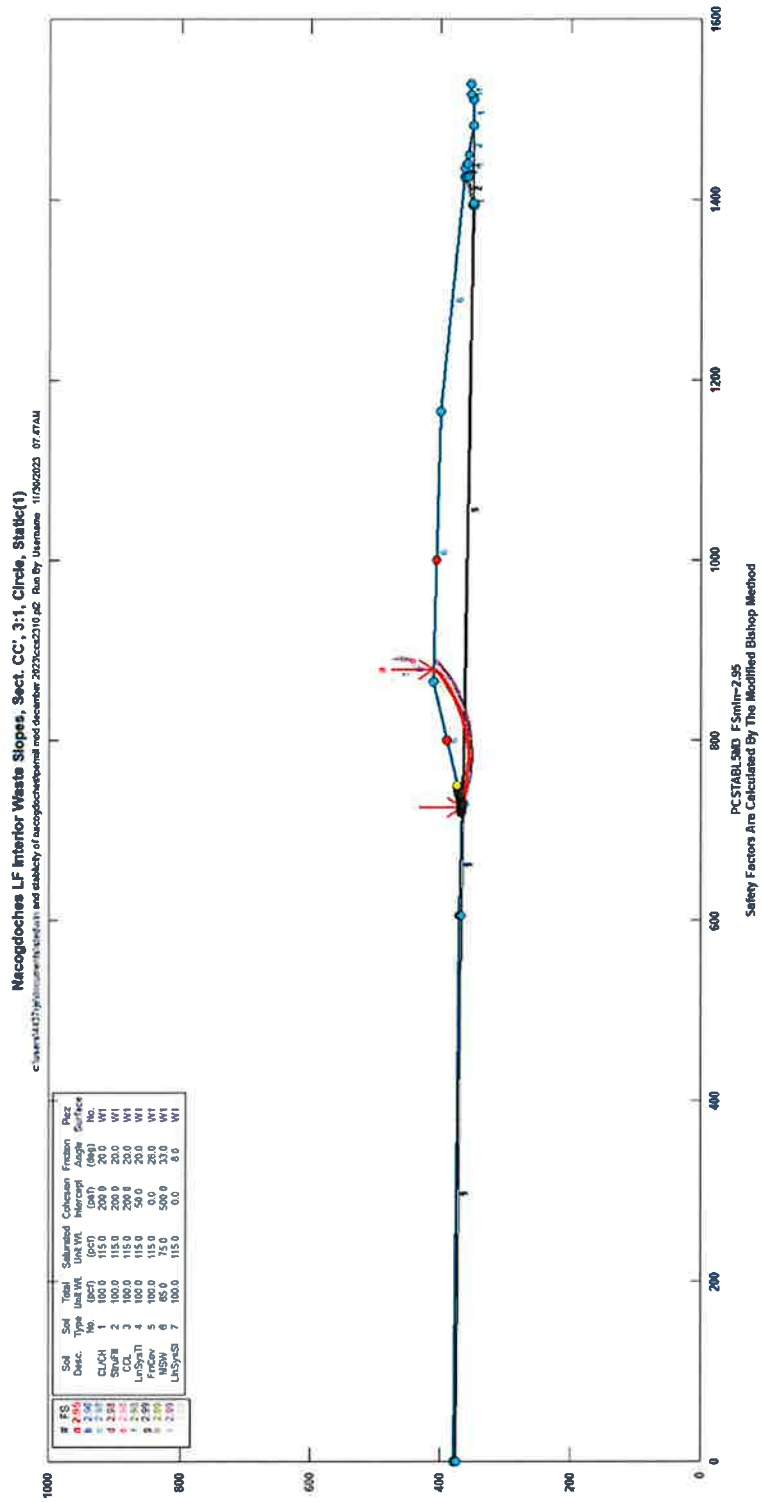


Figure 4. Section Profile BB'




Nacogdoches LF Interior Waste Slopes, Sect. CC', 3:1, Circle, Static(1)
Soil Desc | Soil Type No. | Total Unit Wt. (pcf) | Saturated Unit Wt. (pcf) | Cohesion Intercept (psf) | Friction Angle (deg) | Piez Surface No.
CL/CH 1 100.0 115.0 200.0 20.0 W1
StruFill 2 100.0 115.0 200.0 20.0 W1
CCL 3 100.0 115.0 200.0 20.0 W1
LinSysTi 4 100.0 115.0 50.0 20.0 W1
FinCov 5 100.0 115.0 0.0 28.0 W1
MSW 6 85.0 75.0 500.0 33.0 W1
LinSysSi 7 100.0 115.0 0.0 8.0 W1
0
200
400
600
800
1000
1200
1400
1600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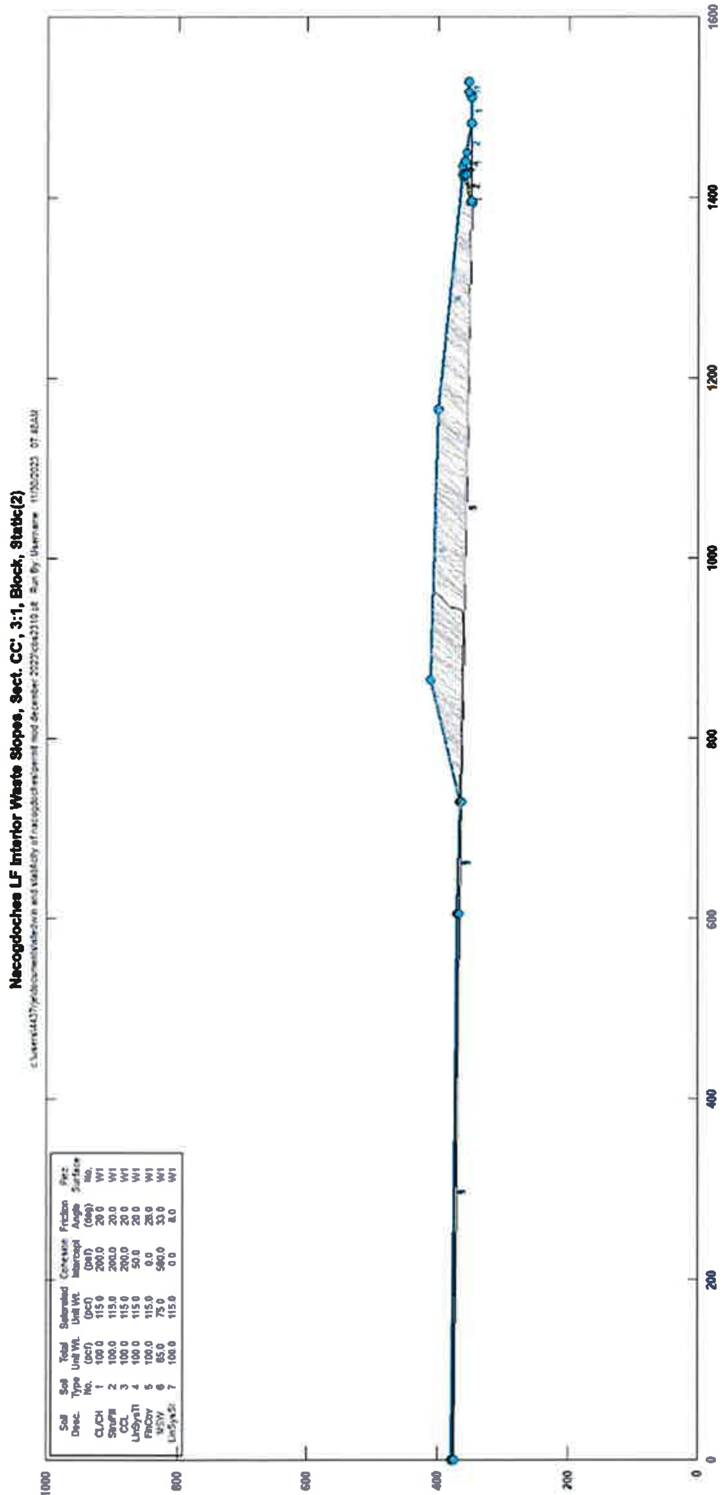
PCSTABL5M3 FSmin=2.95
Safety Factors Are Calculated By The Modified Bishop Method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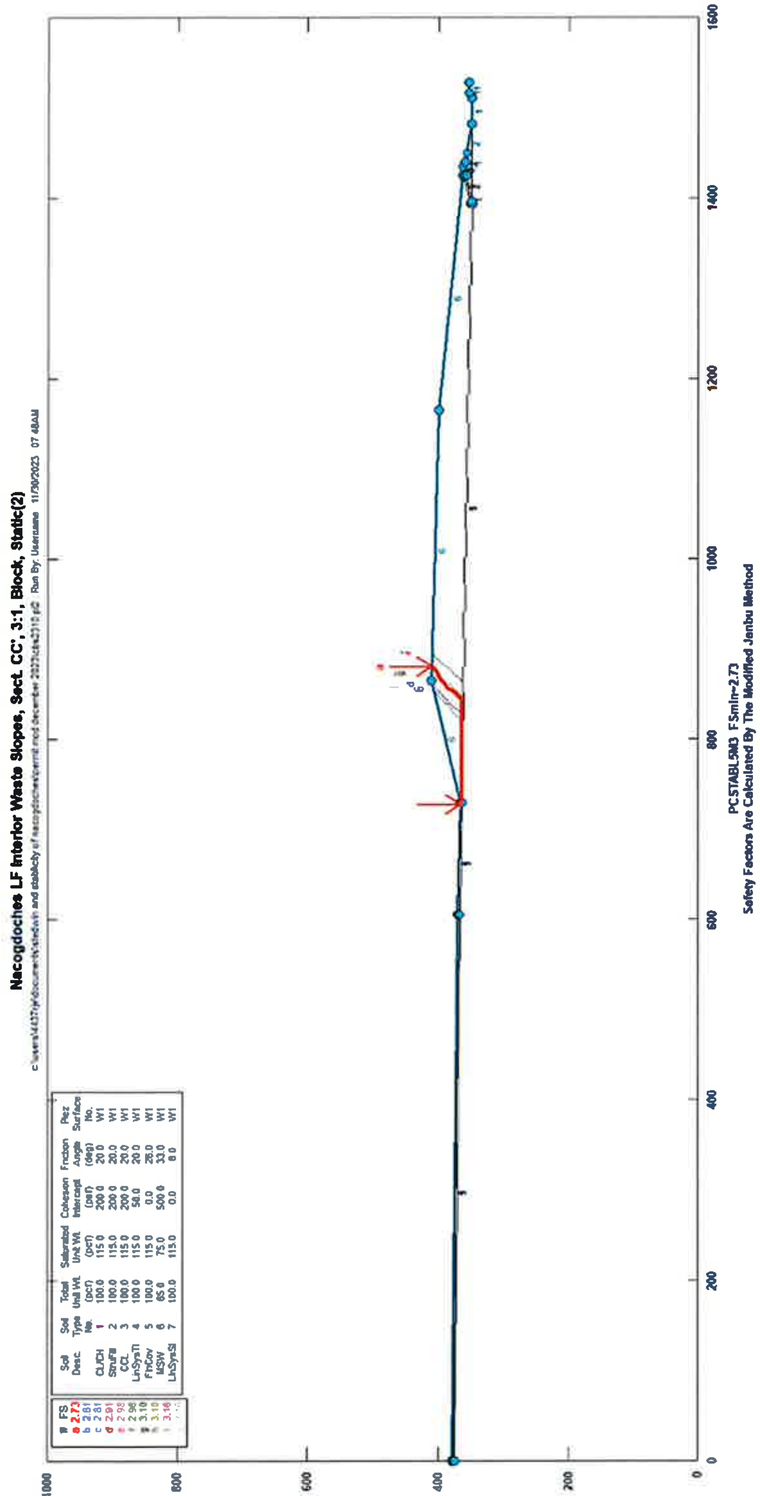
Soil Desc. | Soil Type No. | Total Unit Wt. (pcf) | Saturated Unit Wt. (pcf) | Cohesion Intercept (psf) | Friction Angle (deg) | Piez. Surface No.
CL/CH 1 100.0 115.0 200.0 20.0 W1
StrulFill 2 100.0 115.0 200.0 20.0 W1
CCL 3 100.0 115.0 200.0 20.0 W1
LinSysTI 4 100.0 115.0 50.0 20.0 W1
FinCov 5 100.0 115.0 0.0 28.0 W1
MSW 6 65.0 75.0 500.0 33.0 W1
LinSysSl 7 100.0 115.0 0.0 8.0 W1
0
200
400
600
800
1000
1200
1400
1600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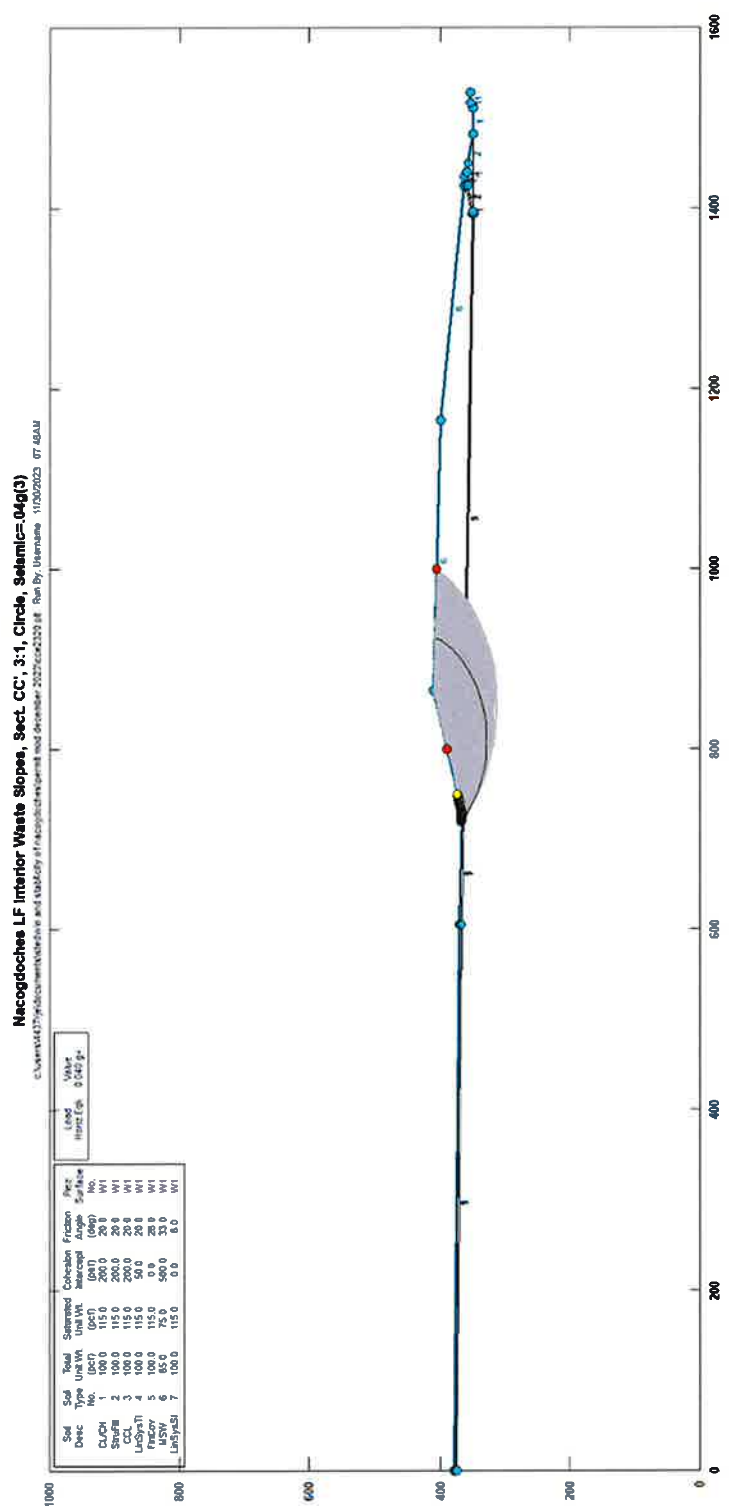
Safety Factors Are Calculated By The Modified Janbu Method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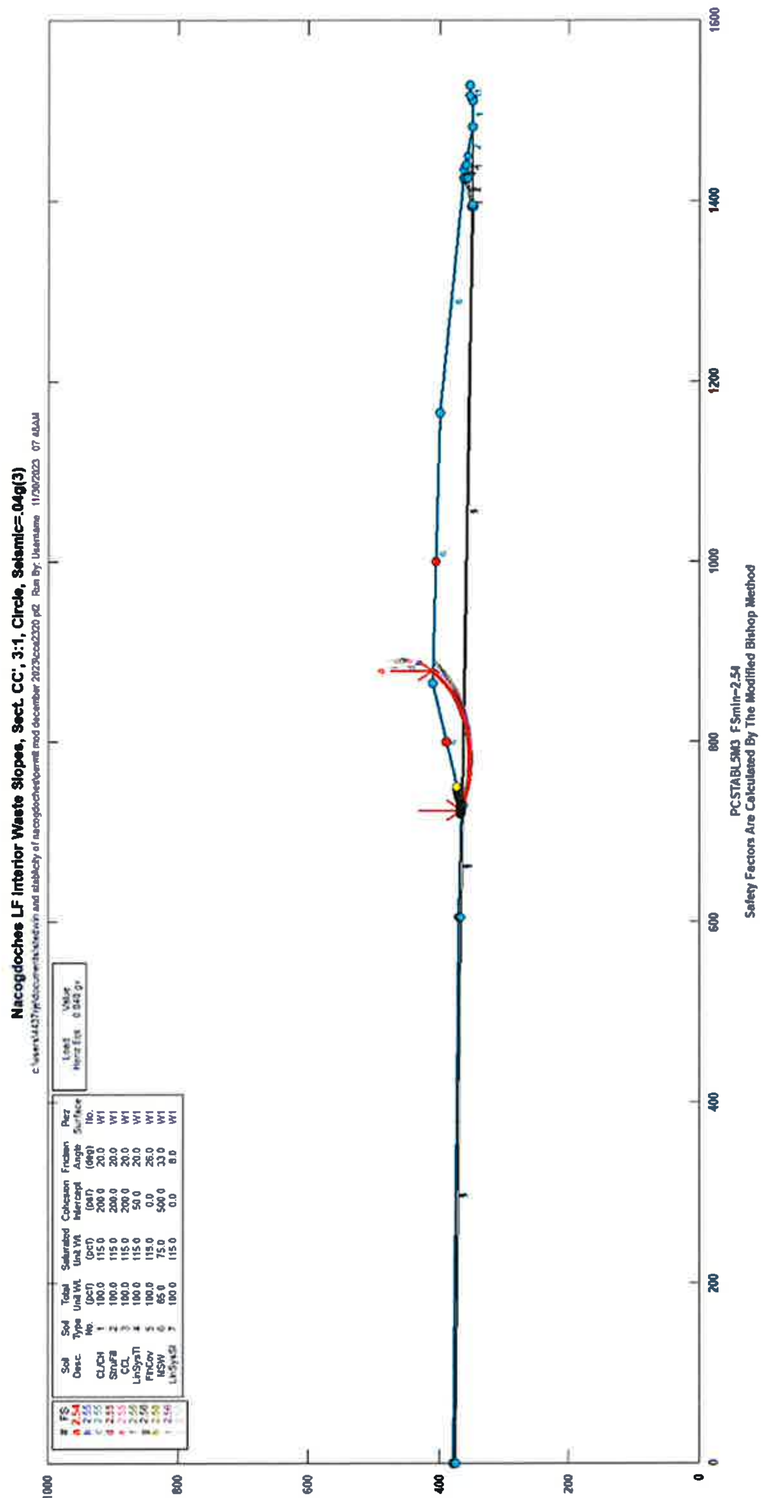
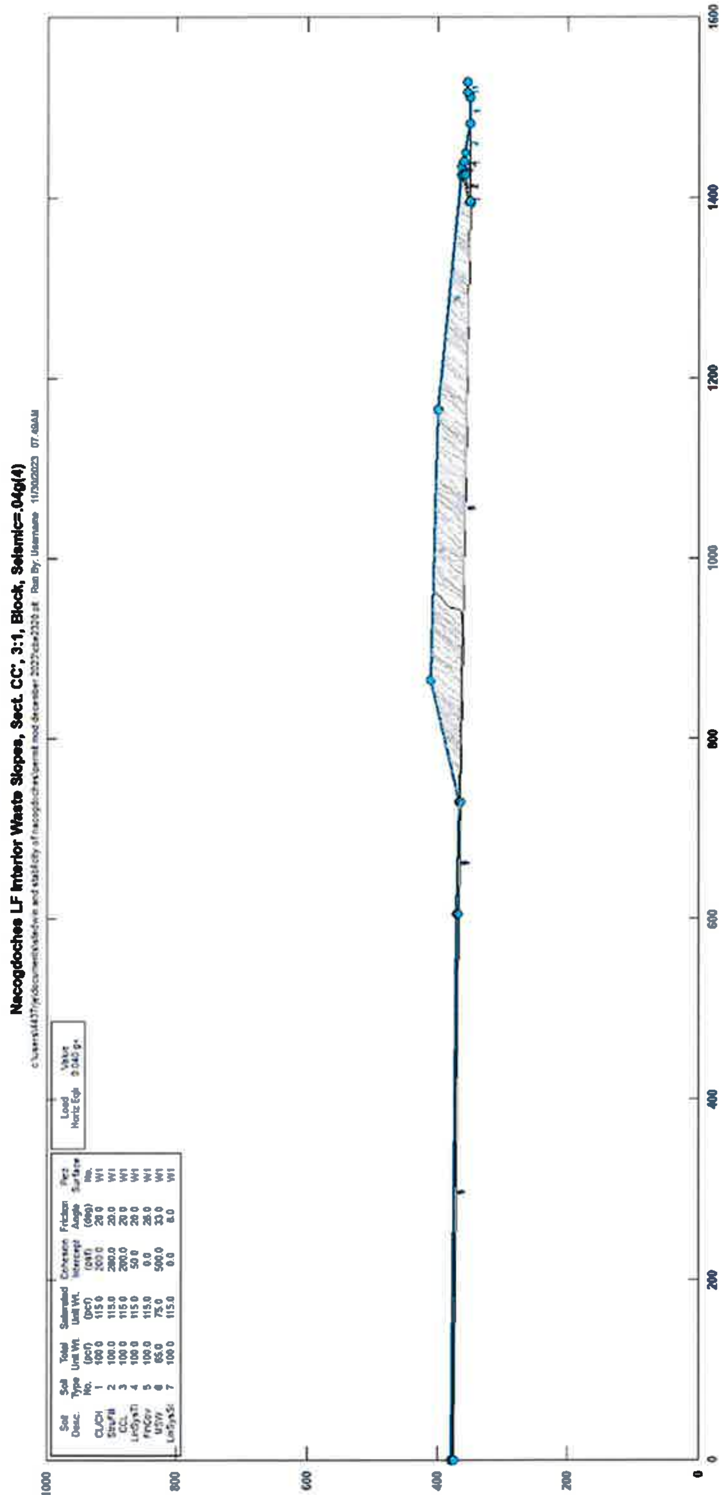

Nacogdoches LF Interior Waste Slopes, Sect. CC', 3:1, Circle, Seismic=.04g(3)
Load Value
Horiz Eqk 0.040 g
FS
a 2.54
Soil Desc. | Soil Type No. | Total Unit Wt. (pcf) | Saturated Unit Wt. (pcf) | Cohesion Intercept (psf) | Friction Angle (deg) | Piez Surface No.
CL/CH 1 100.0 115.0 200.0 20.0 W1
StruFill 2 100.0 115.0 200.0 20.0 W1
CCL 3 100.0 115.0 200.0 20.0 W1
LinSysTl 4 100.0 115.0 50.0 20.0 W1
FinCov 5 100.0 119.0 0.0 26.0 W1
MSW 6 65.0 75.0 500.0 33.0 W1
LinSysSl 7 100.0 115.0 0.0 8.0 W1
0
200
400
600
800
1000
1200
1400
1600
PCSTABL5M3 FSmin=2.54
Safety Factors Are Calculated By The Modified Bishop Method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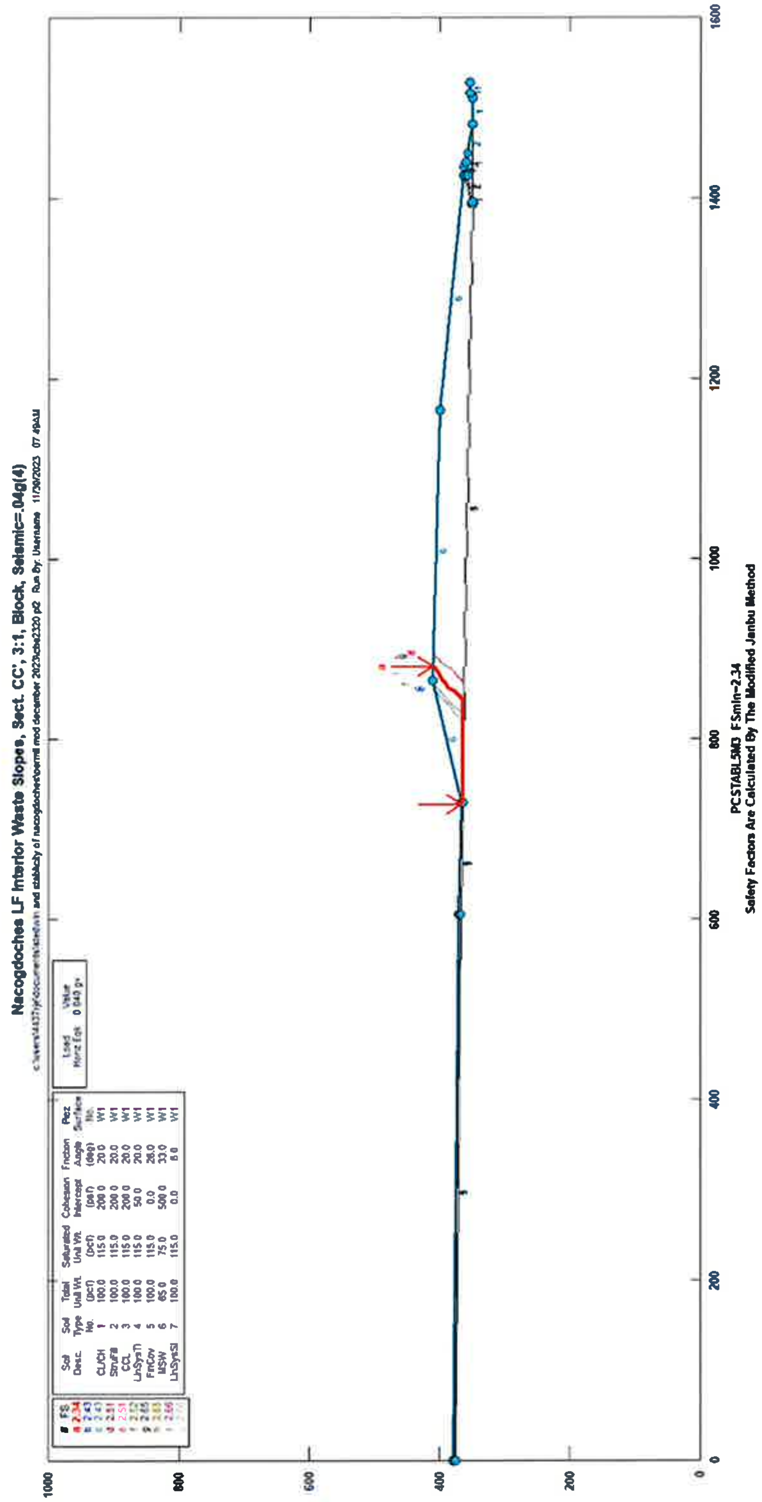
0
200
400
600
800
1000
1200
1400
1600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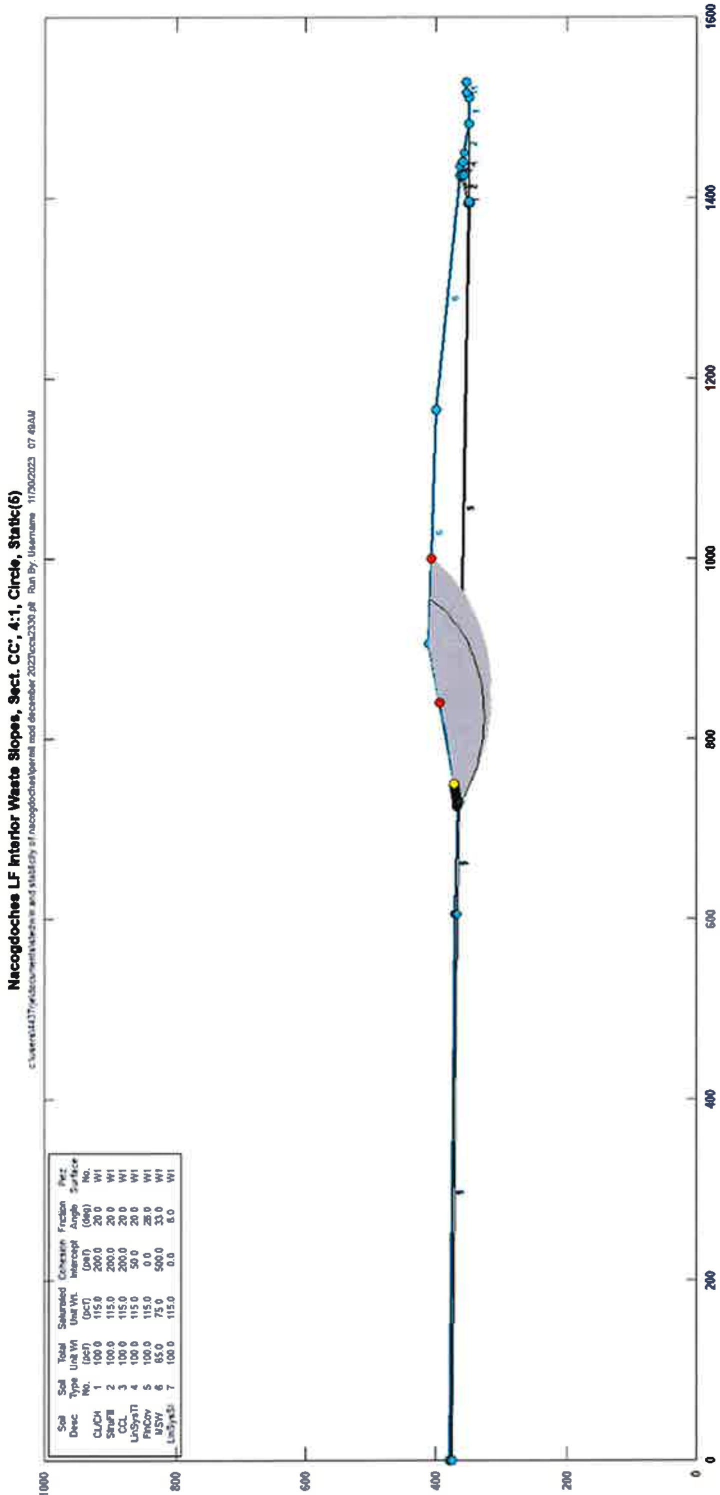
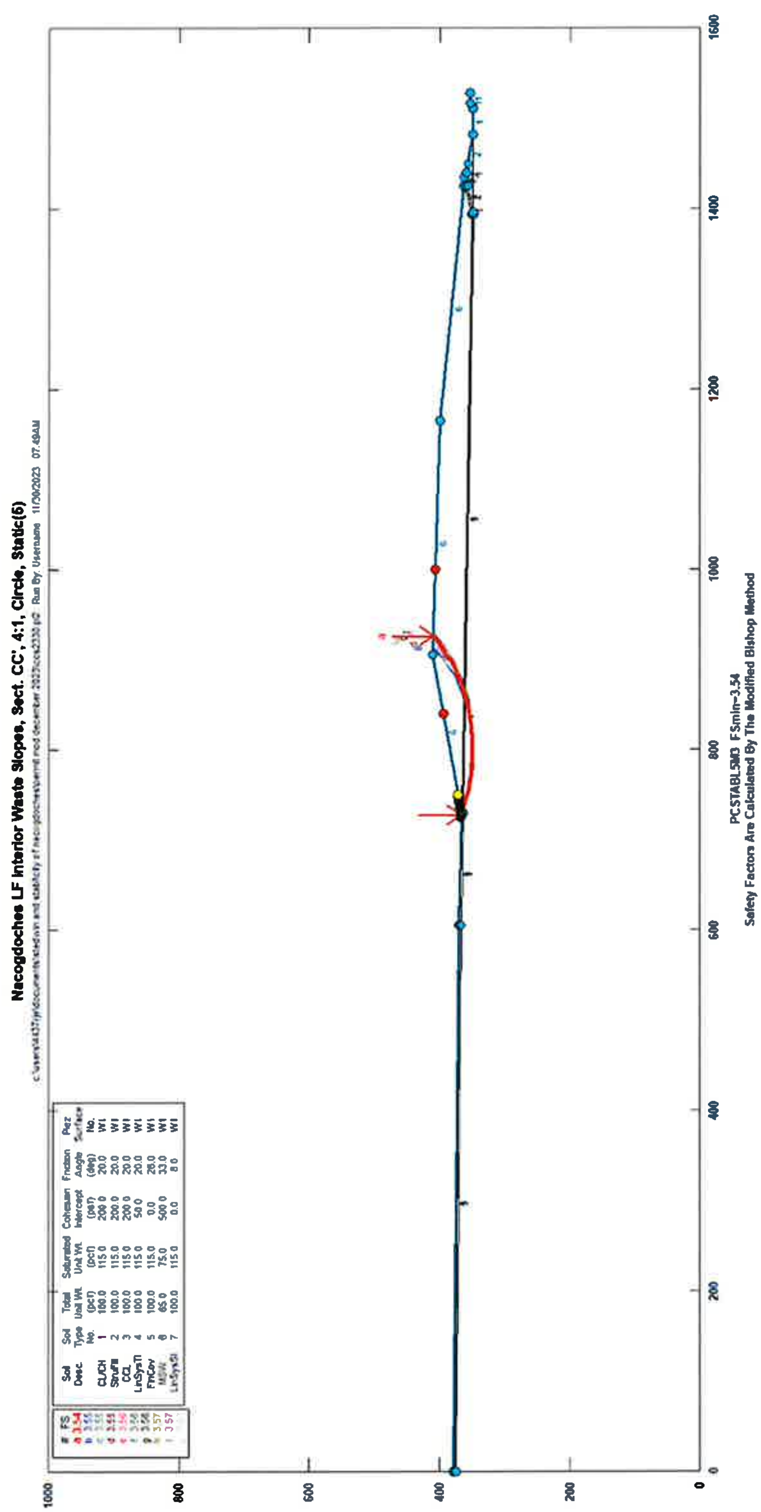
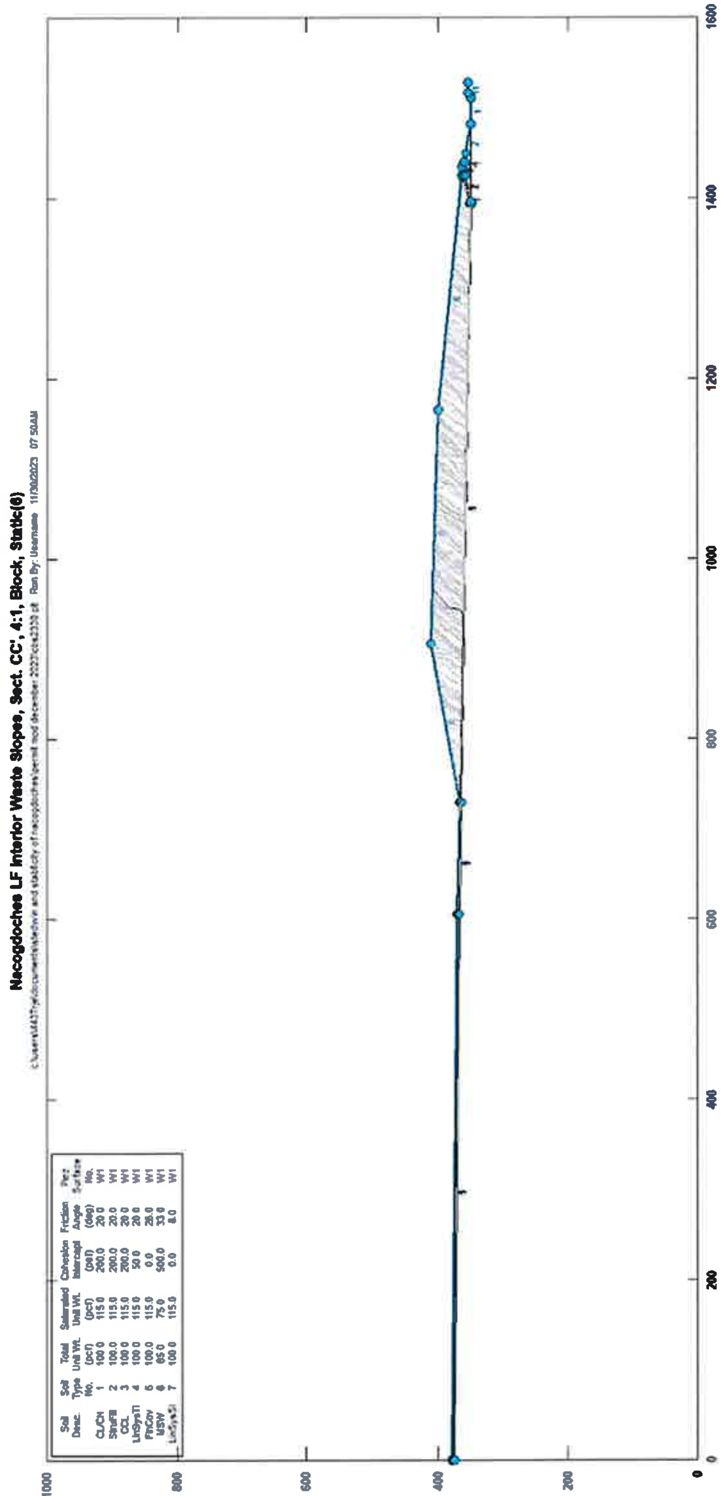
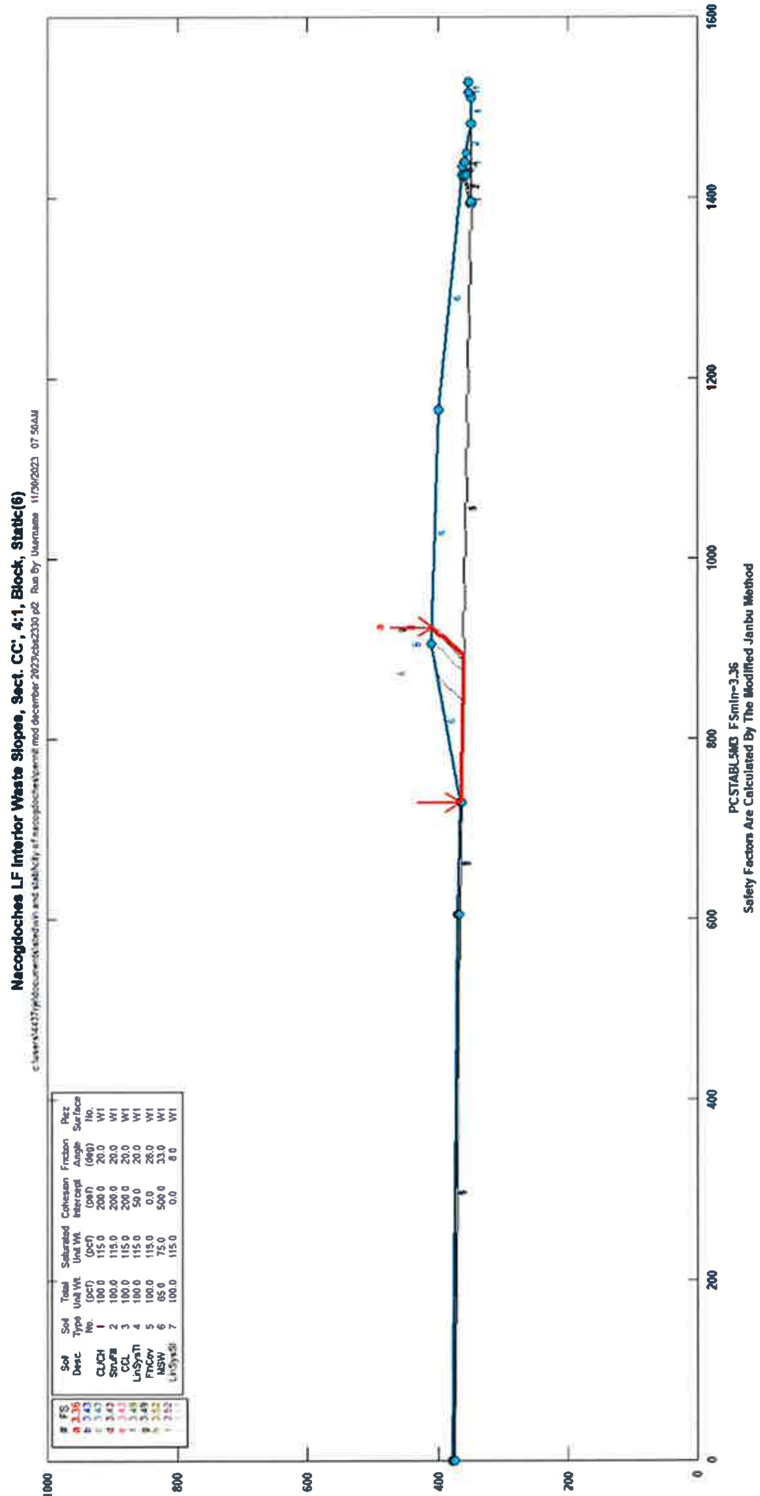
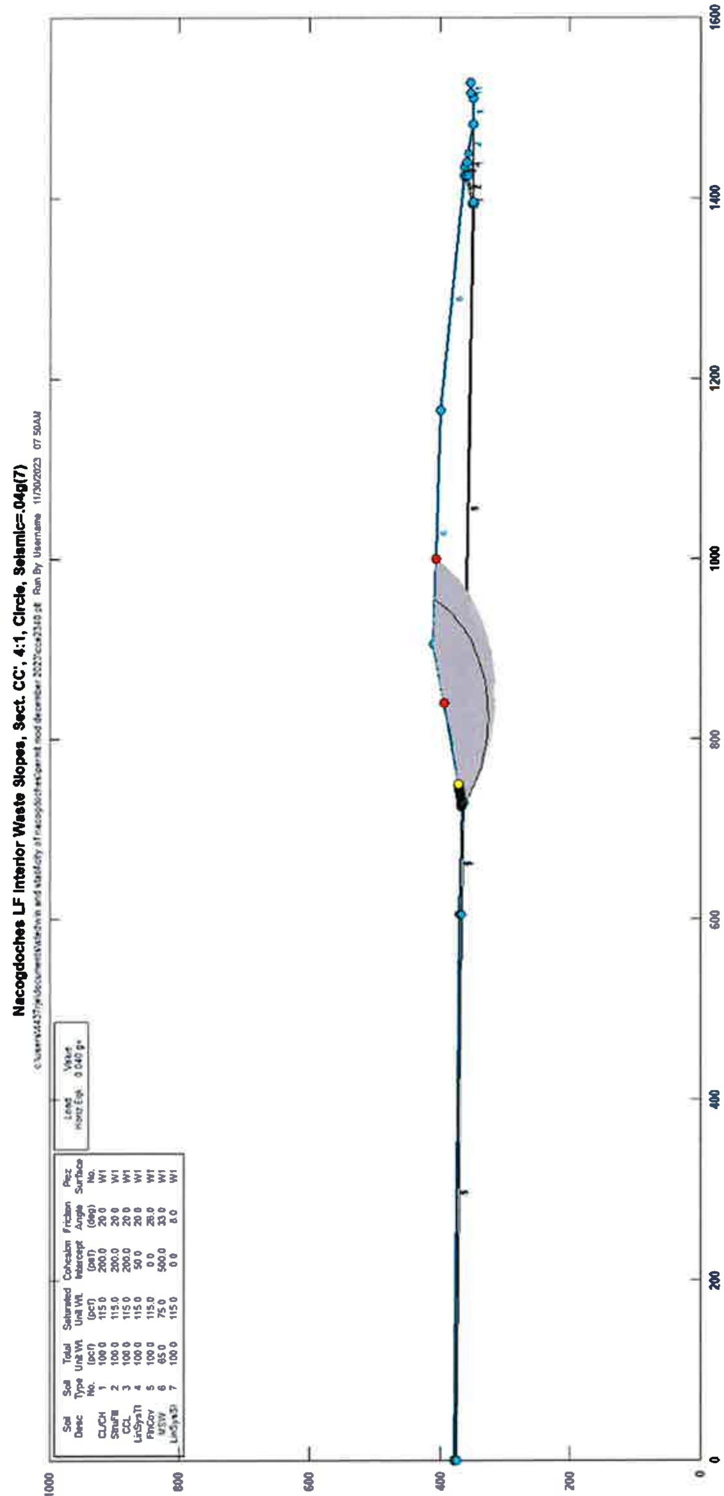
PCSTABL5M3 FSmin=2.34
Safety Factors Are Calculated By The Modified Janbu Method

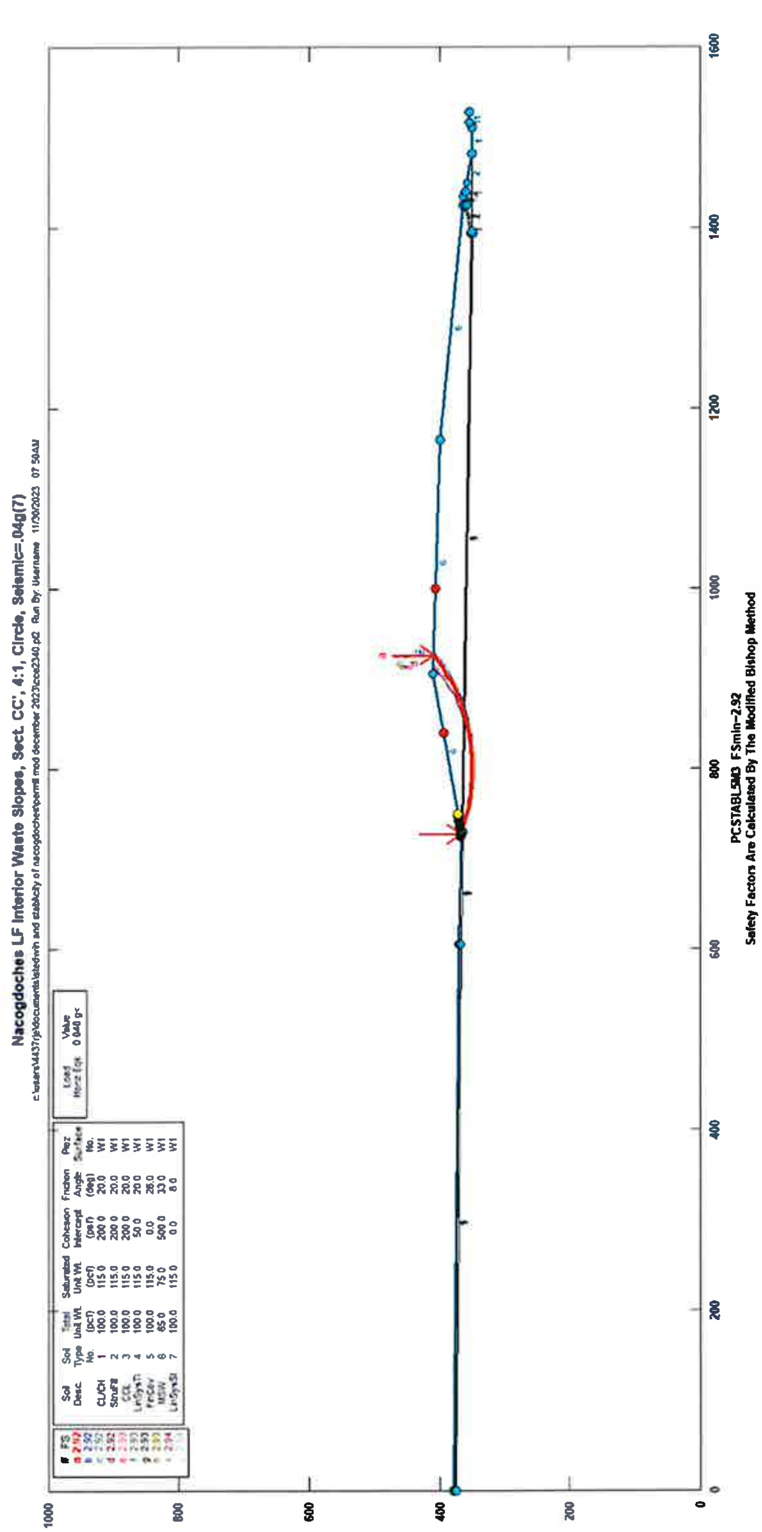

Nacogdoches LF Interior Waste Slopes, Sect. CC', 4:1, Circle, Static(5)
Soil Desc | Soil Type No. | Total Unit Wt. (pcf) | Saturated Unit Wt. (pcf) | Cohesion Intercept (psf) | Friction Angle (deg) | Piez. Surface No.
CL/CH 1 100.0 115.0 200.0 20.0 W1
StrFill 2 100.0 115.0 200.0 20.0 W1
CCL 3 100.0 115.0 200.0 20.0 W1
LinSysTl 4 100.0 115.0 50.0 20.0 W1
FlnCov 5 100.0 115.0 0.0 28.0 W1
MSW 6 85.0 75.0 500.0 33.0 W1
LinSysSl 7 100.0 115.0 0.0 8.0 W1
0
200
400
600
800
1000
1200
1400
1600

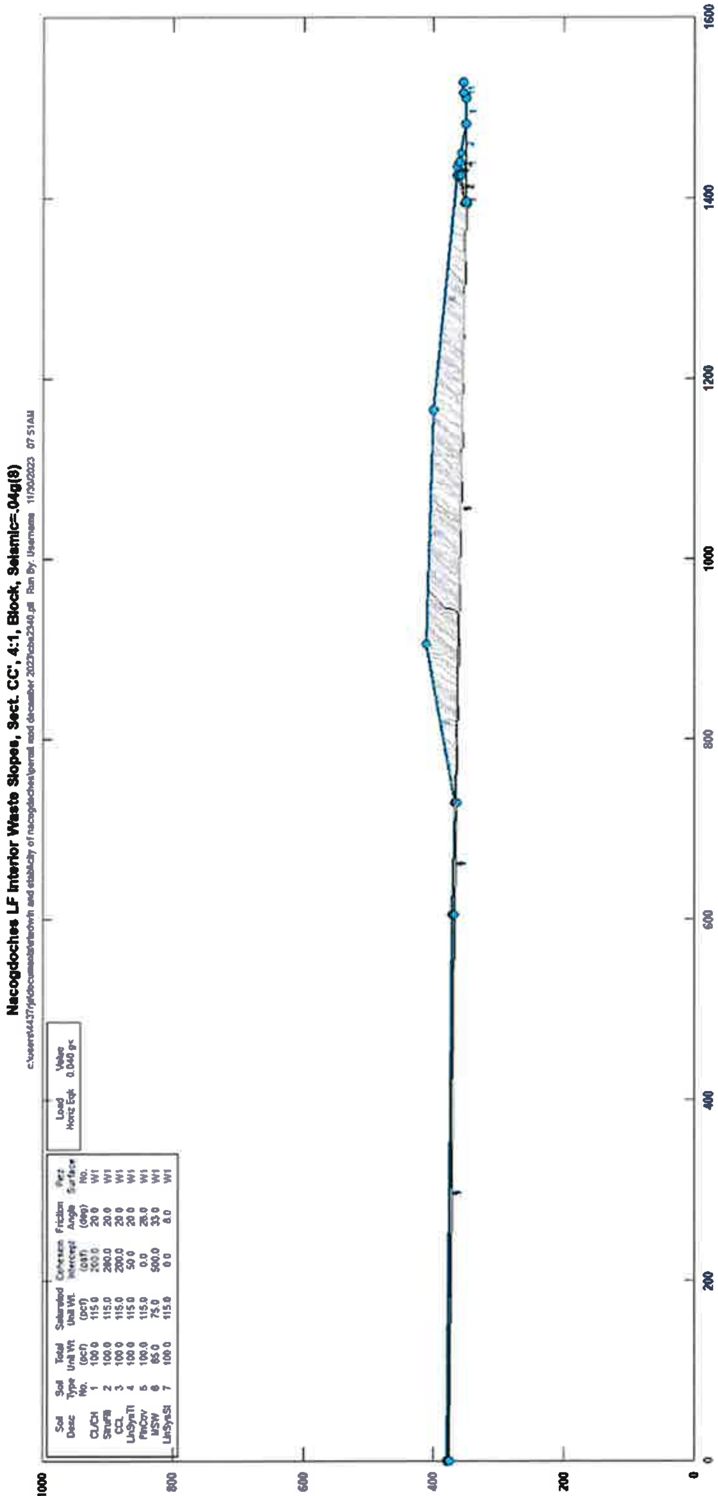

Nacogdoches LF Interior Waste Slopes, Sect. CC', 4:1, Circle, Static(5)
PCSTABL5M3 FSmin=3.54
Safety Factors Are Calculated By The Modified Bishop Method
0
200
400
600
800
1000
1200
1400
1600

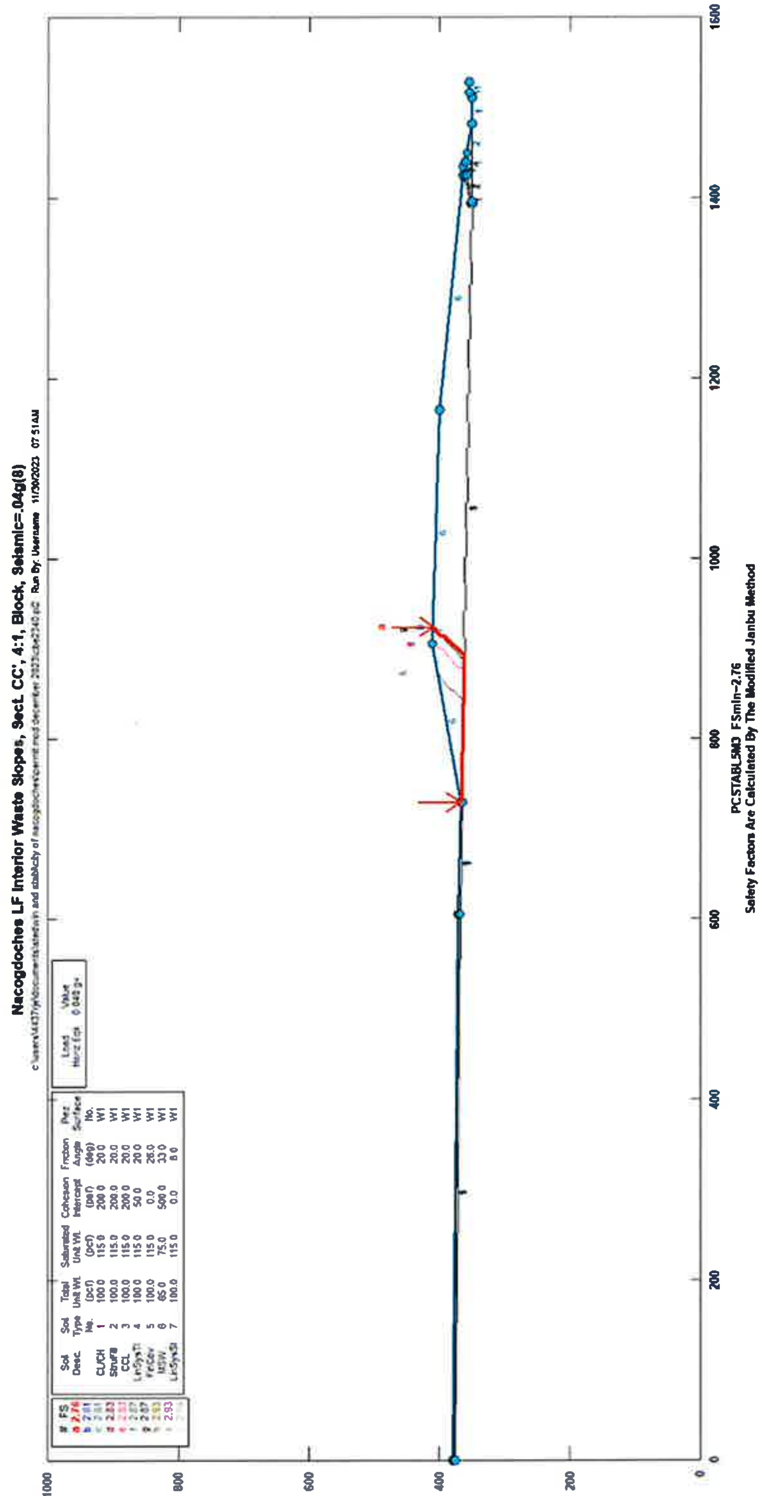

Nacogdoches LF Interior Waste Slopes, Sect. CC', 4:1, Block, Static(6)
Ran By: Username 11/30/2023 07:50AM
Soil Desc. | Soil Type No. | Total Unit Wt. (pcf) | Saturated Unit Wt. (pcf) | Cohesion Intercept (psf) | Friction Angle (deg) | Piez. Surface No.
CL/CH | 1 | 100.0 | 115.0 | 200.0 | 20.0 | W1
StrufFill | 2 | 100.0 | 115.0 | 200.0 | 20.0 | W1
CCL | 3 | 100.0 | 115.0 | 200.0 | 20.0 | W1
LinSysTI | 4 | 100.0 | 115.0 | 50.0 | 20.0 | W1
FinCov | 5 | 100.0 | 115.0 | 0.0 | 28.0 | W1
MSW | 6 | 65.0 | 75.0 | 500.0 | 33.0 | W1
LinSysSl | 7 | 100.0 | 115.0 | 0.0 | 8.0 | W1
0
200
400
600
800
1000
1200
1400
1600

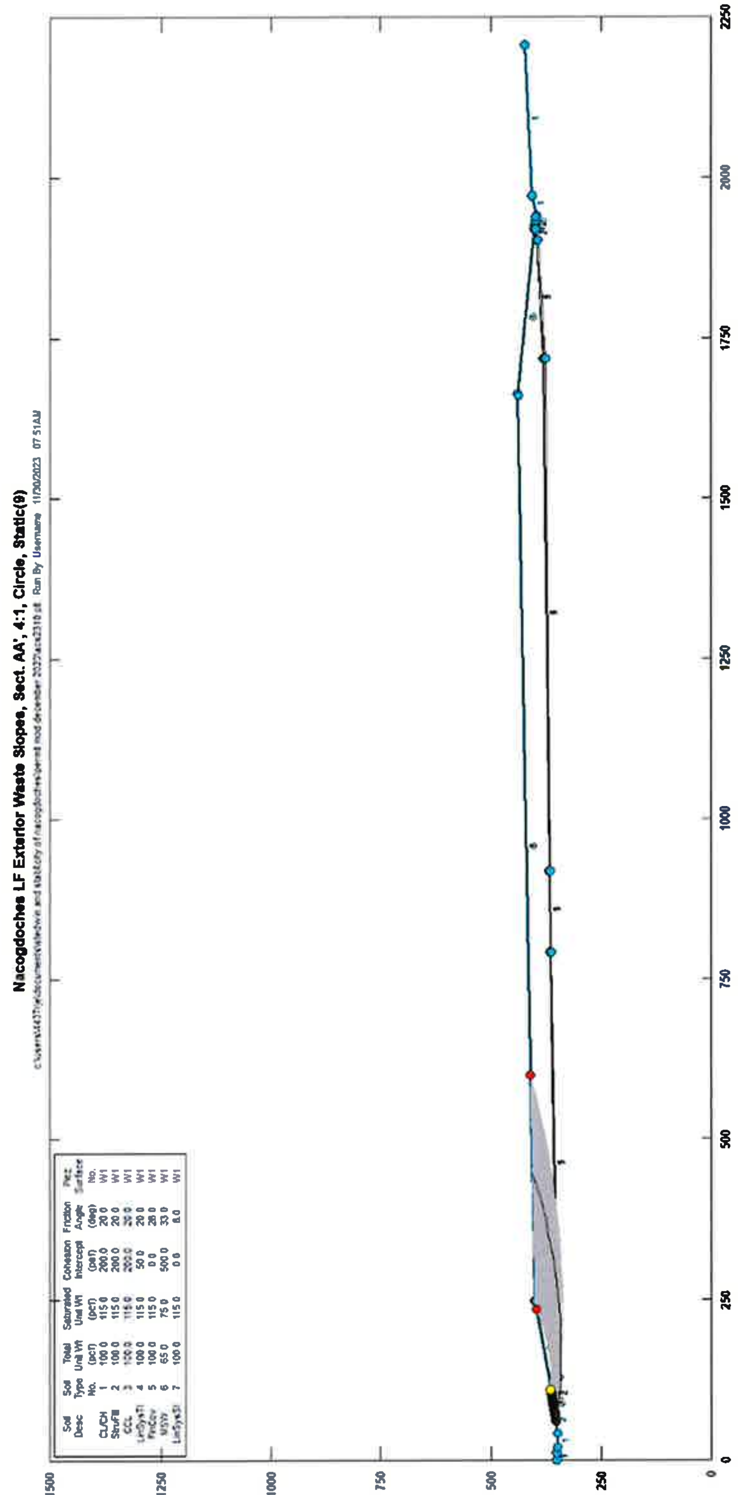

Nacogdoches LF Interior Waste Slopes, Sect. CC', 4:1, Block, Static(6)
PCSTABL5M3 FSmin=3.36
Safety Factors Are Calculated By The Modified Janbu Method

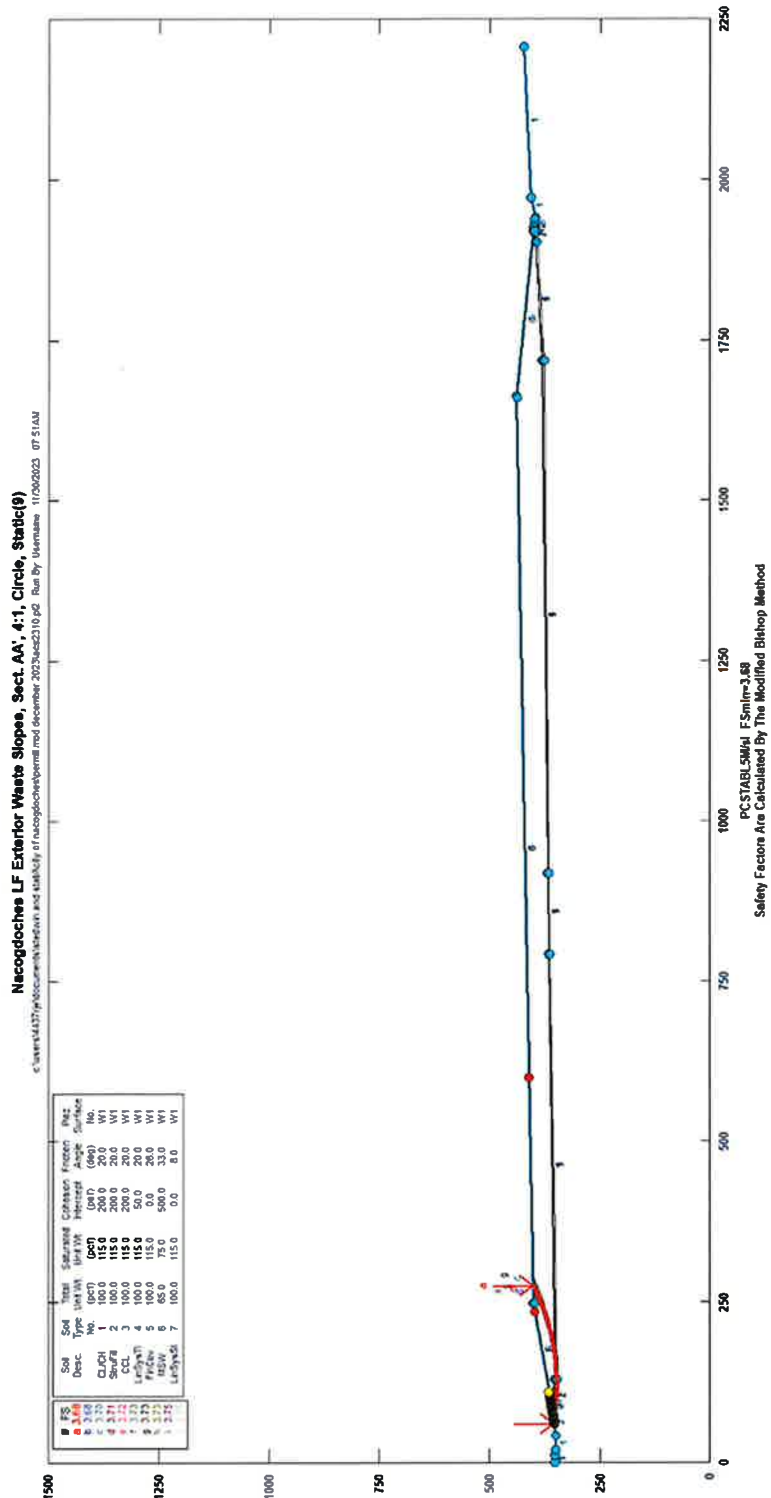

Nacogdoches LF Interior Waste Slopes, Sect. CC', 4:1, Circle, Seismic=.04g(7)
Soil Desc / Soil Type No. / Total Unit Wt. (pcf) / Saturated Unit Wt. (pcf) / Cohesion Intercept (psf) / Friction Angle (deg) / Piez Surface No.
CL/CH 1 100.0 115.0 200.0 20.0 W1
StruFill 2 100.0 115.0 200.0 20.0 W1
CCL 3 100.0 115.0 200.0 20.0 W1
LinSysTI 4 100.0 115.0 50.0 20.0 W1
FlnCov 5 100.0 115.0 0.0 28.0 W1
MSW 6 65.0 75.0 500.0 33.0 W1
LinSys3 7 100.0 115.0 0.0 8.0 W1
Load Value
Horiz Eqk 0.040 g<
0
200
400
600
800
1000
1200
1400
1600

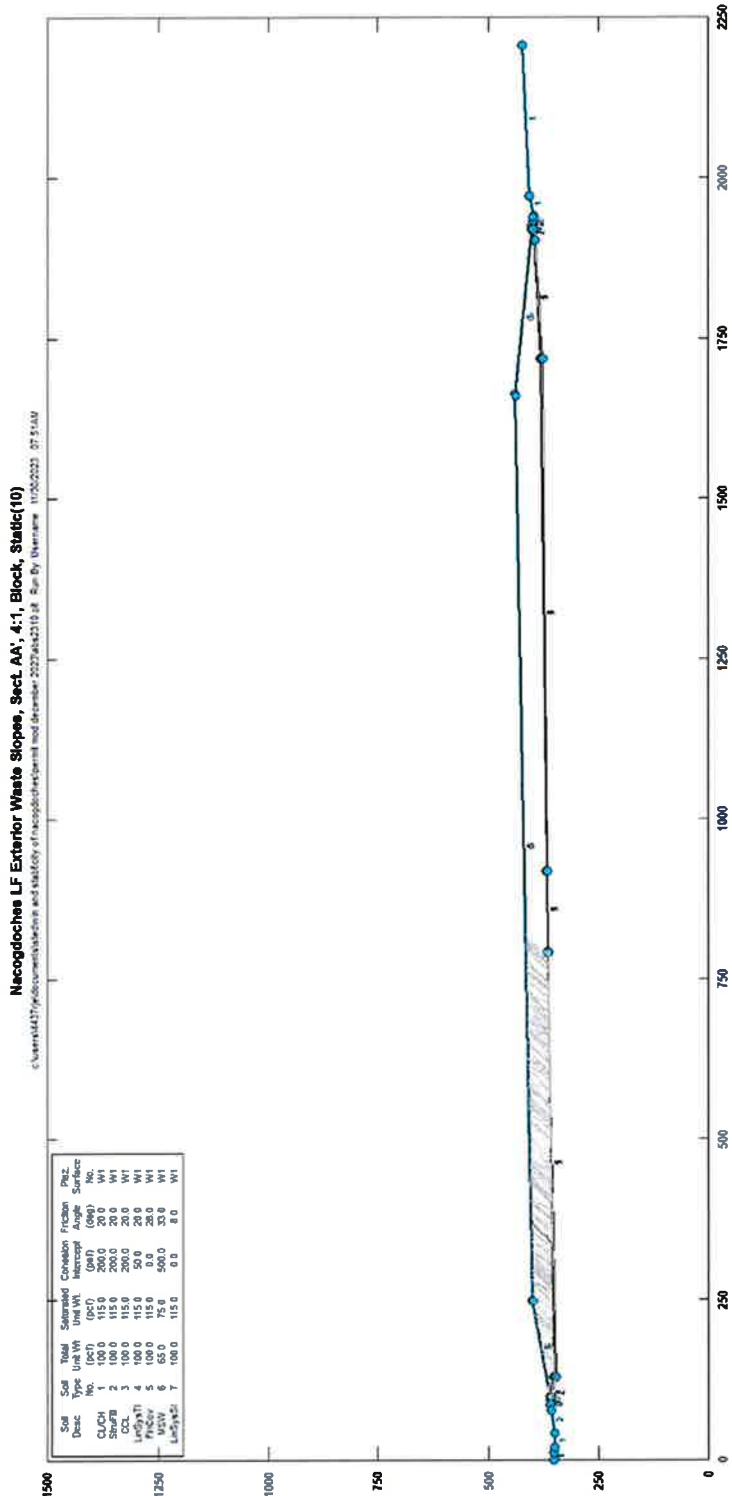

Nacogdoches LF Interior Waste Slopes, Sect. CC', 4:1, Circle, Seismic=.04g(7)
c:\users\4437rjs\documents\stedwin and stability of nacogdoches\permit mod december 2023\cce2340.pl2 Run By: Username 11/30/2023 07:50AM
FS
a 2.92
b 2.92
d 2.92
g 2.93
Soil Desc. | Soil Type No. | Total Unit Wt. (pcf) | Saturated Unit Wt. (pcf) | Cohesion Intercept (psf) | Friction Angle (deg) | Piez Surface No.
CL/CH 1 100.0 115.0 200.0 20.0 W1
StruFill 2 100.0 115.0 200.0 20.0 W1
CCL 3 100.0 115.0 200.0 20.0 W1
LinSysTl 4 100.0 115.0 50.0 20.0 W1
FinCov 5 100.0 115.0 0.0 28.0 W1
MSW 6 65.0 75.0 500.0 33.0 W1
LinSysSl 7 100.0 115.0 0.0 8.0 W1
Load Value
Horiz Eqk 0.040 g<
1000
800
600
400
200
0
0 200 400 600 800 1000 1200 1400 1600
PCSTABL5M3 FSmin=2.92
Safety Factors Are Calculated By The Modified Bishop Method

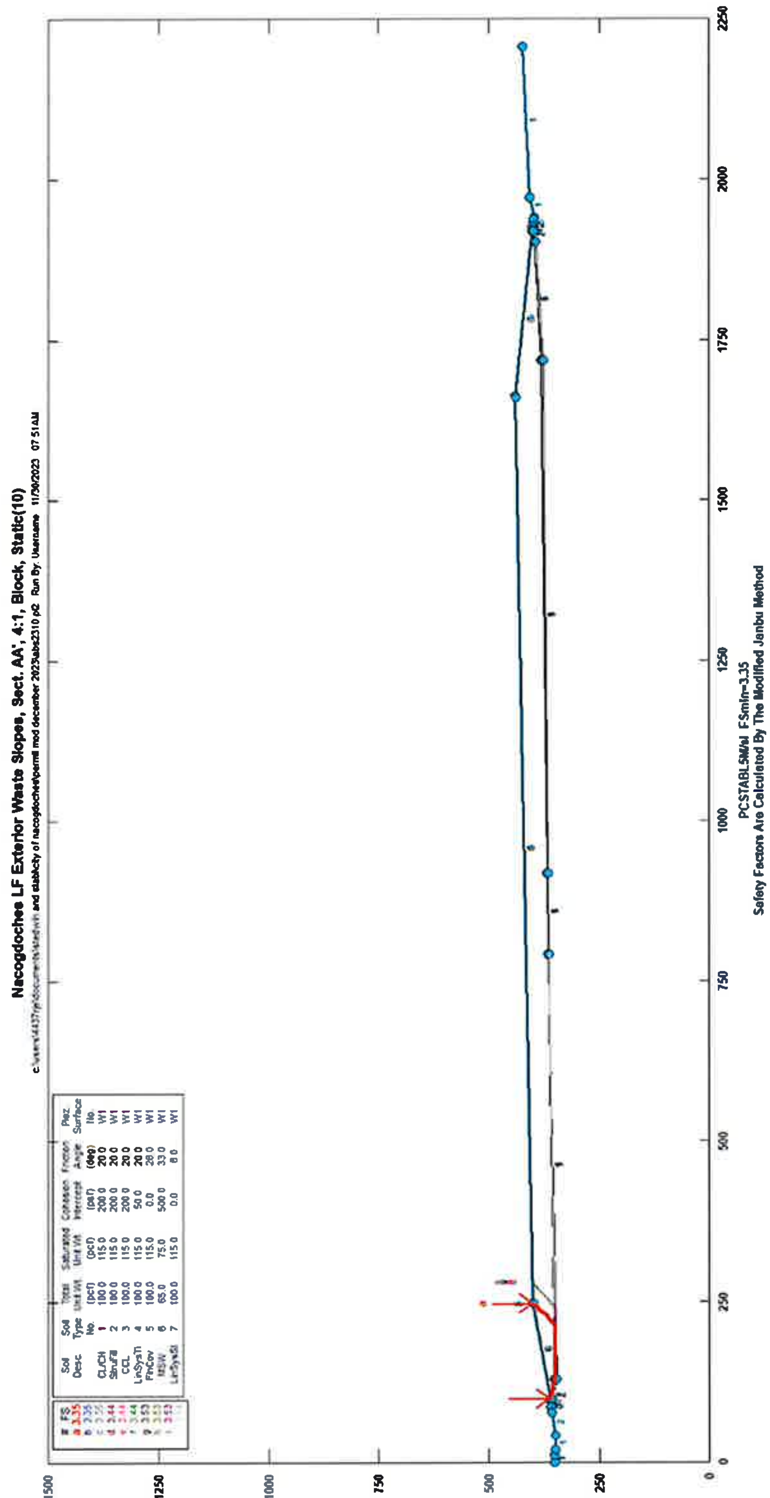

Nacogdoches LF Interior Waste Slopes, Sect. CC', 4:1, Block, Seismic=.04g(8)
Run By: Username 11/30/2023 07:51AM
Soil Desc | Soil Type No. | Total Unit Wt (pcf) | Saturated Unit Wt. (pcf) | Cohesion Intercept (psf) | Friction Angle (deg) | Piez Surface No.
CL/CH 1 100.0 115.0 200.0 20.0 W1
StruFill 2 100.0 115.0 280.0 20.0 W1
CCL 3 100.0 115.0 200.0 20.0 W1
LinSysTl 4 100.0 115.0 50.0 20.0 W1
FinCov 5 100.0 115.0 0.0 28.0 W1
MSW 6 85.0 75.0 500.0 33.0 W1
LinSysSl 7 100.0 115.0 0.0 8.0 W1
Load Horiz Eqk Value 0.040 g<
0
200
400
600
800
1000
1200
1400
1600

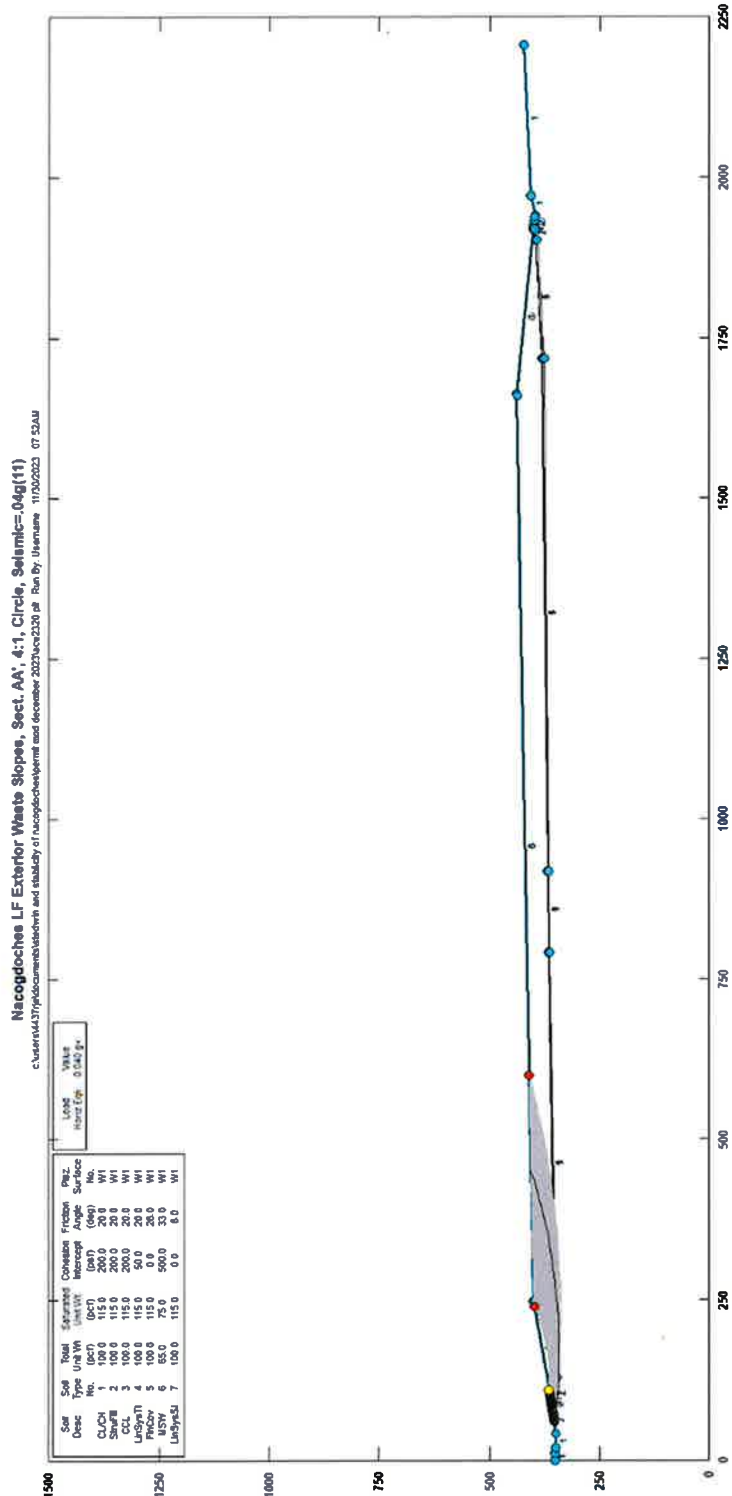

Nacogdoches LF Interior Waste Slopes, Sect. CC', 4:1, Block, Seismic=.04g(8)
PCSTABL5M3 FSmin=2.76
Safety Factors Are Calculated By The Modified Janbu Method

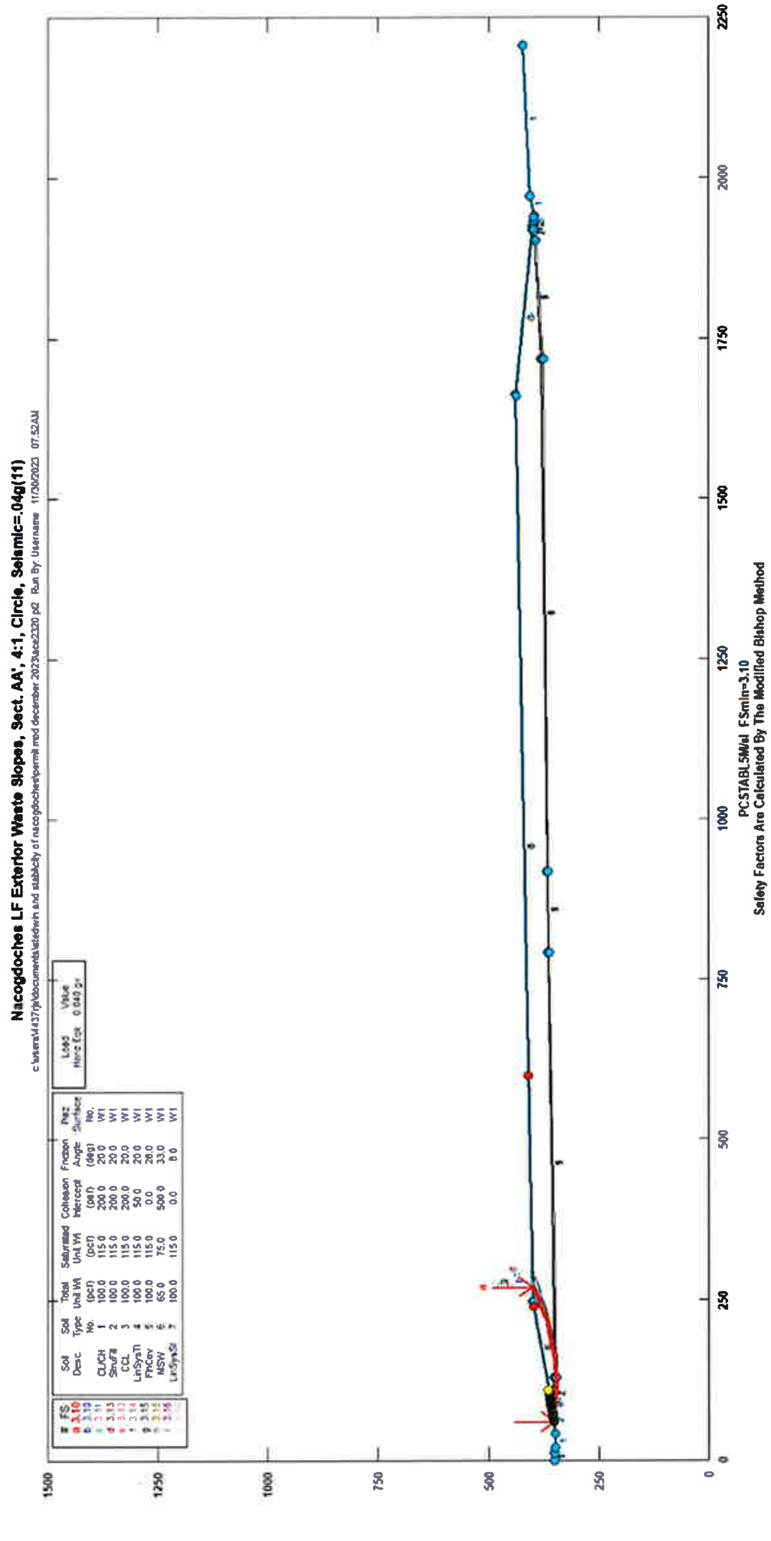

Nacogdoches LF Exterior Waste Slopes, Sect. AA', 4:1, Circle, Static(9)

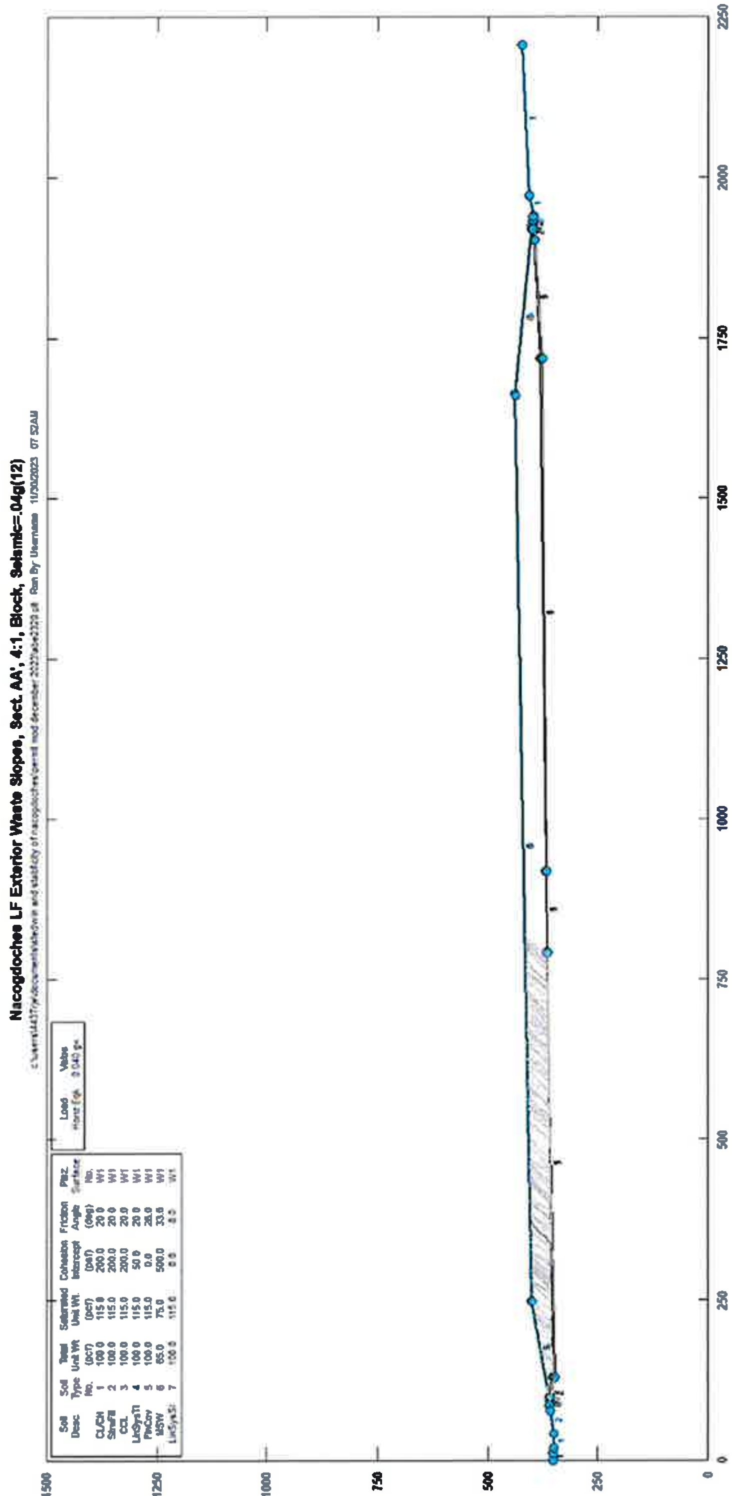

Nacogdoches LF Exterior Waste Slopes, Sect. AA', 4:1, Circle, Static(9)
PCSTABL5M/si FSmin=3.68
Safety Factors Are Calculated By The Modified Bishop Method

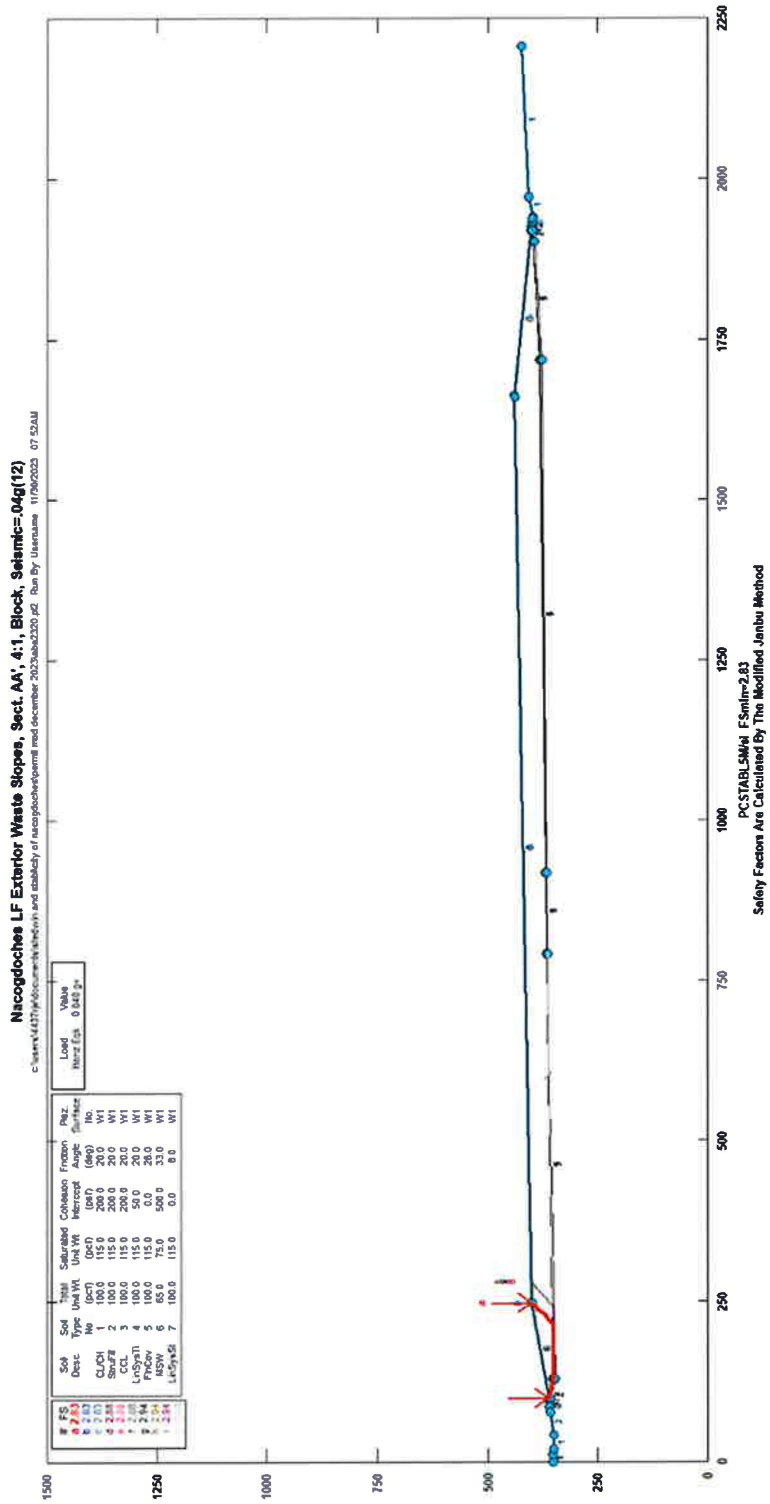

Nacogdoches LF Exterior Waste Slopes, Sect. AA', 4:1, Block, Static(10)
Soil Desc
Soil Type No.
Total Unit Wt. (pcf)
Saturated Unit Wt. (pcf)
Cohesion Intercept (psf)
Friction Angle (deg)
Piez. Surface No.
CL/CH 1 100.0 115.0 200.0 20.0 W1
StruFill 2 100.0 115.0 200.0 20.0 W1
CCL 3 100.0 115.0 200.0 20.0 W1
4 100.0 115.0 50.0 20.0 W1
5 100.0 115.0 0.0 28.0 W1
MSW 6 65.0 75.0 500.0 33.0 W1
7 100.0 115.0 0.0 8.0 W1
0
250
500
750
1000
1250
1500
1750
2000
2250

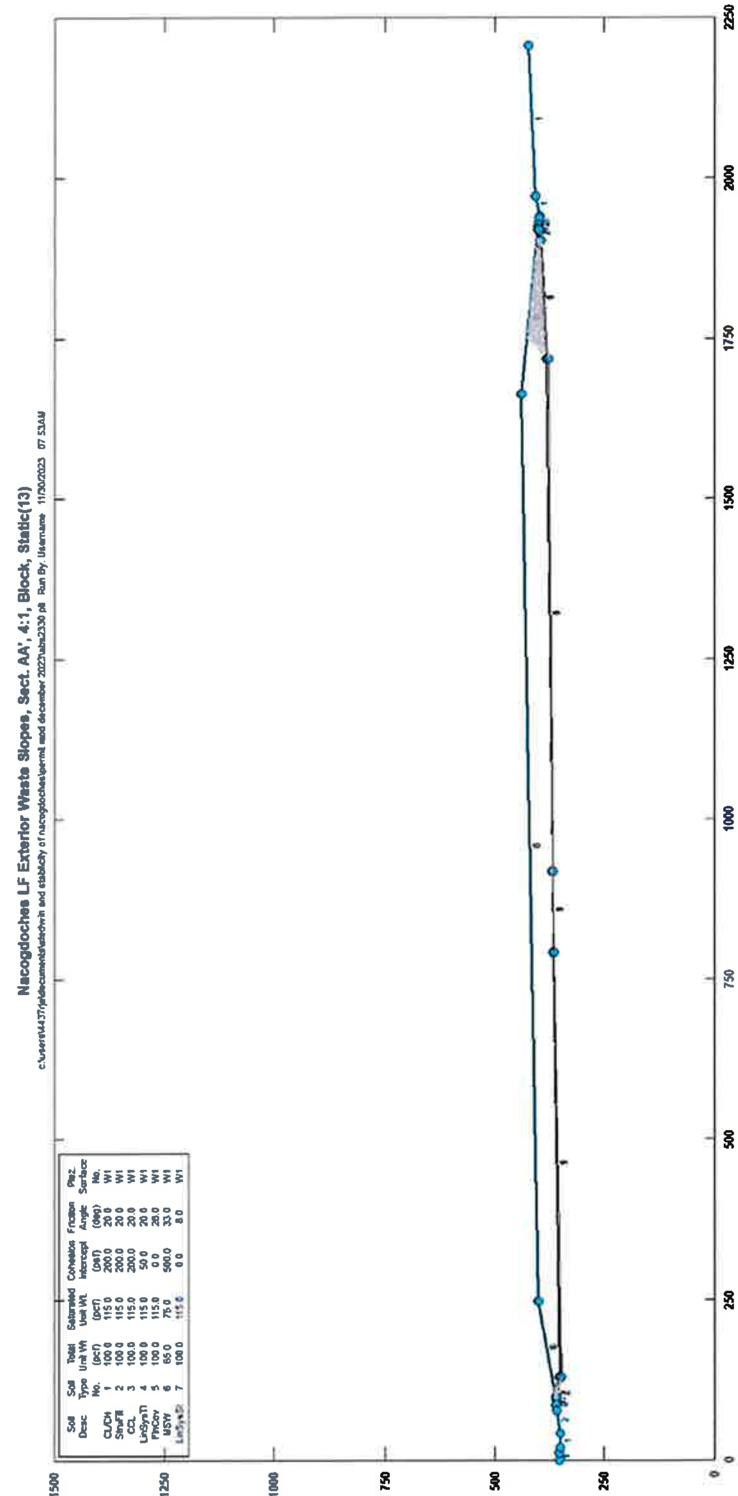

Nacogdoches LF Exterior Waste Slopes, Sect. AA', 4:1, Block, Static(10)
PCSTABL5M/si FSmin=3.35
Safety Factors Are Calculated By The Modified Janbu Method

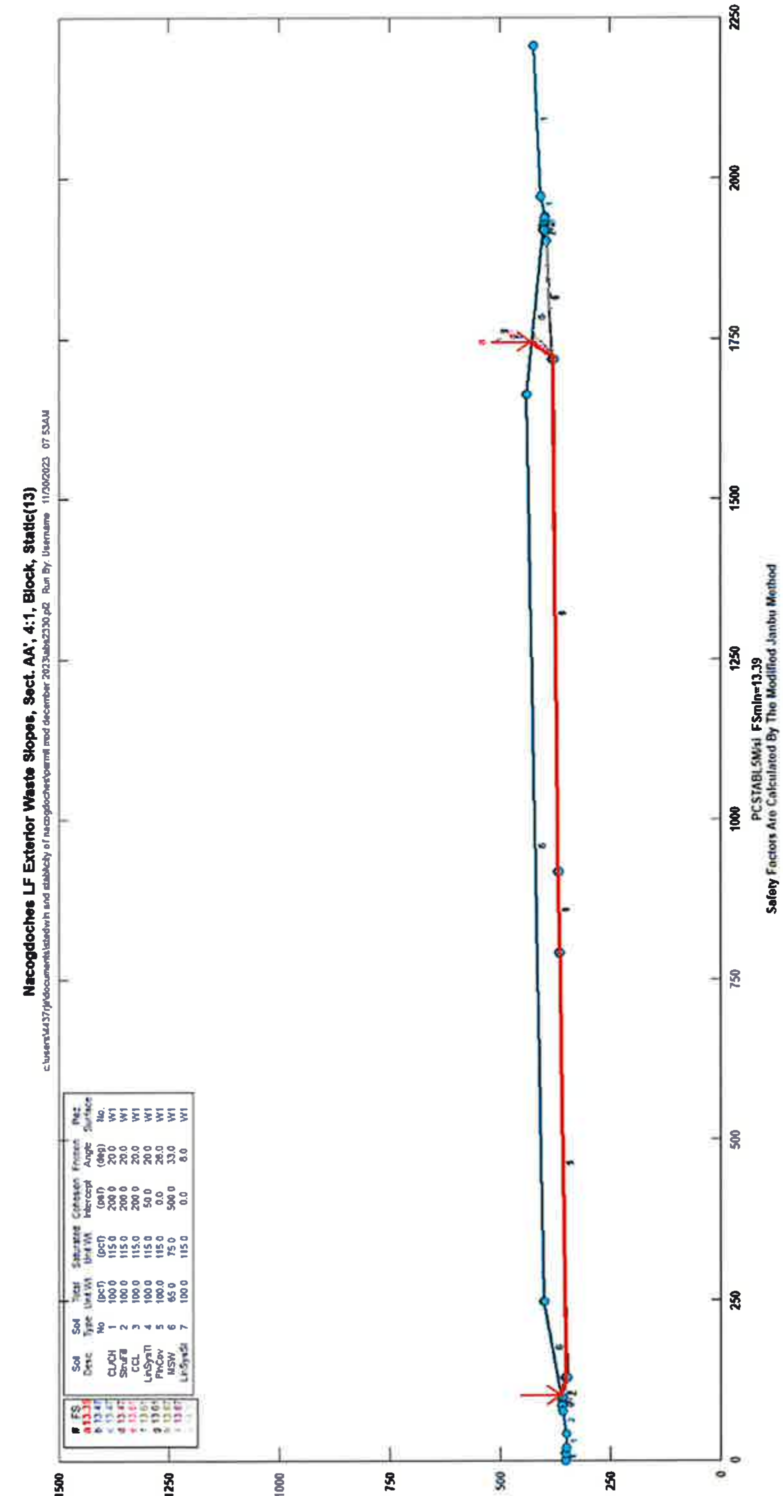

Nacogdoches LF Exterior Waste Slopes, Sect. AA', 4:1, Circle, Seismic=.04g(11)
Run By: Username 11/30/2023 07:52AM
Soil Desc | Soil Type No. | Total Unit Wt. (pcf) | Saturated Unit Wt. (pcf) | Cohesion Intercept (psf) | Friction Angle (deg) | Piez. Surface No.
CL/CH 1 100.0 115.0 200.0 20.0 W1
StrucFill 2 100.0 115.0 200.0 20.0 W1
CCL 3 100.0 115.0 200.0 20.0 W1
LinSysTl 4 100.0 115.0 50.0 20.0 W1
FinCov 5 100.0 115.0 0.0 28.0 W1
MSW 6 65.0 75.0 500.0 33.0 W1
LinSysSJ 7 100.0 115.0 0.0 6.0 W1
Load Value
Horiz Eqk 0.040 g
0
250
500
750
1000
1250
1500
1750
2000
2250

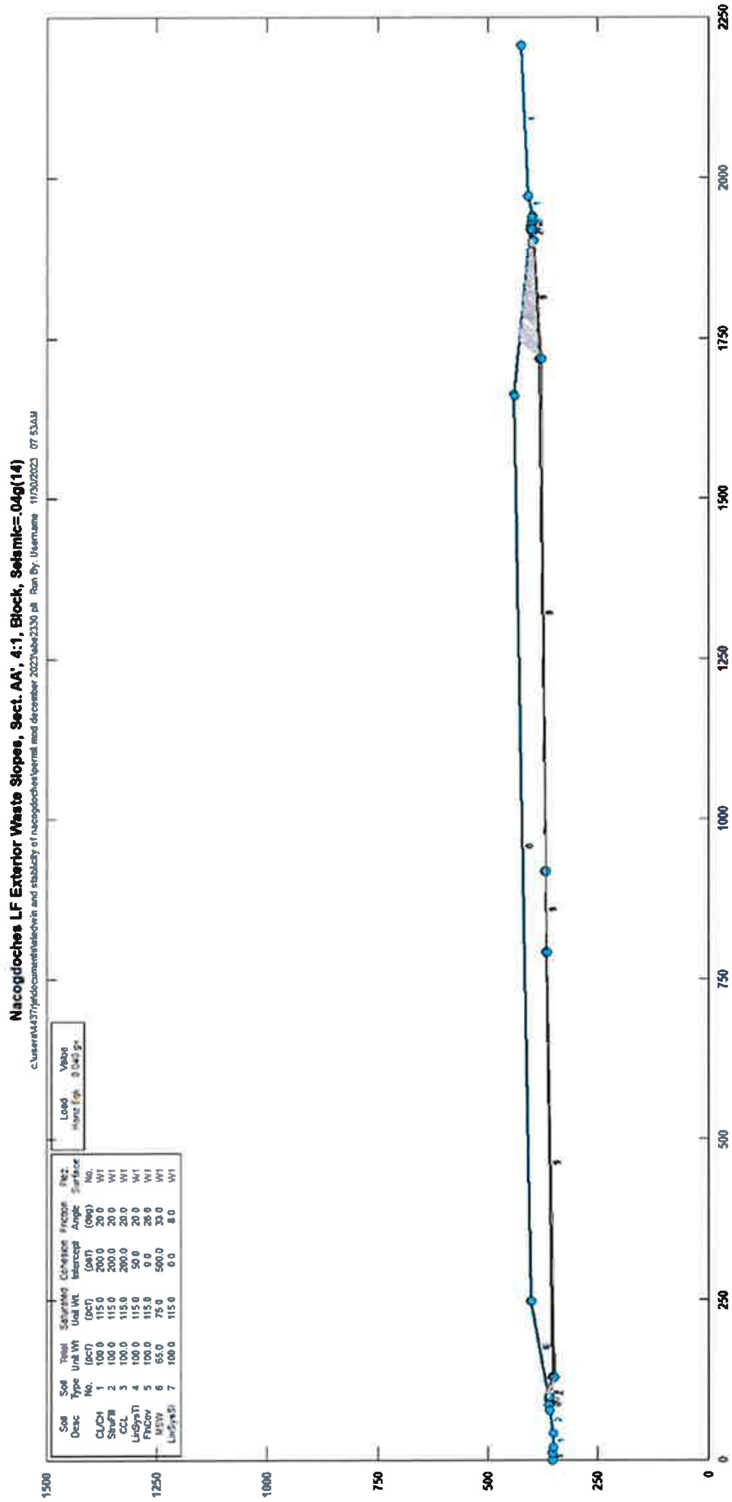

Nacogdoches LF Exterior Waste Slopes, Sect. AA', 4:1, Circle, Seismic=.04g(11)
Run By: Username 11/30/2023 07:52AM
Load Value
Horiz Eqk 0.040 g<
PCSTABL5M/si FSmin=3.10
Safety Factors Are Calculated By The Modified Bishop Method
0
250
500
750
1000
1250
1500
1750
2000
2250

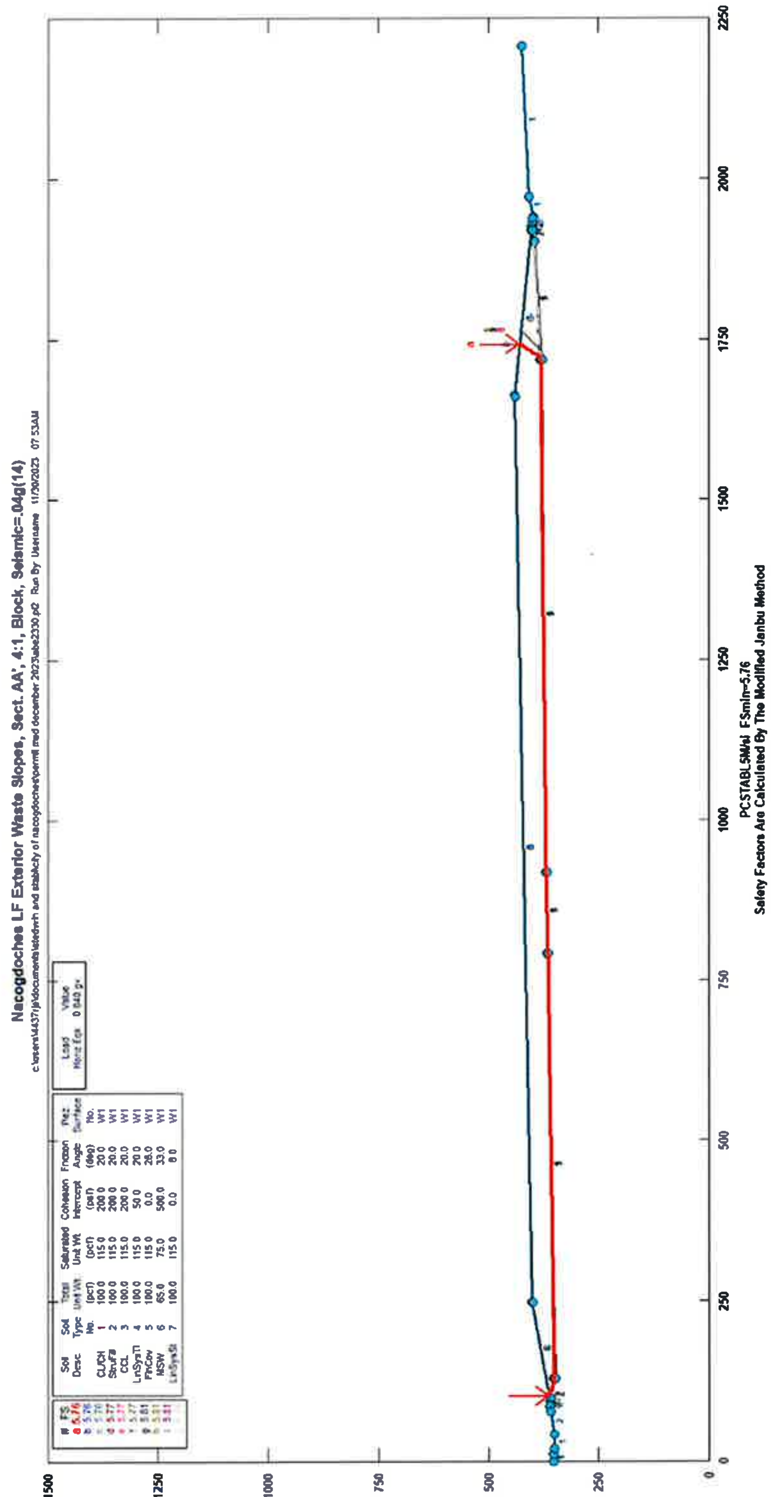

Nacogdoches LF Exterior Waste Slopes, Sect. AA', 4:1, Block, Seismic=.04g(12)
0
250
500
750
1000
1250
1500
1750
2000
2250


Nacogdoches LF Exterior Waste Slopes, Sect. AA', 4:1, Block, Seismic=.04g(12)
PCSTABL5M/si FSmin=2.83
Safety Factors Are Calculated By The Modified Janbu Method
0
250
500
750
1000
1250
1500
1750
2000
2250


Nacogdoches LF Exterior Waste Slopes, Sect. AA', 4:1, Block, Static(13)
0
250
500
750
1000
1250
1500
1750
2000
2250


Nacogdoches LF Exterior Waste Slopes, Sect. AA', 4:1, Block, Static(13)
PCSTABL5M/si FSmin=13.39
Safety Factors Are Calculated By The Modified Janbu Method


Nacogdoches LF Exterior Waste Slopes, Sect. AA', 4:1, Block, Seismic=.04g(14)
Soil Desc | Soil Type No. | Total Unit Wt (pcf) | Saturated Unit Wt. (pcf) | Cohesion Intercept (psf) | Friction Angle (deg) | Piez. Surface No.
CL/CH | 1 | 100.0 | 115.0 | 200.0 | 20.0 | W1
StruFill | 2 | 100.0 | 115.0 | 200.0 | 20.0 | W1
CCL | 3 | 100.0 | 115.0 | 200.0 | 20.0 | W1
LinSysTl | 4 | 100.0 | 115.0 | 50.0 | 20.0 | W1
FinCov | 5 | 100.0 | 115.0 | 0.0 | 26.0 | W1
MSW | 6 | 65.0 | 75.0 | 500.0 | 33.0 | W1
LinSysSl | 7 | 100.0 | 115.0 | 0.0 | 8.0 | W1
Load | Value
0
250
500
750
1000
1250
1500
1750
2000
2250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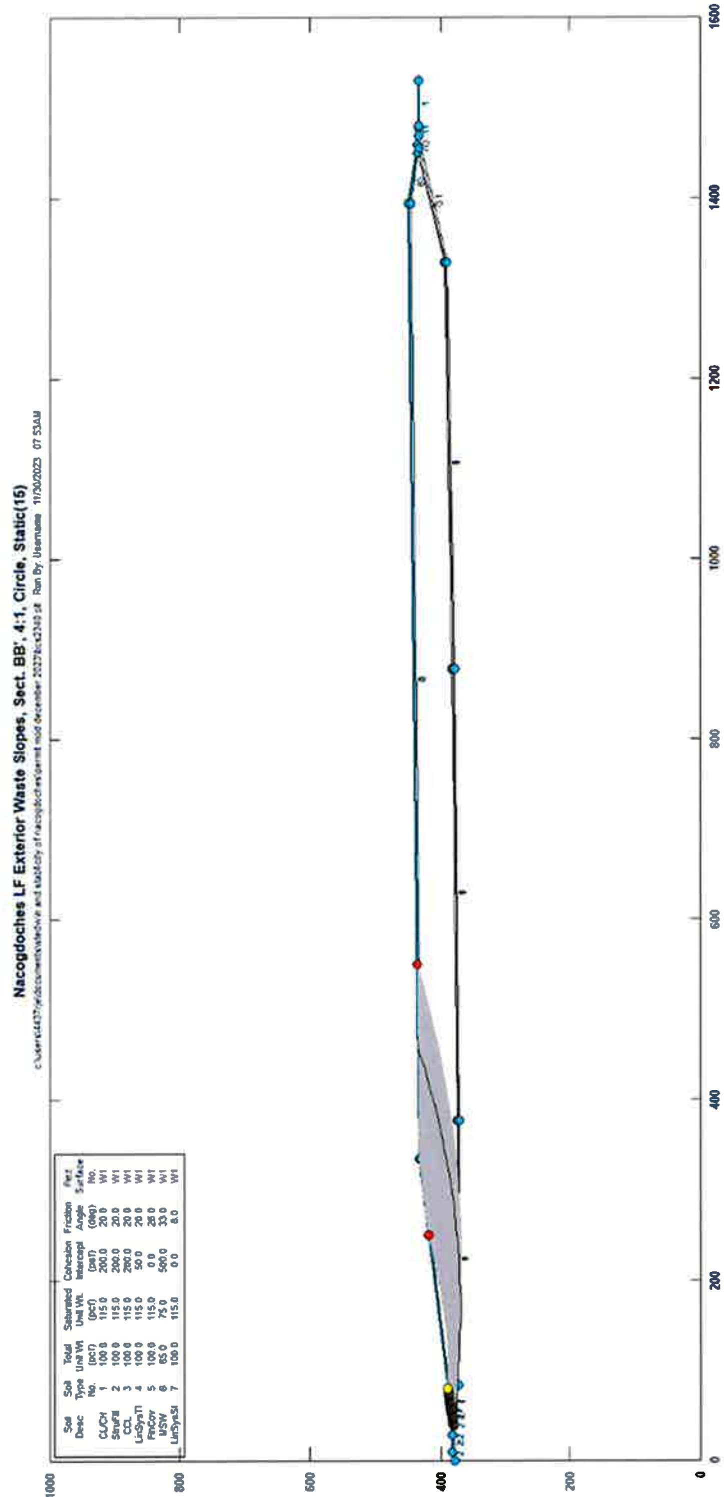
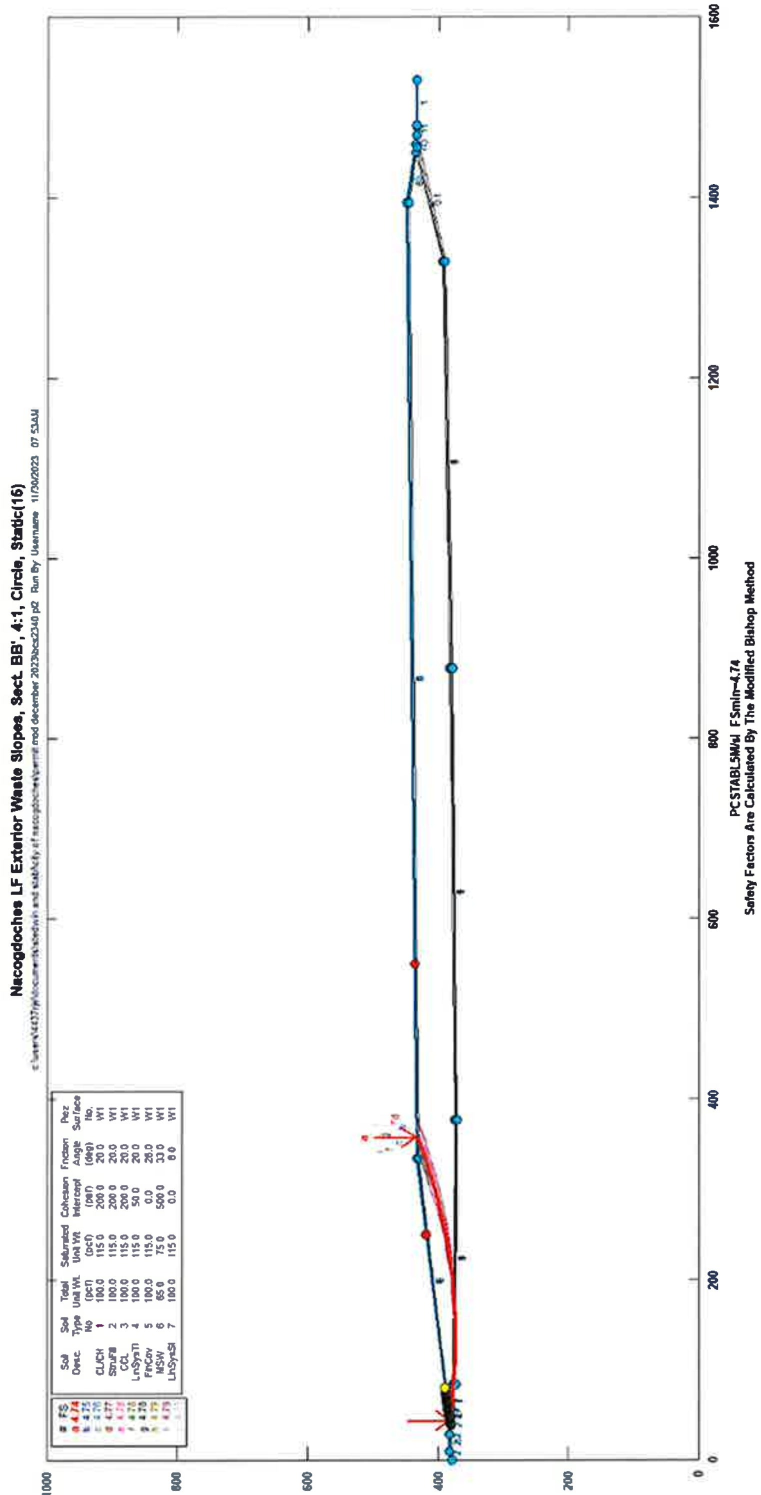
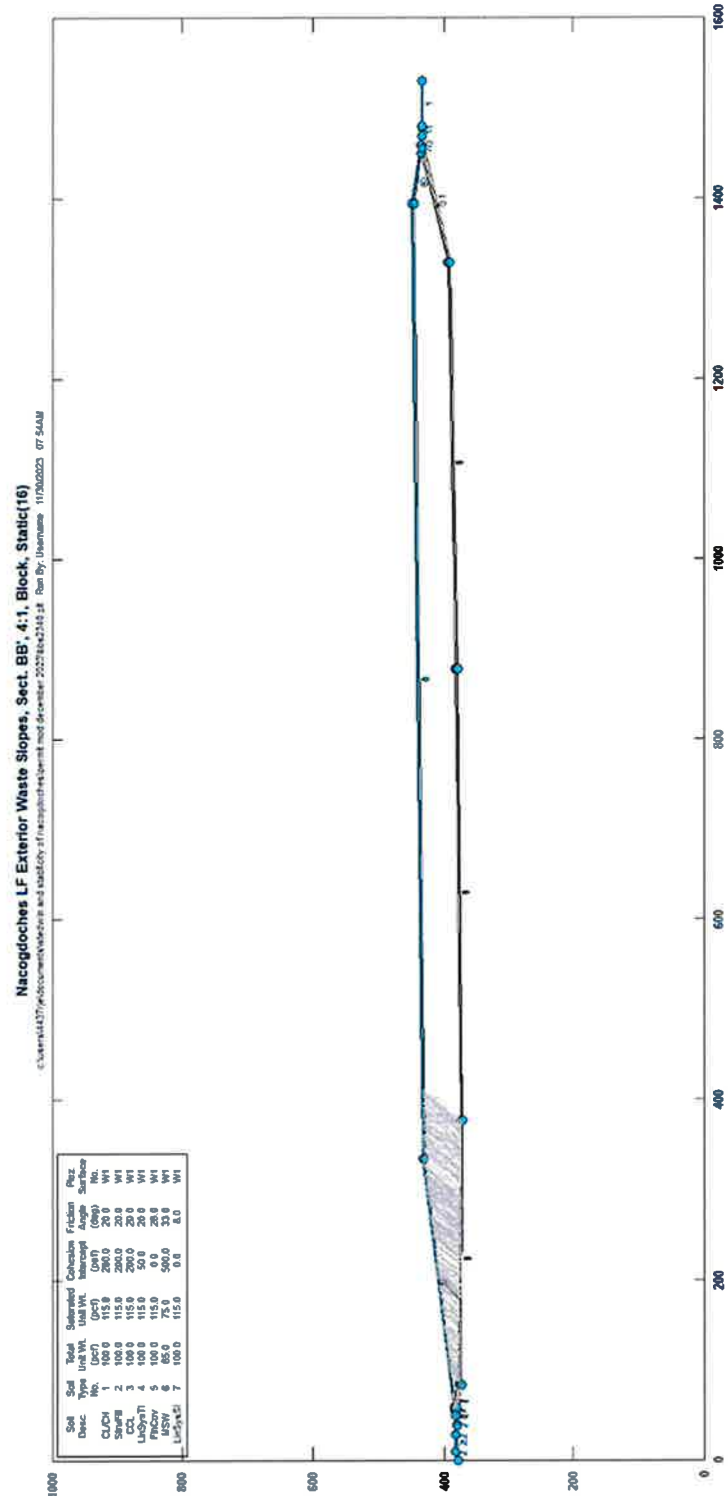
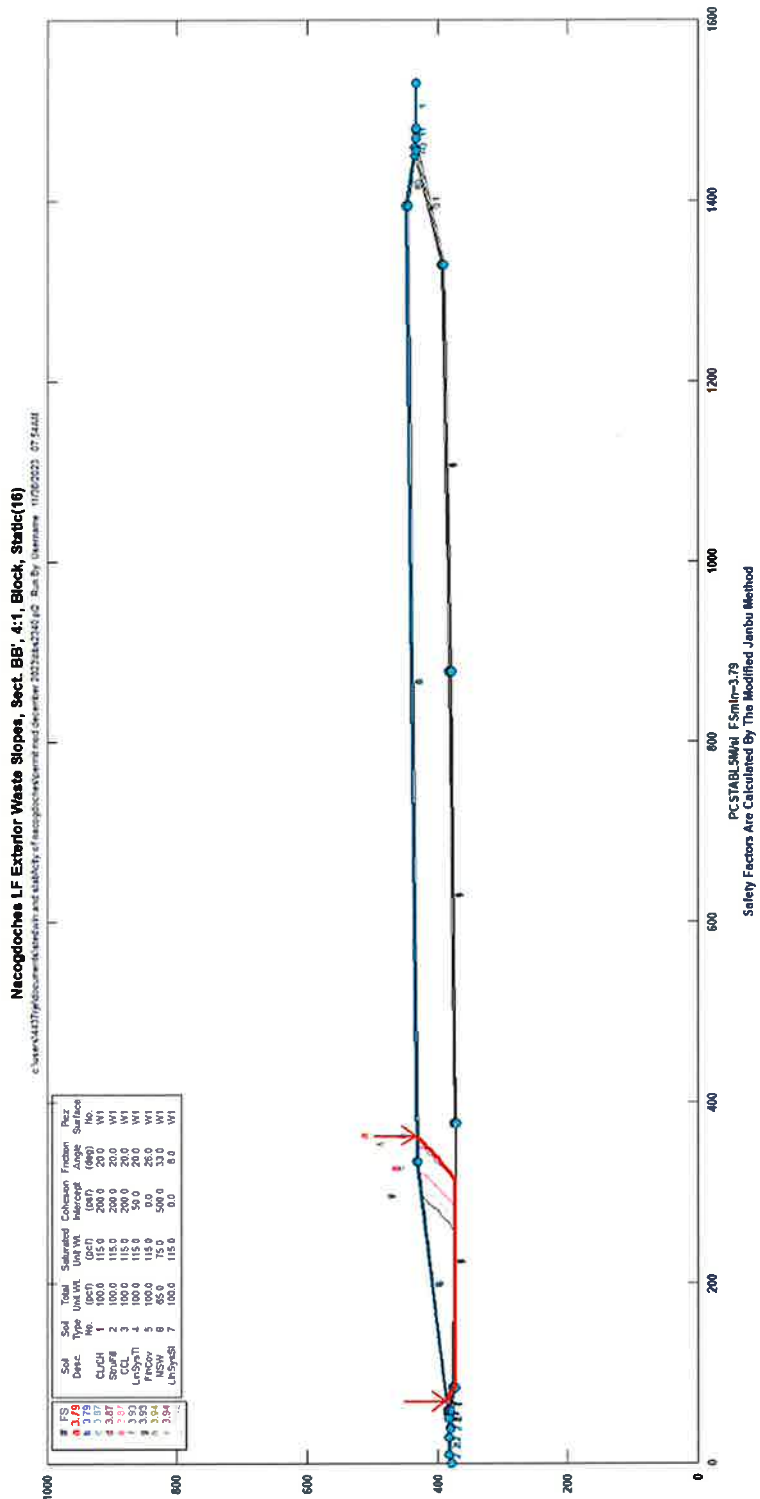
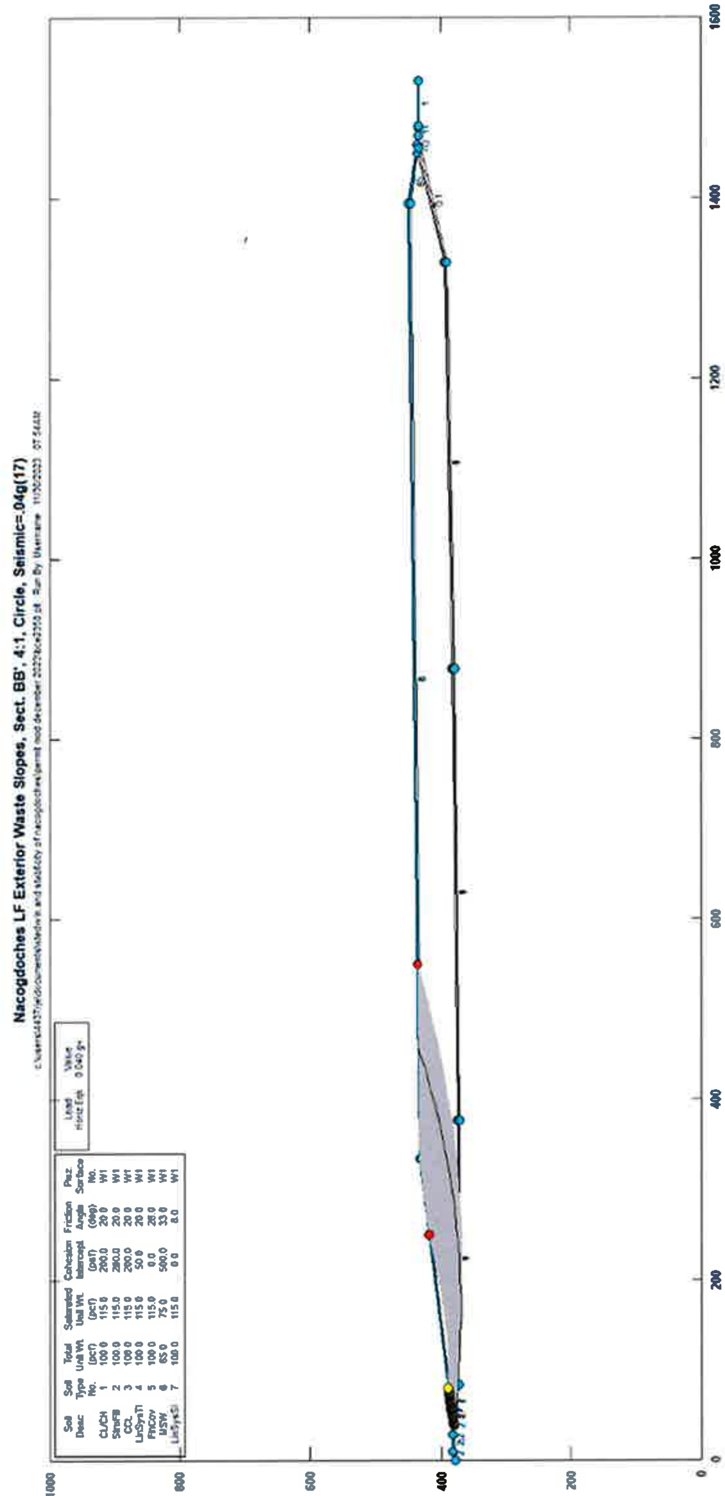
PCSTABL5M/si FSmin=5.76
Safety Factors Are Calculated By The Modified Janbu Method

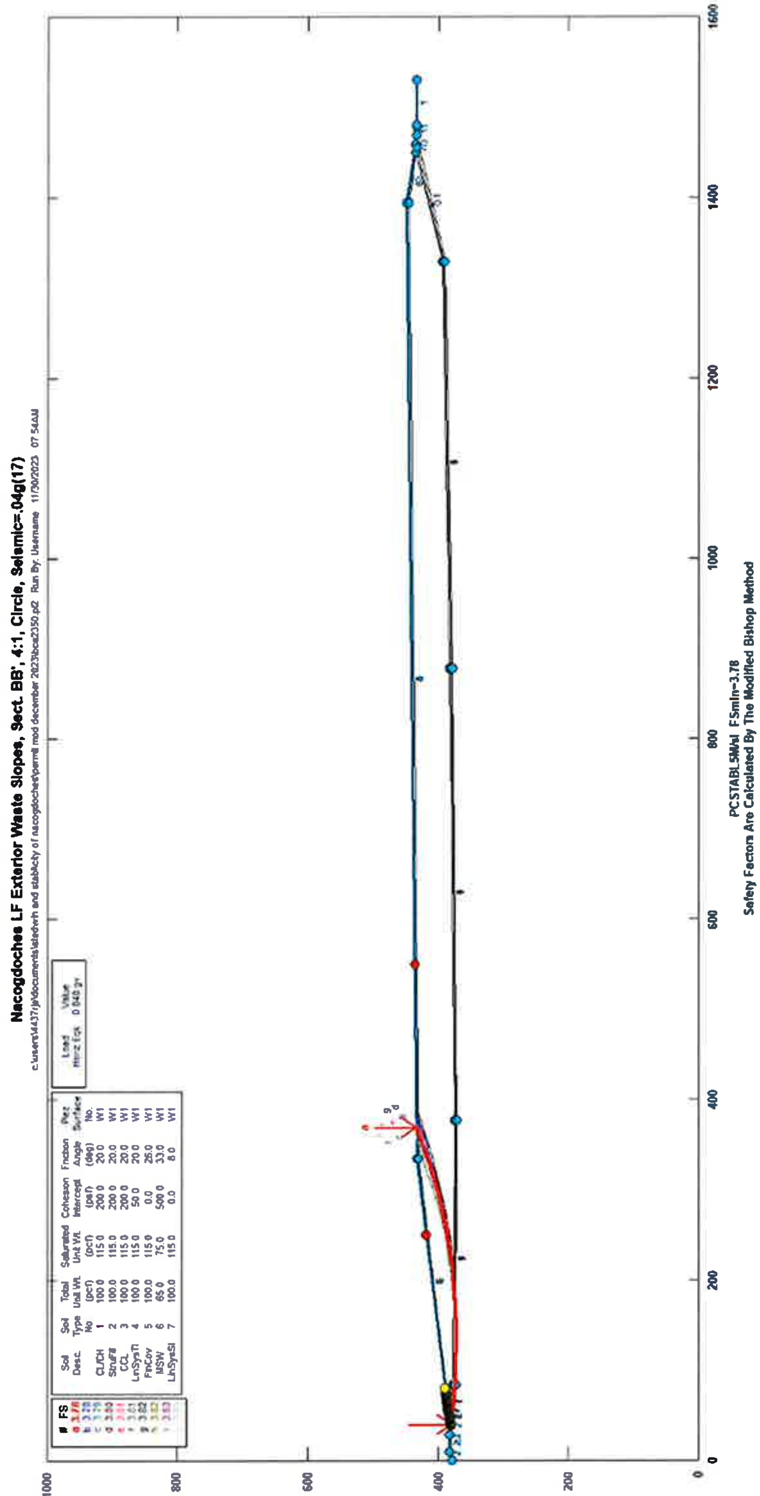

Nacogdoches LF Exterior Waste Slopes, Sect. BB', 4:1, Circle, Static(15)
Run By: Username 11/30/2023 07 53AM
Soil Desc | Soil Type No. | Total Unit Wt. (pcf) | Saturated Unit Wt. (pcf) | Cohesion Intercept (psf) | Friction Angle (deg) | Piez. Surface No.
CL/CH | 1 | 100.0 | 115.0 | 200.0 | 20.0 | W1
StrufFill | 2 | 100.0 | 115.0 | 200.0 | 20.0 | W1
CCL | 3 | 100.0 | 115.0 | 200.0 | 20.0 | W1
LinSysTl | 4 | 100.0 | 115.0 | 50.0 | 20.0 | W1
FinCov | 5 | 100.0 | 115.0 | 0.0 | 28.0 | W1
MSW | 6 | 65.0 | 75.0 | 500.0 | 33.0 | W1
LinSysSl | 7 | 100.0 | 115.0 | 0.0 | 8.0 | W1
1000
800
600
400
200
0
200
400
600
800
1000
1200
1400
1600

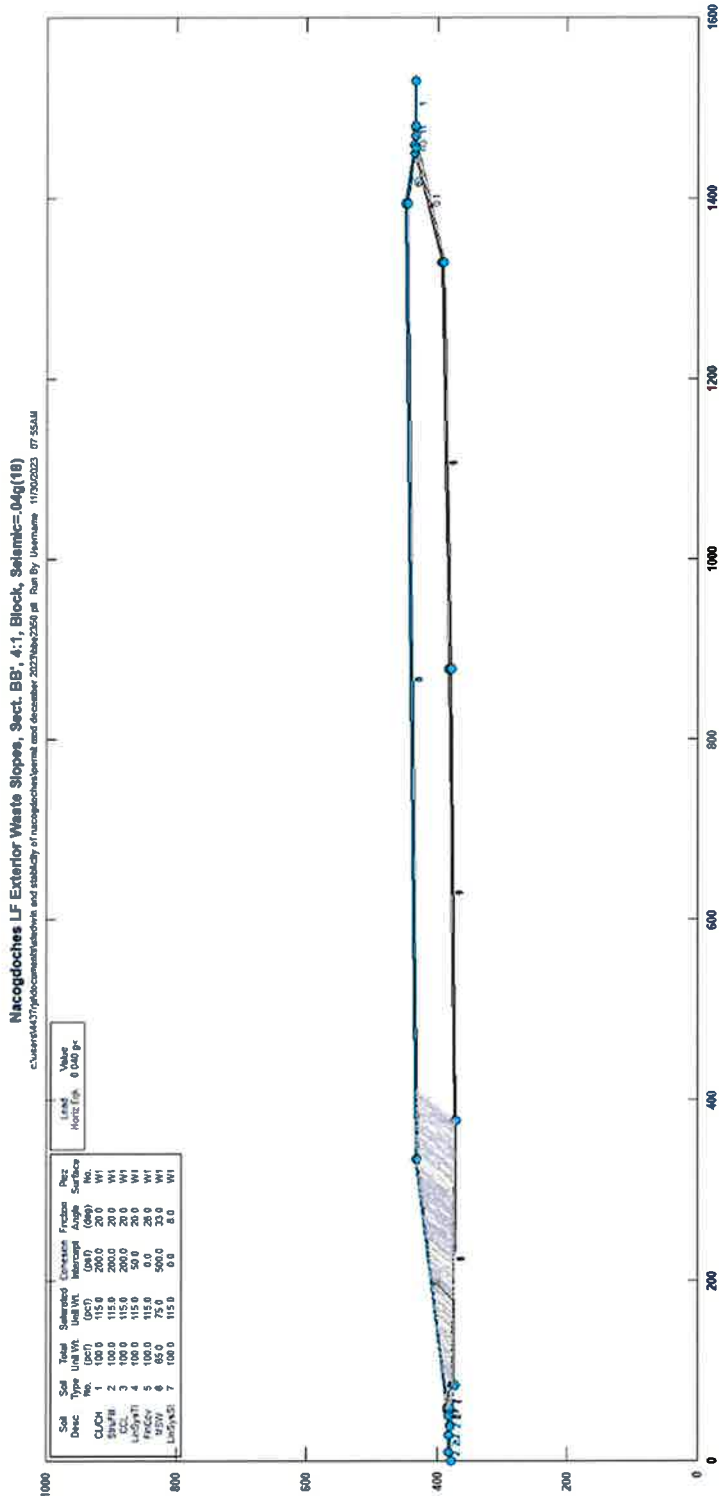

Nacogdoches LF Exterior Waste Slopes, Sect. BB', 4:1, Circle, Static(16)
PCSTABL5M/si FSmin=4.74
Safety Factors Are Calculated By The Modified Bishop Method

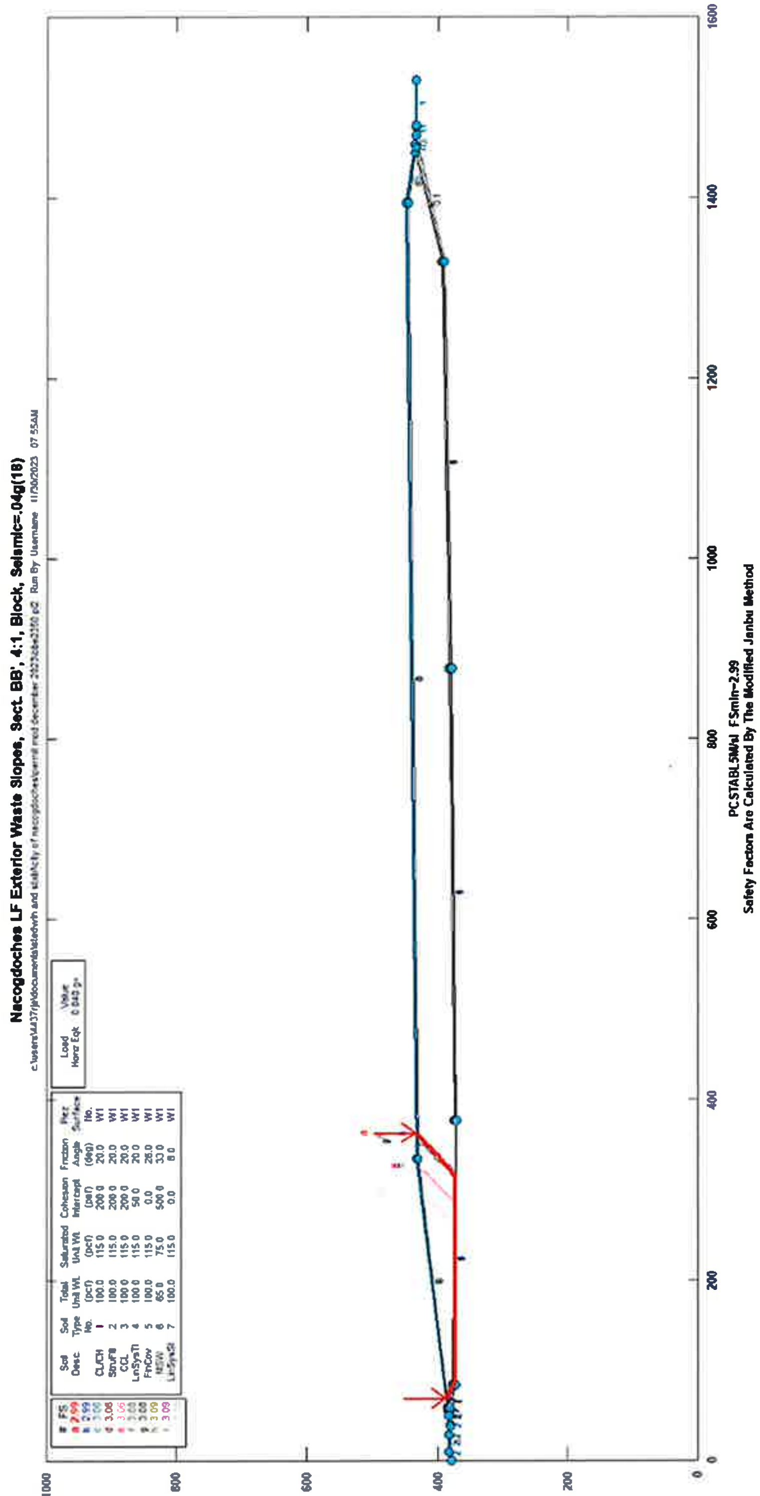

Nacogdoches LF Exterior Waste Slopes, Sect. BB', 4:1, Block, Static(16)
Ran By: Username 11/30/2023 07:54AM
Soil Desc. | Soil Type No. | Total Unit Wt. (pcf) | Saturated Unit Wt. (pcf) | Cohesion Intercept (psf) | Friction Angle (deg) | Piez. Surface No.
CL/CH 1 100.0 115.0 200.0 20.0 W1
StrwFill 2 100.0 115.0 200.0 20.0 W1
CCL 3 100.0 115.0 200.0 20.0 W1
LinSysTI 4 100.0 115.0 50.0 20.0 W1
FinCov 5 100.0 115.0 0.0 28.0 W1
MSW 6 65.0 75.0 500.0 33.0 W1
LinSysSl 7 100.0 115.0 0.0 8.0 W1
0
200
400
600
800
1000
1200
1400
1600

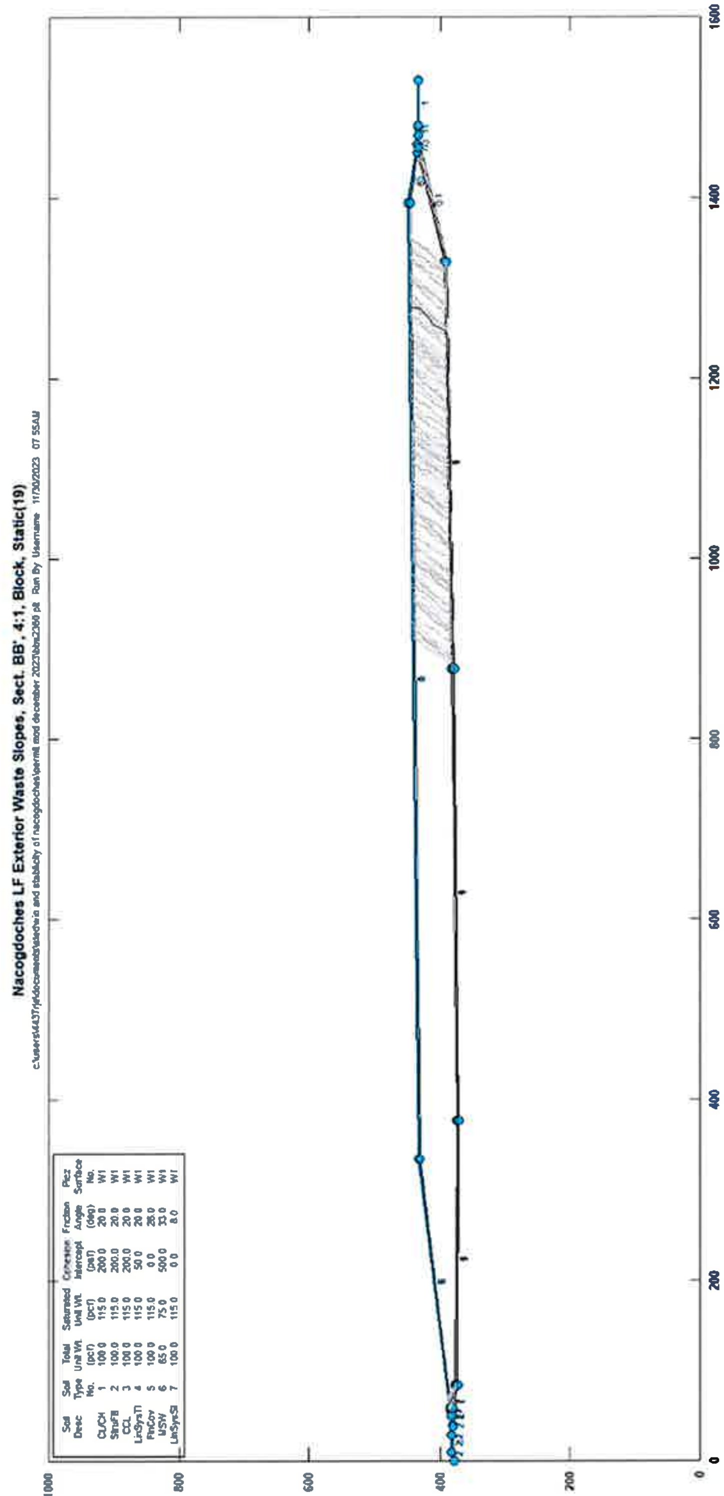

Nacogdoches LF Exterior Waste Slopes, Sect. BB', 4:1, Block, Static(16)
PCSTABL5M/si FSmin=3.79
Safety Factors Are Calculated By The Modified Janbu Method

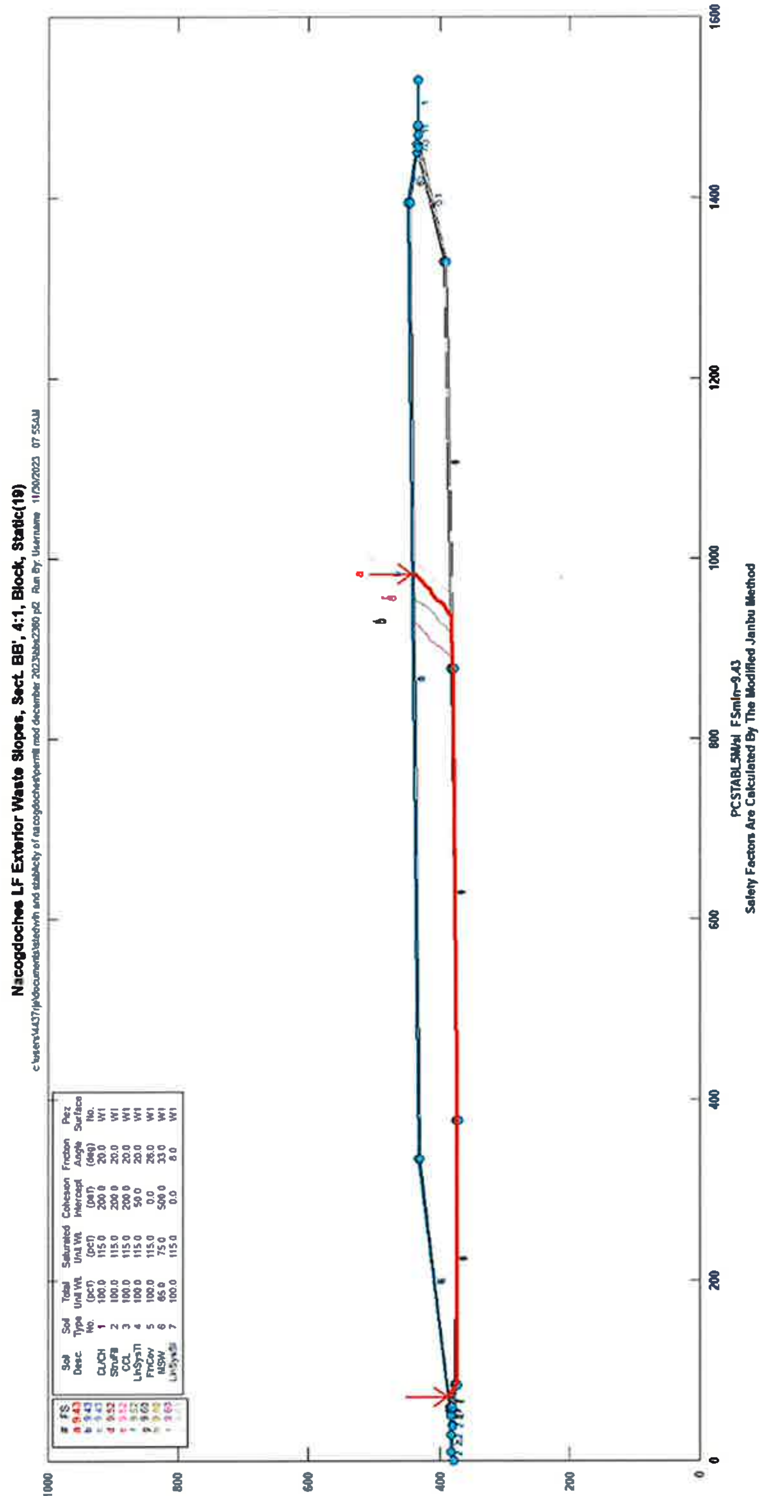

Nacogdoches LF Exterior Waste Slopes, Sect. BB', 4:1, Circle, Seismic=.04g(17)
0
200
400
600
800
1000
1200
1400
1600
0
200
400
600
800
1000


Nacogdoches LF Exterior Waste Slopes, Sect. BB', 4:1, Circle, Seismic=.04g(17)
PCSTABL5M/si FSmin=3.78
Safety Factors Are Calculated By The Modified Bishop Method
0
200
400
600
800
1000
1200
1400
1600


Nacogdoches LF Exterior Waste Slopes, Sect. BB', 4:1, Block, Seismic=.04g(18)
Run By: Username 11/30/2023 07:55AM
Soil Desc | Soil Type No. | Total Unit Wt. (pcf) | Saturated Unit Wt. (pcf) | Cohesion Intercept (psf) | Friction Angle (deg) | Piez Surface No.
CL/CH 1 100.0 115.0 200.0 20.0 W1
2 100.0 115.0 200.0 20.0 W1
3 100.0 115.0 200.0 20.0 W1
4 100.0 115.0 50.0 20.0 W1
5 100.0 115.0 0.0 28.0 W1
MSW 6 65.0 75.0 500.0 33.0 W1
7 100.0 115.0 0.0 8.0 W1
Value
0.040 g
1000
800
600
400
200
0
200
400
600
800
1000
1200
1400
1600


Nacogdoches LF Exterior Waste Slopes, Sect. BB', 4:1, Block, Seismic=.04g(18)
PCSTABL5M/sl FSmin=2.99
Safety Factors Are Calculated By The Modified Janbu Method


Nacogdoches LF Exterior Waste Slopes, Sect. BB', 4:1, Block, Static(19)
Soil Desc | Soil Type No. | Total Unit Wt. (pcf) | Saturated Unit Wt. (pcf) | Cohesion Intercept (psf) | Friction Angle (deg) | Piez Surface No.
CL/CH 1 100.0 115.0 200.0 20.0 W1
StrFill 2 100.0 115.0 200.0 20.0 W1
CCL 3 100.0 115.0 200.0 20.0 W1
LinSysTl 4 100.0 115.0 50.0 20.0 W1
FinCov 5 100.0 115.0 0.0 28.0 W1
MSW 6 65.0 75.0 500.0 33.0 W1
LinSysSl 7 100.0 115.0 0.0 8.0 W1
0
200
400
600
800
1000
1200
1400
1600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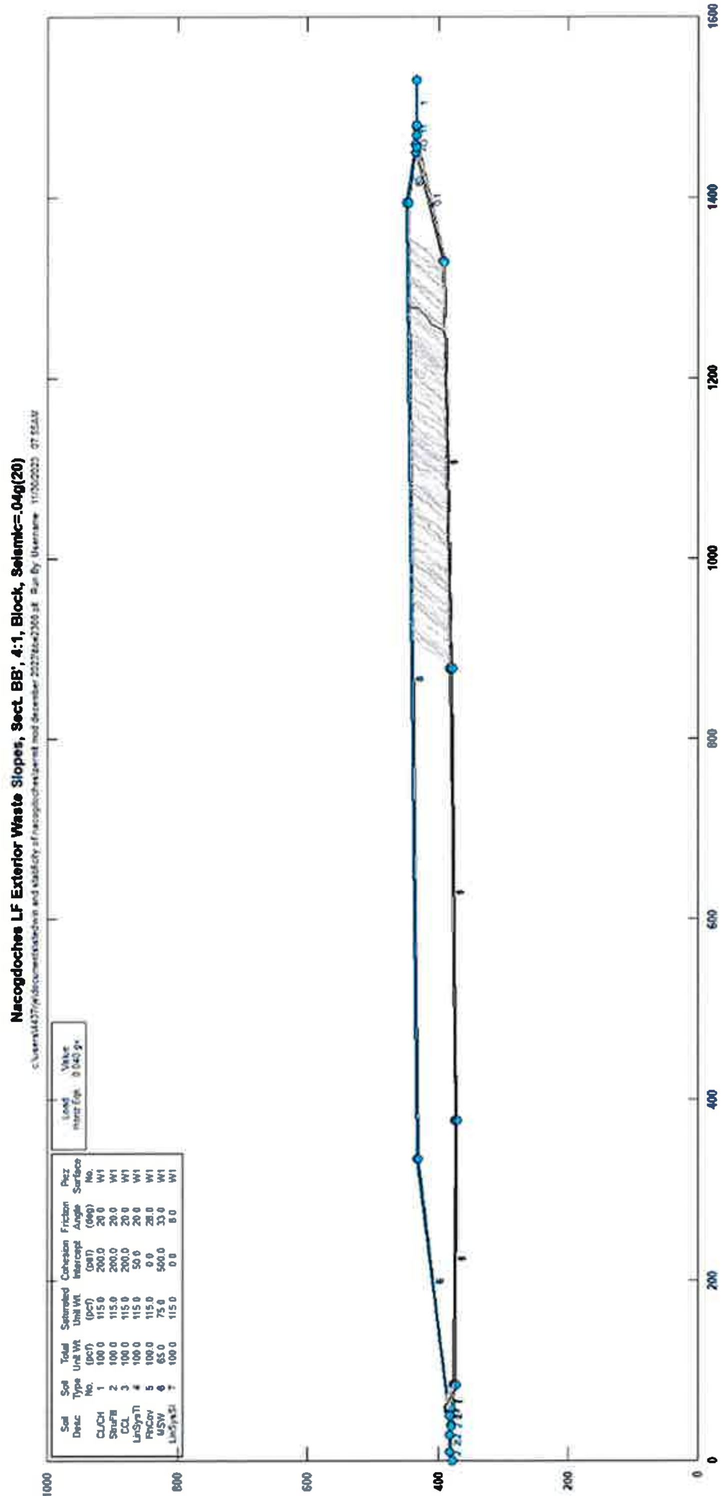
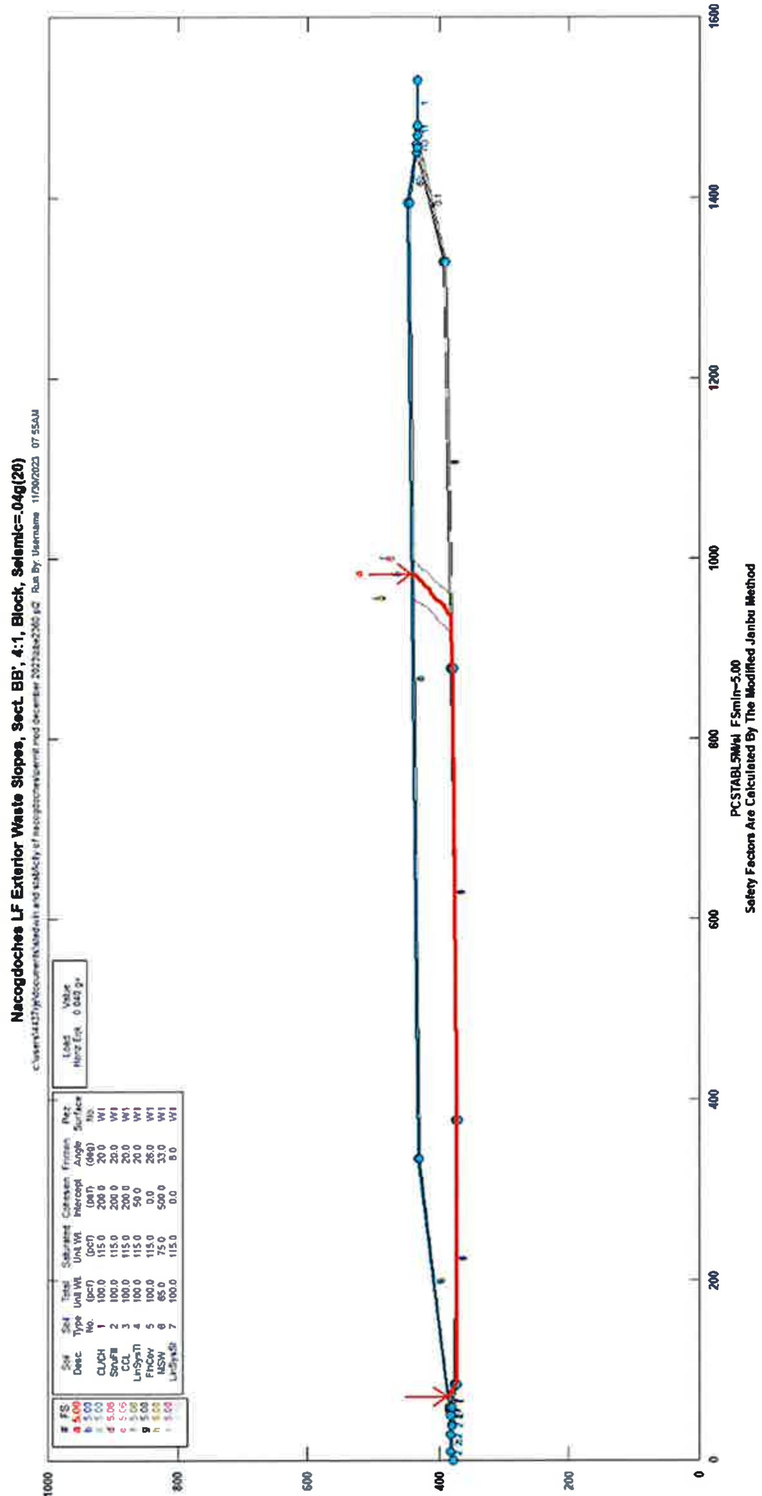
PCSTABL5M/si FSmin=9.43
Safety Factors Are Calculated By The Modified Janbu Method


Nacogdoches LF Exterior Waste Slopes, Sect. BB', 4:1, Block, Seismic=.04g(20)
Soil Desc. | Soil Type No. | Total Unit Wt. (pcf) | Saturated Unit Wt. (pcf) | Cohesion Intercept (psf) | Friction Angle (deg) | Piez Surface No.
CL/CH 1 100.0 115.0 200.0 20.0 W1
StruFill 2 100.0 115.0 200.0 20.0 W1
CCL 3 100.0 115.0 200.0 20.0 W1
LinSysTl 4 100.0 115.0 50.0 20.0 W1
FinCov 5 100.0 115.0 0.0 28.0 W1
MSW 6 65.0 75.0 500.0 33.0 W1
LinSysSl 7 100.0 115.0 0.0 8.0 W1
Load Value
Horiz Eqk 0.040 g<
0
200
400
600
800
1000
1200
1400
1600


Nacogdoches LF Exterior Waste Slopes, Sect. BB', 4:1, Block, Seismic=.04g(20)
PCSTABL5M/si FSmin=5.00
Safety Factors Are Calculated By The Modified Janbu Method
0
200
400
600
800
1000
1200
1400
1600

CITY OF NACOGDOCHES LANDFILL
NACOGDOCHES COUNTY, TEXAS
TCEQ PERMIT APPLICATION NO. MSW-720

PART III - SITE DEVELOPMENT PLAN
ATTACHMENT 15

Prepared for:

CITY OF NACOGDOCHES
4602 NW Stallings Drive
Nacogdoches, TX 75964

FOR PERMITTING
PURPOSES ONLY

5/7/24
STATE OF TEXAS
JEFFREY K. REED
80103
LICENSED
PROFESSIONAL ENGINEER

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Revision 4 – May 2024

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80103
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5/7/24

Appendices

FOR PERMITTING PURPOSES ONLY

CITY OF NACOGDOCHES LANDFILL
NACOGDOCHES COUNTY, TEXAS
TCEQ PERMIT APPLICATION NO. MSW-720

PART III - SITE DEVELOPMENT PLAN
ATTACHMENT 15, APPENDIX G
BLOCK O - LEACHATE GENERATION MODEL

FOR PERMITTING PURPOSES ONLY

5/7/24

STATE OF TEXAS
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Prepared for:

CITY OF NACOGDOCHES
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Revision 3 – May 2024
SCS Project No. 16209006.26

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APPENDIX G2

GEOCOMPOSITE DEMONSTRATION

SCS Engineers
TBPE Reg. # F-3407

STATE OF TEXAS
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LICENSED
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5/7/24

inclusive of pgs. G2-1 to G2-23

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Required:

Determine the hydraulic conductivity of the geocomposite drainage layer in the leachate collection system for use in the HELP model. This demonstration is based on the worst case conditions for leachate generation and geocomposite loading.

Method:

1. Determine the geocomposite thickness under the expected loading conditions.
2. Determine reduction factors for strength and environmental conditions based on expected duration in each stage of landfill development.
3. Compute the required minimum hydraulic conductivity of the geocomposite using the calculated reduction factors. The minimum hydraulic conductivity for the HELP modeling is designated as the minimum value that keeps the depth of leachate over the liner generally confined to the full thickness of the geocomposite drainage layer.
4. Using the hydraulic conductivity values from Method No. 3. (above), calculate minimum required transmissivity values for the geocomposite.
5. Obtain values for geocomposite transmissivity from manufacturer's data, and compare with the minimum required transmissivity values developed in Method Nos. 3. and 4. (above) to confirm that geocomposite properties used in the HELP model are representative of available geocomposites.

References:

1. Koerner, R.M., *Designing With Geosynthetics, Fifth Edition*, 2005.
2. Giroud, J.P., Zornberg, J.G., and Zhao, A., 2000, "Hydraulic Design of Geosynthetic and Granular Liquid Collection Layers", Geosynthetics International, Vol. 7, Nos. 4-6, pp. 285-380
3. GSE, FabriNet TRx Single-sided Geocomposite Transmissivity Data.

Solution:

1. Estimate geocomposite thickness for the worst case leachate generation and loading conditions, based on an initial thickness of 200 mils:

Assume the geocomposite will undergo linear compression due to weight of soil (i.e., daily, intermediate, or final cover and protective cover) and waste.

Unloaded Geocomposite Thickness =	0.20	in
Percent Thickness Retained When Subjected to 15,000 psf Surcharge =	80	%, as provided by manufacturer
Unit Weight of Waste =	65	pcf
Unit Weight of Soil Only =	120	pcf
Composite Unit Weight of Waste and Daily Cover = (80% Waste and 20% Daily Cover)	76	pcf

Table 1 - Geocomposite Thickness

Fill Condition	d_W[1] (ft)	d_S[2] (ft)	P[3] (psf)	t[4] (in)
Active	10	2.5	1,060	0.20
Interim	60	3.0	4,920	0.19
Final	60	4.5	5,100	0.19

[1] d_W is the depth of waste and daily cover soil above the geocomposite.

[2] d_S is the depth of soil (i.e., protective, daily, and intermediate) above the geocomposite.

[3] P is the pressure on the geocomposite due to the weight of the waste and soil.

[4] t is the thickness of the geocomposite after being subjected to linear compression.
t is calculated by equation (Initial Thickness) - (Max. Compression) x P/15,000.

2. Reduction Factors for Strength and Environmental Conditions

Table 2 - Reduction Factors

Environmental Condition	Range	Fill Condition Active[2] (10' Waste)	Interim (60' Waste)	Closed (60' Waste)
Geotextile Intrusion [1]	1.0 - 1.2	1.00	1.10	1.20
Creep Deformation [1]	1.4 - 2.0	1.00	1.60	1.80
Chemical Clogging [1,3]	1.5 - 2.0	1.00	1.50	2.00
Biological Clogging [3]	1.1 - 1.3	1.00	1.20	1.30
Composite Reduction Factor[4]	1.00 - 5.62	1.00	3.17	5.62

Notes:

[1] Range values for geotextile intrusion, creep deformation, and chemical clogging were obtained from Giroud, J.P., Zornberg, J.G., and Zhao, A., 2000, "Hydraulic Design of Geosynthetic and Granular Liquid Collection Layers", *Geosynthetics International*, Vol 7, Nos. 4-6, pp. 285-380.

[2] Reduction factors were assumed to be negligible for the active condition due to the short duration of this landfill condition.

[3] Range values for biological clogging were obtained from GRI Standard GC8, Geosynthetic Institute, 2001, "Determination of the Allowable Flow Rate of a Drainage Geocomposite".

[4] The Composite Reduction Factor is the product of all of the factors for the respective fill condition.

3. Develop and confirm assumptions for hydraulic conductivity (k) of the geocomposite for HELP model.

Table 3 - Assumed Hydraulic Conductivity

Fill Condition	d_W[1] (ft)	P[2] (psf)	t[3] (in)	Reduction[4] Factor	k_{min}[5] (cm/s)	Calculated Leachate Head (in)[6]
Active	10	1,060	0.20	1.00	9.00	0.20
Interim	60	4,920	0.19	3.17	4.00	0.19
Closed	60	5,100	0.19	5.62	2.00	0.001

[1] d_W is the depth of waste and daily cover above the geocomposite from Table 1.

[2] P is the pressure on the geocomposite due to the weight of the waste and soil from Table 1.

[3] t is the calculated geocomposite thickness from Table 1.

[4] Reduction Factors from Table 2.

[5] k is the assumed hydraulic conductivity value for HELP model to achieve the calculated leachate head within the geocomposite thickness. Reduction Factors will be applied to determine required minimum manufacturer transmissivity values, below.

[6] Calculated head on the liner, as calculated by HELP model, to achieve the calculated leachate head within the geocomposite thickness.

4. Using the hydraulic conductivity values from Table 3 (above), calculate minimum transmissivity values for use during design and specifying geocomposites.

$$T_{min} = ((t * 2.54 \text{ cm/in}) * k_{min}) * \text{Reduction Factor}$$

Table 4 - Minimum Required Transmissivity for Geocomposite Design

Fill Condition	P (psf)	t (in)	k_{min} (cm/s)	Reduction Factor	T_{min} (cm^2/sec)	**$T_{min\ Required}$ (m^3/sec/m)**
Active	1,060	0.20	9.00	1.00	4.57E+00	**4.57E-04**
Interim	4,920	0.19	4.00	3.17	6.12E+00	**6.12E-04**
Closed	5,100	0.19	2.00	5.62	5.42E+00	**5.42E-04**

5. Compare T_{min} values from Method No. 4 (above) with published manufacturer transmissivity values.

Table 5 - Comparison of Manufacturer's Reported Transmissivity to the Minimum Required Transmissivity

Fill Condition	P (psf)	T_{min} (m^2/sec) (see Table 4)	Manufacturer's Transmissivity Values: P (psf)	Manufacturer's Transmissivity Values: T_{man}[1,3] (m^3/sec/m)	**$T_{min} \leq T_{man}$ (Yes/No)**
Active	1,060	4.57E-04	1,000	1.00E-03	**Yes**
Interim	4,920	6.12E-04	4,920	7.34E-04	**Yes**
Closed	5,100	5.42E-04	5,100	7.21E-04	**Yes**

[1] Geocomposite Transmissivity values determined from tests with hydraulic gradient of 0.02. If higher gradient used by manufacturer to determine transmissivity, manufacturer will be required to certify that geocomposite will provide comparable drainage as described in Table 4, above.

[2] The product shown in the table is provided to demonstrate the availability of a product that will meet or exceed the required drainage characteristics. Other manufactured products, either bi-planar or tri-planar geocomposites are acceptable if confirmed to meet the minimum required transmissivity values indicated in Table 5 (above).

[3] The T_{man} value (i.e., as provided by geocomposite manufacturer), shown in the table above, is representative of the GSE 200-mil Fabrinet. The 1,000-psf surcharge (P) was taken directly from 100-hour Transmissivity Testing performed according to ASTM D 4716. The T_{man} values for the 4,920-psf and 5,100-psf surcharge conditions were interpolated from the 100-hr Transmissivity Test results.

Conclusion: As indicated in Table 5 and as shown on the HELP Model Summary Sheet, a geocomposite with drainage characteristics that meet or exceed the transmissivity values tested by the geocomposite manufacturer will be installed for the liner system, and such geocomposite will maintain less than 30 cm of leachate over the liner system.

HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE
HELP MODEL VERSION 4.0 BETA (2018)
DEVELOPED BY USEPA NATIONAL RISK MANAGEMENT RESEARCH LABORATORY

Title: Active, 10-foot Waste, 2.8% Slope... **Simulated On:** 5/2/2024 12:19

Layer 1
Type 1 - Vertical Percolation Layer (Cover Soil)
CL - Clay Loam
Material Texture Number 11

Thickness	=	6 inches
Porosity	=	0.464 vol/vol
Field Capacity	=	0.31 vol/vol
Wilting Point	=	0.187 vol/vol
Initial Soil Water Content	=	0.3573 vol/vol
Effective Sat. Hyd. Conductivity	=	6.40E-05 cm/sec

Layer 2
Type 1 - Vertical Percolation Layer (Waste)
Municipal Solid Waste (MSW) (900 pcy)
Material Texture Number 18

Thickness	=	120 inches
Porosity	=	0.671 vol/vol
Field Capacity	=	0.292 vol/vol
Wilting Point	=	0.077 vol/vol
Initial Soil Water Content	=	0.3058 vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E-03 cm/sec

Layer 3
Type 1 - Vertical Percolation Layer
CL - Clay Loam
Material Texture Number 11

Thickness	=	24 inches
Porosity	=	0.464 vol/vol
Field Capacity	=	0.31 vol/vol
Wilting Point	=	0.187 vol/vol
Initial Soil Water Content	=	0.3479 vol/vol
Effective Sat. Hyd. Conductivity	=	6.40E-05 cm/sec

Layer 4
Type 2 - Lateral Drainage Layer
Custom Geonet 1

Material Texture Number 123

Thickness	=	0.2	inches
Porosity	=	0.85	vol/vol
Field Capacity	=	0.01	vol/vol
Wilting Point	=	0.005	vol/vol
Initial Soil Water Content	=	0.0346	vol/vol
Effective Sat. Hyd. Conductivity	=	9.00E+00	cm/sec
Slope	=	2.8	%
Drainage Length	=	325	ft

Layer 5

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	=	1	Holes/Acre
FML Installation Defects	=	4	Holes/Acre
FML Placement Quality	=	3	Good

Layer 6

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	=	85	
Fraction of Area Allowing Runoff	=	0	%
Area projected on a horizontal plane	=	1	acres
Evaporative Zone Depth	=	6	inches
Initial Water in Evaporative Zone	=	2.144	inches
Upper Limit of Evaporative Storage	=	2.784	inches
Lower Limit of Evaporative Storage	=	1.122	inches
Initial Snow Water	=	0	inches

Initial Water in Layer Materials	=	57.439 inches
Total Initial Water	=	57.439 inches
Total Subsurface Inflow	=	0 inches/year

Note: SCS Runoff Curve Number was User-Specified.

Evapotranspiration and Weather Data

Station Latitude	=	31.37 Degrees
Maximum Leaf Area Index	=	0
Start of Growing Season (Julian Date)	=	55 days
End of Growing Season (Julian Date)	=	336 days
Average Wind Speed	=	11.3 mph
Average 1st Quarter Relative Humidity	=	69 %
Average 2nd Quarter Relative Humidity	=	69 %
Average 3rd Quarter Relative Humidity	=	62 %
Average 4th Quarter Relative Humidity	=	69 %

Note: Evapotranspiration data was obtained for NACOGDOCHES, TEXAS

Normal Mean Monthly Precipitation (inches)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
4.45	3.17	3.53	3.13	5.29	4.18
2.6	3.08	4.08	4.13	4.54	4.44

Note: Precipitation was simulated using HELP v3.07 data files for the following location: HOUSTON, TEXAS

Normal Mean Monthly Temperature (Degrees Fahrenheit)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
51.4	54.5	61	68.7	74.9	80.6
83.1	82.6	78.4	69.7	60.1	54

Note: Temperature was simulated using HELP v3.07 data files for the following location: HOUSTON, TEXAS
Solar radiation was simulated using HELP v3.07 data files for the following location: HOUSTON, TEXAS (Latitude: 31.37)

Average Annual Totals Summary

Title: Active, 10-foot Waste, 0.028 Slope, 325-foot drainage length
Simulated on: 5/2/2024 12:19

	Average Annual Totals for Years 1 - 30*			
	(inches)	[std dev]	(cubic feet)	(percent)
Precipitation	45.09	[6.73]	163,658.6	100.00
Runoff	0.000	[0]	0.0000	0.00
Evapotranspiration	25.498	[5.124]	92,557.4	56.56
Subprofile1				
Lateral drainage collected from Layer 4	19.6133	[5.0889]	71,196.1	43.50
Percolation/leakage through Layer 6	0.000020	[0.000004]	0.0714	0.00
Average Head on Top of Layer 5	0.0122	[0.0032]	---	---
Water storage				
Change in water storage	-0.0262	[1.8898]	-95.1	-0.06

* Note: Average inches are converted to volume based on the user-specified area.

Prep'd By: RJE
Chkd By:JKR
Date:05/09/2024

Peak Values Summary

Title: Active, 10-foot Waste, 0.028 Slope, 325-foot drainage length
Simulated on: 5/2/2024 12:20

	Peak Values for Years 1 - 30*	
	(inches)	(cubic feet)
Precipitation	4.62	16,770.6
Runoff	0.000	0.0000
Subprofile1		
Drainage collected from Layer 4	0.4208	1,527.6
Percolation/leakage through Layer 6	0.000000	0.0012
Average head on Layer 5	0.0958	---
Maximum head on Layer 5	0.1898	---
Location of maximum head in Layer 4	2.80 (feet from drain)	
Other Parameters		
Snow water	0.7003	2,542.1
Maximum vegetation soil water	0.4640 (vol/vol)	
Minimum vegetation soil water	0.1870 (vol/vol)	

Final Water Storage in Landfill Profile at End of Simulation Period

Title: Active, 10-foot Waste, 0.028 Slope, 325-foot drainage length
Simulated on: 5/2/2024 12:20
Simulation period: 30 years

	Final Water Storage	
Layer	(inches)	(vol/vol)
1	2.3610	0.3935
2	35.4100	0.2951
3	8.6187	0.3591
4	0.0158	0.0792
5	0.0000	0.0000
6	10.2480	0.4270
Snow water	0.0000	---

HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE
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Title: Interim, 60' Waste, 2.8% Slope... **Simulated On:** 5/2/2024 12:05

Layer 1
Type 1 - Vertical Percolation Layer (Cover Soil)
CL - Clay Loam
Material Texture Number 11

Thickness	=	12 inches
Porosity	=	0.464 vol/vol
Field Capacity	=	0.31 vol/vol
Wilting Point	=	0.187 vol/vol
Initial Soil Water Content	=	0.3419 vol/vol
Effective Sat. Hyd. Conductivity	=	6.40E-05 cm/sec

Layer 2
Type 1 - Vertical Percolation Layer (Waste)
Municipal Solid Waste (MSW) (900 pcy)
Material Texture Number 18

Thickness	=	720 inches
Porosity	=	0.671 vol/vol
Field Capacity	=	0.292 vol/vol
Wilting Point	=	0.077 vol/vol
Initial Soil Water Content	=	0.2945 vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E-03 cm/sec

Layer 3
Type 1 - Vertical Percolation Layer
CL - Clay Loam
Material Texture Number 11

Thickness	=	24 inches
Porosity	=	0.464 vol/vol
Field Capacity	=	0.31 vol/vol
Wilting Point	=	0.187 vol/vol
Initial Soil Water Content	=	0.3431 vol/vol
Effective Sat. Hyd. Conductivity	=	6.40E-05 cm/sec

Layer 4
Type 2 - Lateral Drainage Layer
Custom Geonet 2

Material Texture Number 143

Thickness	=	0.19	inches
Porosity	=	0.85	vol/vol
Field Capacity	=	0.01	vol/vol
Wilting Point	=	0.005	vol/vol
Initial Soil Water Content	=	0.0693	vol/vol
Effective Sat. Hyd. Conductivity	=	4.00E+00	cm/sec
Slope	=	2.8	%
Drainage Length	=	325	ft

Layer 5

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	=	1	Holes/Acre
FML Installation Defects	=	4	Holes/Acre
FML Placement Quality	=	3	Good

Layer 6

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	=	85	
Fraction of Area Allowing Runoff	=	100	%
Area projected on a horizontal plane	=	1	acres
Evaporative Zone Depth	=	12	inches
Initial Water in Evaporative Zone	=	4.103	inches
Upper Limit of Evaporative Storage	=	5.568	inches
Lower Limit of Evaporative Storage	=	2.244	inches
Initial Snow Water	=	0	inches

Initial Water in Layer Materials	=	234.629	inches
Total Initial Water	=	234.629	inches
Total Subsurface Inflow	=	0	inches/year

Note: SCS Runoff Curve Number was User-Specified.

Evapotranspiration and Weather Data

Station Latitude	=	31.37	Degrees
Maximum Leaf Area Index	=	2	
Start of Growing Season (Julian Date)	=	55	days
End of Growing Season (Julian Date)	=	336	days
Average Wind Speed	=	11.3	mph
Average 1st Quarter Relative Humidity	=	69	%
Average 2nd Quarter Relative Humidity	=	69	%
Average 3rd Quarter Relative Humidity	=	62	%
Average 4th Quarter Relative Humidity	=	69	%

Note: Evapotranspiration data was obtained for NACOGDOCHES, TEXAS

Normal Mean Monthly Precipitation (inches)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
4.45	3.17	3.53	3.13	5.29	4.18
2.6	3.08	4.08	4.13	4.54	4.44

Note: Precipitation was simulated using HELP v3.07 data files for the following location: HOUSTON, TEXAS

Normal Mean Monthly Temperature (Degrees Fahrenheit)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
51.4	54.5	61	68.7	74.9	80.6
83.1	82.6	78.4	69.7	60.1	54

Note: Temperature was simulated using HELP v3.07 data files for the following location: HOUSTON, TEXAS
Solar radiation was simulated using HELP v3.07 data files for the following location: HOUSTON, TEXAS (Latitude: 31.37)

Average Annual Totals Summary

Title: Interim, 60' Waste, 2.8% Slope, 325' Length
Simulated on: 5/2/2024 12:06

	Average Annual Totals for Years 1 - 30*			
	(inches)	[std dev]	(cubic feet)	(percent)
Precipitation	45.09	[6.73]	163,658.6	100.00
Runoff	3.516	[1.61]	12,763.0	7.80
Evapotranspiration	31.213	[2.692]	113,304.1	69.23
Subprofile1				
Lateral drainage collected from Layer 4	10.2136	[3.9162]	37,075.4	22.65
Percolation/leakage through Layer 6	0.000022	[0.000007]	0.0787	0.00
Average Head on Top of Layer 5	0.0143	[0.0055]	---	---
Water storage				
Change in water storage	0.1422	[3.4521]	516.0	0.32

* Note: Average inches are converted to volume based on the user-specified area.

Prep'd By: RJE
Chkd By:JKR
Date:05/09/2024

Peak Values Summary

Title: Interim, 60' Waste, 2.8% Slope, 325' Length
Simulated on: 5/2/2024 12:06

	Peak Values for Years 1 - 30*	
	(inches)	(cubic feet)
Precipitation	4.62	16,770.6
Runoff	2.340	8,495.8
Subprofile1		
Drainage collected from Layer 4	0.1910	693.2
Percolation/leakage through Layer 6	0.000000	0.0012
Average head on Layer 5	0.0978	---
Maximum head on Layer 5	0.1938	---
Location of maximum head in Layer 4	2.85 (feet from drain)	
Other Parameters		
Snow water	0.7003	2,542.1
Maximum vegetation soil water	0.4516 (vol/vol)	
Minimum vegetation soil water	0.1870 (vol/vol)	

Prep'd By: RJE
Chkd By:JKR
Date:05/09/2024

Final Water Storage in Landfill Profile at End of Simulation Period

Title: Interim, 60' Waste, 2.8% Slope, 325' Length
Simulated on: 5/2/2024 12:06
Simulation period: 30 years

Layer	Final Water Storage (inches)	Final Water Storage (vol/vol)
1	3.7279	0.3107
2	215.5460	0.2994
3	9.3178	0.3882
4	0.0541	0.2849
5	0.0000	0.0000
6	10.2480	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: Closed, 2% Slope, 200' Length **Simulated On:** 5/2/2024 12:09

Layer 1
Type 1 - Vertical Percolation Layer (Cover Soil)
CL - Clay Loam
Material Texture Number 11

Thickness	=	6	inches
Porosity	=	0.464	vol/vol
Field Capacity	=	0.31	vol/vol
Wilting Point	=	0.187	vol/vol
Initial Soil Water Content	=	0.4536	vol/vol
Effective Sat. Hyd. Conductivity	=	6.40E-05	cm/sec

Layer 2
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	=	1	Holes/Acre
FML Installation Defects	=	4	Holes/Acre
FML Placement Quality	=	3	Good

Layer 3
Type 1 - Vertical Percolation Layer
Custom Soil 1
Material Texture Number 43

Thickness	=	18	inches
Porosity	=	0.427	vol/vol
Field Capacity	=	0.418	vol/vol
Wilting Point	=	0.367	vol/vol
Initial Soil Water Content	=	0.4094	vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E-05	cm/sec

Layer 4
Type 1 - Vertical Percolation Layer
CL - Clay Loam
Material Texture Number 11

Thickness	=	6 inches
Porosity	=	0.464 vol/vol
Field Capacity	=	0.31 vol/vol
Wilting Point	=	0.187 vol/vol
Initial Soil Water Content	=	0.31 vol/vol
Effective Sat. Hyd. Conductivity	=	6.40E-05 cm/sec

Layer 5

Type 1 - Vertical Percolation Layer (Waste)
Municipal Solid Waste (MSW) (900 pcy)
Material Texture Number 18

Thickness	=	720 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 6

Type 1 - Vertical Percolation Layer
CL - Clay Loam
Material Texture Number 11

Thickness	=	24 inches
Porosity	=	0.464 vol/vol
Field Capacity	=	0.31 vol/vol
Wilting Point	=	0.187 vol/vol
Initial Soil Water Content	=	0.31 vol/vol
Effective Sat. Hyd. Conductivity	=	6.40E-05 cm/sec

Layer 7

Type 2 - Lateral Drainage Layer
Custom Geonet 1
Material Texture Number 123

Thickness	=	0.19 inches
Porosity	=	0.85 vol/vol
Field Capacity	=	0.01 vol/vol
Wilting Point	=	0.005 vol/vol
Initial Soil Water Content	=	0.0116 vol/vol
Effective Sat. Hyd. Conductivity	=	2.00E+00 cm/sec
Slope	=	2 %
Drainage Length	=	200 ft

Layer 8

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	=	1 Holes/Acre
FML Installation Defects	=	4 Holes/Acre
FML Placement Quality	=	3 Good

Layer 9
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	=	85
Fraction of Area Allowing Runoff	=	100 %
Area projected on a horizontal plane	=	1 acres
Evaporative Zone Depth	=	6 inches
Initial Water in Evaporative Zone	=	2.721 inches
Upper Limit of Evaporative Storage	=	2.784 inches
Lower Limit of Evaporative Storage	=	1.122 inches
Initial Snow Water	=	0 inches
Initial Water in Layer Materials	=	239.88 inches
Total Initial Water	=	239.88 inches
Total Subsurface Inflow	=	0 inches/year

Note: SCS Runoff Curve Number was User-Specified.

Evapotranspiration and Weather Data

Station Latitude	=	31.37 Degrees
Maximum Leaf Area Index	=	3.5
Start of Growing Season (Julian Date)	=	55 days
End of Growing Season (Julian Date)	=	336 days

Average Wind Speed	=	11.3 mph
Average 1st Quarter Relative Humidity	=	69 %
Average 2nd Quarter Relative Humidity	=	69 %
Average 3rd Quarter Relative Humidity	=	62 %
Average 4th Quarter Relative Humidity	=	69 %

Note: Evapotranspiration data was obtained for NACOGDOCHES, TEXAS

Normal Mean Monthly Precipitation (inches)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
4.45	3.17	3.53	3.13	5.29	4.18
2.6	3.08	4.08	4.13	4.54	4.44

Note: Precipitation was simulated using HELP v3.07 data files for the following location:
HOUSTON, TEXAS

Normal Mean Monthly Temperature (Degrees Fahrenheit)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
51.4	54.5	61	68.7	74.9	80.6
83.1	82.6	78.4	69.7	60.1	54

Note: Temperature was simulated using HELP v3.07 data files for the following location:
HOUSTON, TEXAS
Solar radiation was simulated using HELP v3.07 data files for the following location:
HOUSTON, TEXAS (Latitude: 31.37)

Prep'd By: RJE
Chkd By:JKR
Date:05/09/2024

Average Annual Totals Summary

Title: Closed, 2% Slope, 200' Length
Simulated on: 5/2/2024 12:11

	Average Annual Totals for Years 1 - 30*			
	(inches)	[std dev]	(cubic feet)	(percent)
Precipitation	45.09	[6.73]	163,658.6	100.00
Runoff	13.984	[5.121]	50,761.5	31.02
Evapotranspiration	31.053	[2.761]	112,722.7	68.88
Subprofile1				
Percolation/leakage through Layer 2	0.045954	[0.006734]	166.8	0.10
Average Head on Top of Layer 2	1.7634	[0.2677]	---	---
Subprofile2				
Lateral drainage collected from Layer 7	0.0460	[0.0067]	166.8	0.10
Percolation/leakage through Layer 9	0.000002	[0]	0.0065	0.00
Average Head on Top of Layer 8	0.0001	[0]	---	---
Water storage				
Change in water storage	0.0021	[0.568]	7.5660	0.00

* Note: Average inches are converted to volume based on the user-specified area.

Peak Values Summary

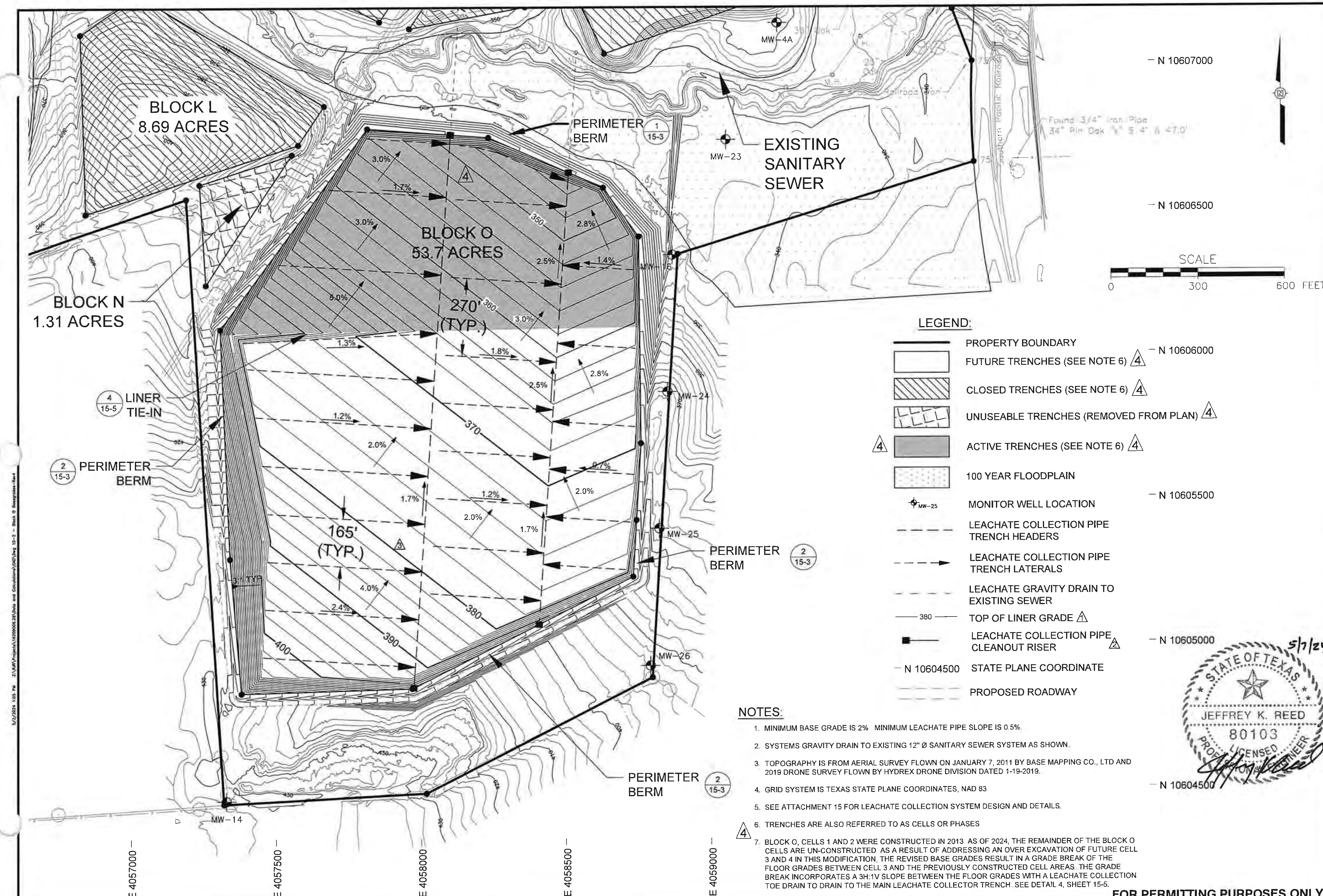
Title: Closed, 2% Slope, 200' Length
Simulated on: 5/2/2024 12:11

	Peak Values for Years 1 - 30*	
	(inches)	(cubic feet)
Precipitation	4.62	16,770.6
Runoff	4.085	14,827.1
Subprofile1		
Percolation/leakage through Layer 2	0.000415	1.5059
Average head on Layer 2	6.0000	
Subprofile2		
Drainage collected from Layer 7	0.0004	1.4913
Percolation/leakage through Layer 9	0.000000	0.0000
Average head on Layer 8	0.0004	---
Maximum head on Layer 8	0.0007	---
Location of maximum head in Layer 7	0.00 (feet from drain)	
Other Parameters		
Snow water	0.7003	2,542.1
Maximum vegetation soil water	0.4640 (vol/vol)	
Minimum vegetation soil water	0.1870 (vol/vol)	

Final Water Storage in Landfill Profile at End of Simulation Period

Title: Closed, 2% Slope, 200' Length
Simulated on: 5/2/2024 12:11
Simulation period: 30 years

	Final Water Storage	
Layer	(inches)	(vol/vol)
1	2.7840	0.4640
2	0.0000	0.0000
3	7.3688	0.4094
4	1.8600	0.3100
5	210.2400	0.2920
6	7.4400	0.3100
7	0.0021	0.0108
8	0.0000	0.0000
9	10.2480	0.4270
Snow water	0.0000	---



NOTES:

1. MINIMUM BASE GRADE IS 2% MINIMUM LEACHATE PIPE SLOPE IS 0.5%.
2. SYSTEMS GRAVITY DRAIN TO EXISTING 12" Ø SANITARY SEWER SYSTEM AS SHOWN.
3. TOPOGRAPHY IS FROM AERIAL SURVEY FLOWN ON JANUARY 7, 2011 BY BASE MAPPING CO., LTD AND 2019 DRONE SURVEY FLOWN BY HYDREX DRONE DIVISION DATED 1-19-2019.
4. GRID SYSTEM IS TEXAS STATE PLANE COORDINATES, NAD 83
5. SEE ATTACHMENT 15 FOR LEACHATE COLLECTION SYSTEM DESIGN AND DETAILS.
6. TRENCHES ARE ALSO REFERRED TO AS CELLS OR PHASES
7. BLOCK O, CELLS 1 AND 2 WERE CONSTRUCTED IN 2013 AS OF 2024, THE REMAINDER OF THE BLOCK O CELLS ARE UN-CONSTRUCTED AS A RESULT OF ADDRESSING AN OVER EXCAVATION OF FUTURE CELL 3 AND 4 IN THIS MODIFICATION, THE REVISED BASE GRADES RESULT IN A GRADE BREAK OF THE FLOOR GRADES BETWEEN CELL 3 AND THE PREVIOUSLY CONSTRUCTED CELL AREAS THE GRADE BREAK INCORPORATES A 3H:1V SLOPE BETWEEN THE FLOOR GRADES WITH A LEACHATE COLLECTION TOE DRAIN TO DRAIN TO THE MAIN LEACHATE COLLECTOR TRENCH. SEE DETAIL 4, SHEET 15-5.

STATE OF TEXAS
JEFFREY K. REED
80103
LICENSED
PROFESSIONAL ENGINEER
5/7/24

FOR PERMITTING PURPOSES ONLY

REV	DATE	DESCRIPTION	BY
4	05/2024	REVISE LEGEND, NOTES, AND ADD DETAIL	SCS
3	12/2023	REVISE BLOCK O BASE GRADES AND LCS	SCS
2	8/2019	REVISE BLOCK O, LCS	SCS
1	8/2013	REVISED LEGEND	JKR

TEXAS BOARD OF PROFESSIONAL ENGINEERS REG. NO. F-3407

DRAWING TITLE

BASE GRADES - BLOCK O

PROJECT TITLE

LANDFILL RECONFIGURATION PERMIT MODIFICATION

CLIENT

CITY OF NACOGDOCHES LANDFILL

PERMIT NO. MSW-720
NACOGDOCHES, NACOGDOCHES COUNTY, TEXAS

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT
CONSULTING ENGINEERS
12651 BRIAR FOREST, SUITE 205, HOUSTON, TX 77077
PH (281) 397-6747 FAX NO. (281) 293-7878

PROJ. NO. 16209006.02	DWN. BY: RLD	Q/A RVW BY: JRM
DSN. BY: RLD	CHK. BY: JKR	APP. BY: JKR

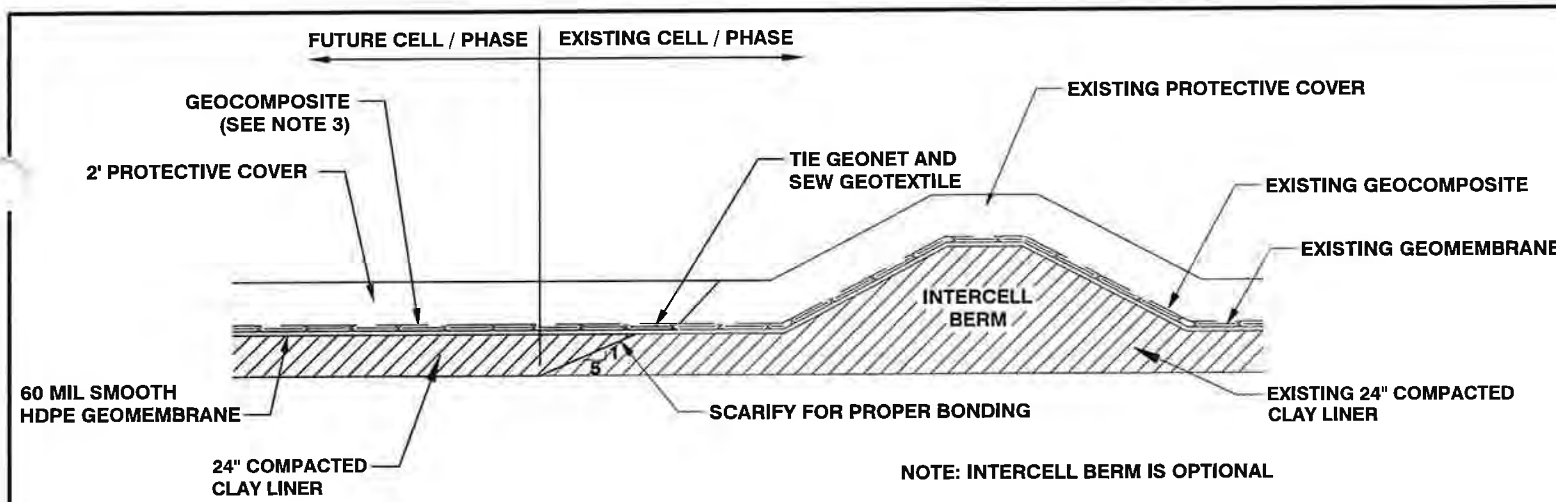
CADD FILE: DWG 15-2 - BLOCK O BASEGRADES-REV4

DATE: 6-2011

SCALE: AS SHOWN

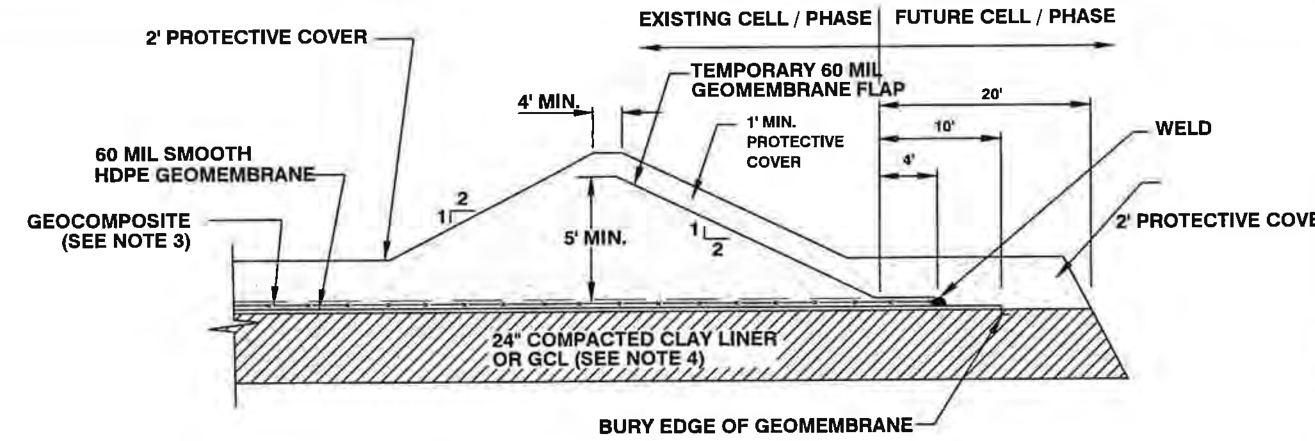
DRAWING NO.

15-2



LINER TIE-IN TO ADJACENT CELL AT INTERCELL BERM

1 / 15-5 — NOT TO SCALE (Rev. 1)

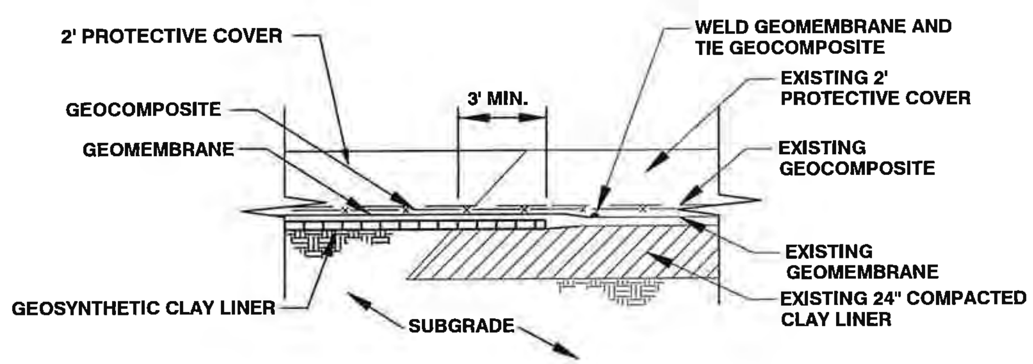


TEMPORARY RAINFLAP

2 / 15-5 — NOT TO SCALE (Rev. 1)

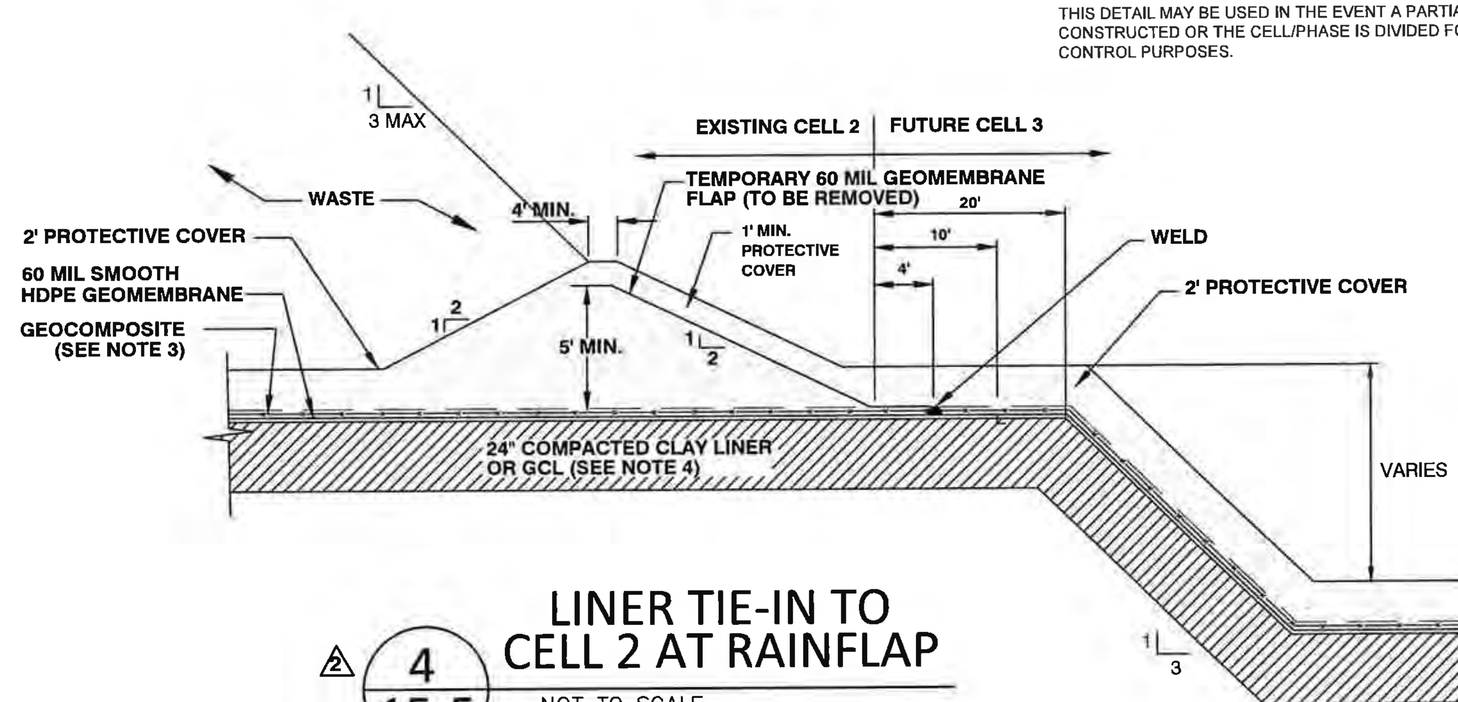
NOTE:

THIS DETAIL MAY BE USED IN THE EVENT A PARTIAL CELL IS CONSTRUCTED OR THE CELL/PHASE IS DIVIDED FOR STORMWATER CONTROL PURPOSES.



LINER TIE-IN TO ADJACENT CELL (GCL/CCL)

3 / 15-5 — NOT TO SCALE (Rev. 1)



LINER TIE-IN TO CELL 2 AT RAINFLAP

4 / 15-5 — NOT TO SCALE (Rev. 2)

NOTES:

1. ALL DIMENSIONS INDICATE MINIMUM VALUES UNLESS OTHERWISE NOTED
2. GEOCOMPOSITE DRAINAGE LAYER SHALL HAVE A MINIMUM TRANSMISSIVITY OF $1E^{-4}M^2$/SEC AT A GRADIENT OF 0.1 UNDER A LOAD OF 10,000 P.S.F. DOUBLE SIDED GEOCOMPOSITE SHALL BE HEAT-BONDED BOTH SIDES.
3. THE DRAINAGE LAYER ON THE CELL FLOOR SHALL CONSIST OF A SINGLE-SIDED GEOCOMPOSITE ON SMOOTH GEOMEMBRANE. TEXTURED GEOMEMBRANE MAY BE USED ON FLOOR WITH DOUBLE-SIDED GEOCOMPOSITE
4. FOR BLOCK O, A REINFORCED GEOSYNTHETIC CLAY LINER MAY BE USED IN LEIU OF A 2' COMPACTED CLAY LINER. (Rev. 1)

REV	DATE	DESCRIPTION	BY
2	05/2024	ADDED DETAIL 4.	SCS
1	8/2013	ADDED GCL/CCL LINER TIE-IN	JKR

TEXAS BOARD OF PROFESSIONAL ENGINEERS REG. NO. F-3407

DRAWING TITLE: LINER SYSTEM DETAILS

PROJECT TITLE: LANDFILL RECONFIGURATION PERMIT MODIFICATION

CLIENT: CITY OF NACOGDOCHES LANDFILL
PERMIT NO. MSW-720
NACOGDOCHES, NACOGDOCHES COUNTY, TEXAS

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT CONSULTING ENGINEERS
12651 BRIAR FOREST, SUITE 205, HOUSTON, TX 77077
PH (281) 397-6747 FAX NO. (281) 293-7878

PROJ. NO. 16209006.02 | DWN. BY: JMG | CHK. BY: RLD | DSN. BY: | Q/A RVW BY: | APP. BY:

CADD FILE: DWG 15-5 LINER SYSTEM DET-REV2

DATE: 6/2011

SCALE: AS SHOWN

DRAWING NO. 15-5

Attachment No. 3

Redline/Strikeout Pages

Texas Commission on Environmental Quality

Application Form for Municipal Solid Waste Permit or Registration Modification or Temporary Authorization

Application Tracking Information

Facility Name: City of Nacogdoches Landfill

Permittee or Registrant Name: City of Nacogdoches

MSW Authorization Number: MSW-720

Initial Submission Date: 01/24/2024

Revision Date: 05/09/2024

Instructions for completing this form are provided in form TCEQ-20650-instr[1]. If you have questions, contact the Municipal Solid Waste Permits Section by email to mswper@tceq.texas.gov, or by phone at 512-239-2335.

Application Data

1. Submission Type

- [x] Initial Submission
- [x] Notice of Deficiency (NOD) Response

2. Authorization Type

- [x] Permit
- [ ] Registration

3. Application Type

- [x] Modification with Public Notice
- [ ] Modification without Public Notice
- [ ] Temporary Authorization (TA)
- [ ] Modification for Name Change or Transfer

4. Application Fee

Amount

The application fee for a modification or temporary authorization is $150.

Payment Method

- [ ] Check
- [x] Online through ePay portal www3.tceq.texas.gov/epay/

If paid online, enter ePay Trace Number: 683354, 683355

[1] www.tceq.texas.gov/downloads/permitting/waste-permits/msw/forms/20650-instr.pdf

5. Application URL

For modifications that require notice (other than those for arid exempt landfills), provide the URL address of a publicly accessible internet web site where the application and all revisions to the application will be posted:

https://www.scsengineers.com/state/

6. Party Responsible for Mailing Notice

For modifications that require notice, indicate who will be responsible for mailing notice:

☒ Applicant ☐ Agent in Service ☐ Consultant

Contact Name: Case Opperman, PE

Title: Director of Public Works/City Engineer

Email Address: oppermanc@nactx.us

7. Confidential Documents

Does the application contain confidential documents?

☐ Yes ☒ No

If "Yes", reference the confidential documents in the application, but submit the confidential documents as an attachment in a separate binder marked "CONFIDENTIAL."

8. Facility General Information

Facility Name: City of Nacogdoches Landfill

Contact Name: Case Opperman, PE Title: Director of Public Works/City Engineer

MSW Authorization Number (if existing): MSW-720

Regulated Entity Reference Number: **RN** 102217395

Physical or Street Address: 4602 NW Stallings Drive

City: Nacogdoches County: Nacogdoches State: TX Zip Code: 75964

Phone Number: 936/559-2583

Latitude (Degrees, Minutes Seconds): N 31° 38' 57"

Longitude (Degrees, Minutes Seconds): W 94° 40' 86" (36")

9. Facility Types

☒ Type I ☐ Type IV ☐ Type V

☐ Type IAE ☐ Type IVAE ☐ Type VI

10. Description of the Revisions to the Facility

Provide a brief description of revisions to permit or registration conditions and supporting documents referred to by the permit or registration, and a reference to the specific provisions under which the modification or temporary authorization application is being made. Also, provide an explanation of why the modification or temporary authorization is needed:

This modification request is to revise the base and final grades of Block O. This change is being made under 30 TAC §305.70(k)(8) and (9). This modification is to compensate for over excavated areas of future cells in Block O.

11. Facility Contact Information

Site Operator (Permittee or Registrant)

Name: City of Nacogdoches

Customer Reference Number: **CN** 600134076

Contact Name: Case Opperman, PE Title: Director of Public Works/City Engineer

Mailing Address: P.O. Box 635030

City: Nacogdoches County: Nacogdoches State: TX Zip Code: 75963

Phone Number: (936) 559-2515

Email Address: oppermanc@nactx.us

Texas Secretary of State (SOS) Filing Number: ____________

Operator (if different from *Site Operator*)

Name: ____________

Customer Reference Number: **CN**____________

Contact Name: ____________ Title: ____________

Mailing Address: ____________

City: ____________ County: ____________ State: _____ Zip Code: _____

Phone Number: ____________

Email Address: ____________

Texas Secretary of State (SOS) Filing Number: ____________

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SCS Engineers
TBPE Reg. # F-3407

STATE OF TEXAS
JEFFREY K. REED
80103
LICENSED
PROFESSIONAL ENGINEER

1/19/24

FOR PERMITTING PURPOSES ONLY

31 TAC 330.54 - .56 PART III SITE DEVELOPMENT PLAN

SCS Engineers
TBPE Reg. # F-3407
1/19/24
STATE OF TEXAS
JEFFREY K. REED
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UPDATE

VOLUME 2

UPDATE

SCS Engineers
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1/19/24

STATE OF TEXAS
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SCS Engineers
TBPE Reg. # F-3407

1/19/24

STATE OF TEXAS
JEFFREY K. REED
80103
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PART III, ATTACHMENT 6, APPENDIX A

Top Dome Surface and External Embankment Erosion Control Plan

CITY OF NACOGDOCHES LANDFILL
TCEQ PERMIT MSW-720
NACOGDOCHES, TEXAS

TOP DOME SURFACE AND EXTERNAL EMBANKMENT EROSION CONTROL PLAN

PART III, ATTACHMENT 6, APPENDIX A

Prepared for:

CITY OF NACOGDOCHES
P.O. Box 635030
Nacogdoches, Texas 75963

Prepared by:

SCS ENGINEERS
Texas Board of Professional Engineers Registration No. F-3407
12651 Briar Forest Dr., Suite 205
Houston, Texas 77077

UPDATE

FEBRUARY 2011
Revision 1 – September 2019
Revision 2 – December 2023
Revision 3- May 2024

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UPDATE

STATE OF TEXAS
JAMES ROY MURRAY III
73860
LICENSED
PROFESSIONAL ENGINEER
12/12/23
SCS Engineers
TBPE Reg. # F-3407

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 designed in accordance with 30 TAC §§330.63(c), 330.303, and 330.305);

b) have received intermediate or final cover; and,

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

For example, after an above grade slope has reached the permitted elevation, the intermediate cover will be provided and structural erosion control features (e.g., diversion dikes, letdown structures, and/or silt fence) will be in-place within 180 days of placement of intermediate cover. If an external slope has received intermediate cover, but is not at the final permitted grade and the area will not receive waste for a period greater than 180 days, erosion control features will be in-place within 180 days of placement of the intermediate cover.

1.0.1 EROSION ANALYSIS RESULTS

Existing vegetated intermediate covered slopes with a minimum of 60 percent vegetated coverage will not require additional structural erosion controls for top dome surfaces with ~~1,710~~1,670 feet or less drainage flow lengths, and 25% external embankment side slopes with 780 feet or less drainage flow lengths. All Blocks yet to receive final cover (Blocks O and P) have soil losses well below the TCEQ minimum of 50 tons per acre per year. Block O, with a flow length of ~~1,930~~1,890 feet and 60 percent vegetative coverage, has a soil loss of 21.20 tons per acre per year. Block P, with a flow length of 480 feet and 60 percent vegetative coverage, has a soil loss of 22.76 tons per acre per year. These calculations are included in Appendix III-6A-2. For additional discussion, see Section 1.1.1.1, Non-erosive Slopes.

Slopes which drain to ongoing waste placement areas, pre-excavated areas, areas that have received only daily cover or areas under construction which have not received waste are not considered external side slopes.

Site perimeter drainage features such as perimeter drainage channels and toe berms will be constructed adjacent to and downstream of areas to be excavated for waste fill. In some cases, the slopes drain directly into the existing creek. These drainage features will be constructed in accordance with the Part III, Attachment 6, Groundwater and Surface Water Protection Plan and Drainage Plan.

The top dome surfaces will be filled to non-erosive grades, not exceeding 5 percent. Top dome surfaces will be graded to sheet flow with non erosive velocities and acceptable soil losses and therefore will not require any water diversion. The top dome surface will establish a minimum 60 percent vegetative coverage or utilize mulch stabilization or erosion control matting to accomplish the 60 percent coverage within 180 days. Water handling devices; including diversion dikes, let-down structures, and silt fence, as described in Section 1.1.2, will be utilized at the base of the surface.

Top dome surfaces will have a maximum sheetflow length of ~~1,710~~1,670 feet (130 feet for 10% slopes and 1,540 feet for 3.~~7~~2% slopes) and 350 feet for 5% slopes. Top dome surfaces with 3.~~7~~2% slopes will have velocities of 1.~~82~~62 feet per second (fps) and a shear stress of 0.1~~6~~4 pounds per square foot (psf). Top dome surfaces with 5% slopes will have velocities of 1.14 feet per second (fps) and a shear stress of 0.08 pounds per square foot (psf). Top dome surfaces with 10% slopes will have velocities of 0.60 feet per second (fps) and a shear stress of 0.18 pounds per square foot (psf). According to the Texas Department of Transportation Hydraulic Design Manual, Revised March 2009 (TxDOT Manual) the values for "Permissible Shear Stresses for Various Linings" for a vegetated lining is 0.35 psf to 3.70 psf. The top dome surface will establish a minimum 60 percent vegetative coverage or equivalent cover with primary grind mulch. Where vegetative cover is utilized, interim top dome and external embankment slopes may be seeded with winter rye or other seed mixture determined to be effective at stabilizing soils. Native grasses are the most likely vegetation to establish and thrive on the top dome and external embankment slopes. The native grasses in the area of the landfill consist primarily of Bermuda, with some Foxtail Millet. Other grasses that are found in the vicinity of the landfill include Little Bluestem, Indian Grass, and Switchgrass. These grasses are similar to the Retardance Class C from the "Retardance Class for Lining Materials" table found in the TxDOT Manual and are reflective of the grasses and cover conditions evident on the existing waste hills at the site. Retardance Class E consists of Burmuda Grass in either good stand, cut to 1.5 inches, or burned stubble. Since this scenario is not reflective of any the grasses or cover conditions seen at the site, Retardance Class E is eliminated. For determining the Permissible Shear Stress, Retardance Class C, with a Permissible Shear Stress of 1.00 would correspond to the conditions evident at the landfill; however, to be conservative, for these calculations, a Permissible Shear Stress for Retardance Class D of 0.60 is used to evaluate top dome and external embankment flows. The 5 percent top dome surface with 350 feet of sheetflow will have a maximum shear stress of 0.08 psf, well below the 0.60 psf permissible shear stress. The 3.~~7~~2 percent top dome surface with ~~1,710~~1,540 feet of sheetflow will have a maximum shear stress of 0.1~~6~~4 psf, also well below the 0.60 psf permissible shear stress. The 10 percent top dome surface with 130 feet of sheetflow will have a maximum shear stress of 0.18 psf, also well below the 0.60 psf permissible shear stress.

Maximum permissible velocities were computed for sheetflow conditions for 10 percent, 3.~~7~~2 percent and 5 percent slopes based on a permissible shear stress of 0.60 psf. The maximum permissible velocity for 3.~~7~~2 percent slopes is 4.3~~4~~9 fps, well above the 1.~~82~~62 fps velocity calculated in the sheetflow condition. For 10 percent slopes, the maximum permissible velocity is 1.92 fps, well above the 0.60 fps velocity calculated in the sheetflow condition. For 5 percent slopes, the maximum permissible velocity is 4.10 fps, also well above the 1.14 fps velocity calculated in the sheetflow condition. Additionally, the calculated velocities are less than the Maximum Velocities from Table 6.7 of the Erosion and Sediment Control Handbook, which lists that the native Bermuda grass has a maximum permissible velocity of 6 fps for 0-5 percent slopes.

The external embankment slopes will be filled to non-erosive grades, typically 25 percent. The external embankment slopes will establish a minimum 60 percent vegetative coverage. The 25 percent slopes will have a maximum flow length of 780 feet without water diversion. Block O is the only block which has not received final cover that will have a flow length requiring diversion. Block P has maximum flow lengths shorter than 780 feet. External embankment slopes will be graded to sheet flow and will have non erosive velocities and acceptable soil losses and therefore will not require any water diversion for distances less than 780 feet for 25 percent slopes. Water handling devices; including diversion dikes, let-down structures, and silt fence, as described in Section 1.1.2, will be utilized as required to maintain these maximum flow lengths.

Recently completed or external embankment slopes that do not have an established vegetative cover of at least 60 percent, will have a maximum sheetflow length of 780 feet. The 25 percent slopes will have velocities of ~~3.05~~2.72 feet per second (fps) and a shear stress of 0.58 pounds per square foot (psf). The external embankment slope will establish a minimum 60 percent vegetative coverage or equivalent cover using primary grind mulch. The Permissible Shear Stress for top dome and external embankment flows, as calculated above, is 0.60 psf. The 25 percent external embankment slope with 780 feet of sheetflow will have a maximum shear stress of 0.58 psf, less than the 0.60 psf permissible shear stress.

A maximum permissible velocity was computed for a sheetflow condition on a 25 percent slope based on a permissible shear stress of 0.60 psf. The maximum permissible velocity in this case is 3.0~~5~~0 fps, which is ~~equal to~~above the ~~3.05~~2.72 fps velocity calculated in the sheetflow condition. Additionally, the calculated velocities are less than the Maximum Velocities from Table 6.7 of the Erosion and Sediment Control Handbook, which lists that the native Bermuda grass has a maximum permissible velocity of 4 fps for slopes greater than 10 percent. Therefore, the flows from external embankment slopes with 25percent slopes and a maximum drainage length of 780 feet will have non-erosive velocities. For all velocity and shear stress calculations, see Appendix III-6A-1.

Top dome surfaces and external embankment side slopes will have erosion control structures, including vegetation, established within 180 days of placement of the intermediate cover. Vegetation will be in accordance with Section 1.2.1.

1.1.2 WATER HANDLING PRACTICES

Water handling practices include diversion and flow spreading of water.

Diversion is the use of strategically placed control devices to intercept runoff and divert it to another location. A diversion will be installed to keep clean water from crossing and eroding a disturbed area or to move runoff with silt to a location where it can be treated more effectively.

Diversion structures will be constructed with the construction of intermediate cover and within 180 days of the construction of top dome or external side slopes surfaces.

1.1.2.1 Diversion Dike

A diversion dike intercepts runoff from upland areas and diverts it away from exposed slopes to a let-down structure or a stabilized outlet. Diversion dikes are a ridge of compacted soil located in such a manner as to direct water to a desired location. Diversion dikes will be located above external embankment fill slopes. These diversion dikes have been designed for the 25 year, 24 hour peak flowrate. Diversion dikes will be constructed so that 780 feet is the maximum drainage length to a 4:1 slope. Diversion dikes will be constructed on the top slope so that the maximum drainage area to any one diversion dike is ~~15.2~~14.1 acres. The calculated maximum shear stress caused by the 25 year storm event in the diversion dike is ~~1.05~~0.99 pounds per square foot for a diversion dike built with a 4% drainage slope. Block O is the only block requiring water diversion.

Diversion dikes will be constructed with a minimum slope of 2 percent and a maximum slope of 4 percent. Diversion dikes will be lined with an erosion protection with a minimum permissible shear stress of greater than 1.0 pounds per square foot. This includes straw mat, curled wood mat (Excelsior), rock (d_{50} = 6"), or other TCEQ approved materials that provide a minimum permissible shear stress greater than 1.0 pounds per square foot.

Diversion dikes will be constructed to direct stormwater to a let-down structure or stabilized outlet such as a stone rip-rap pad or approved alternate. For more information on let-down structures, see 1.1.2.2

DELETE SPACES

Calculations for these diversion dikes are included in Appendix III-6A-1.

1.1.2.2 Let-Down Structure

A let-down structure will convey concentrated runoff down steep slopes. The let-down structure will be used on the external embankment side slopes. Runoff will be directed to the let-down structure by means of diversion dikes. The let-down structure will consist of a channel with either a 6 inch gabion, geomembrane, or Reno Mattress (or similar) lining.

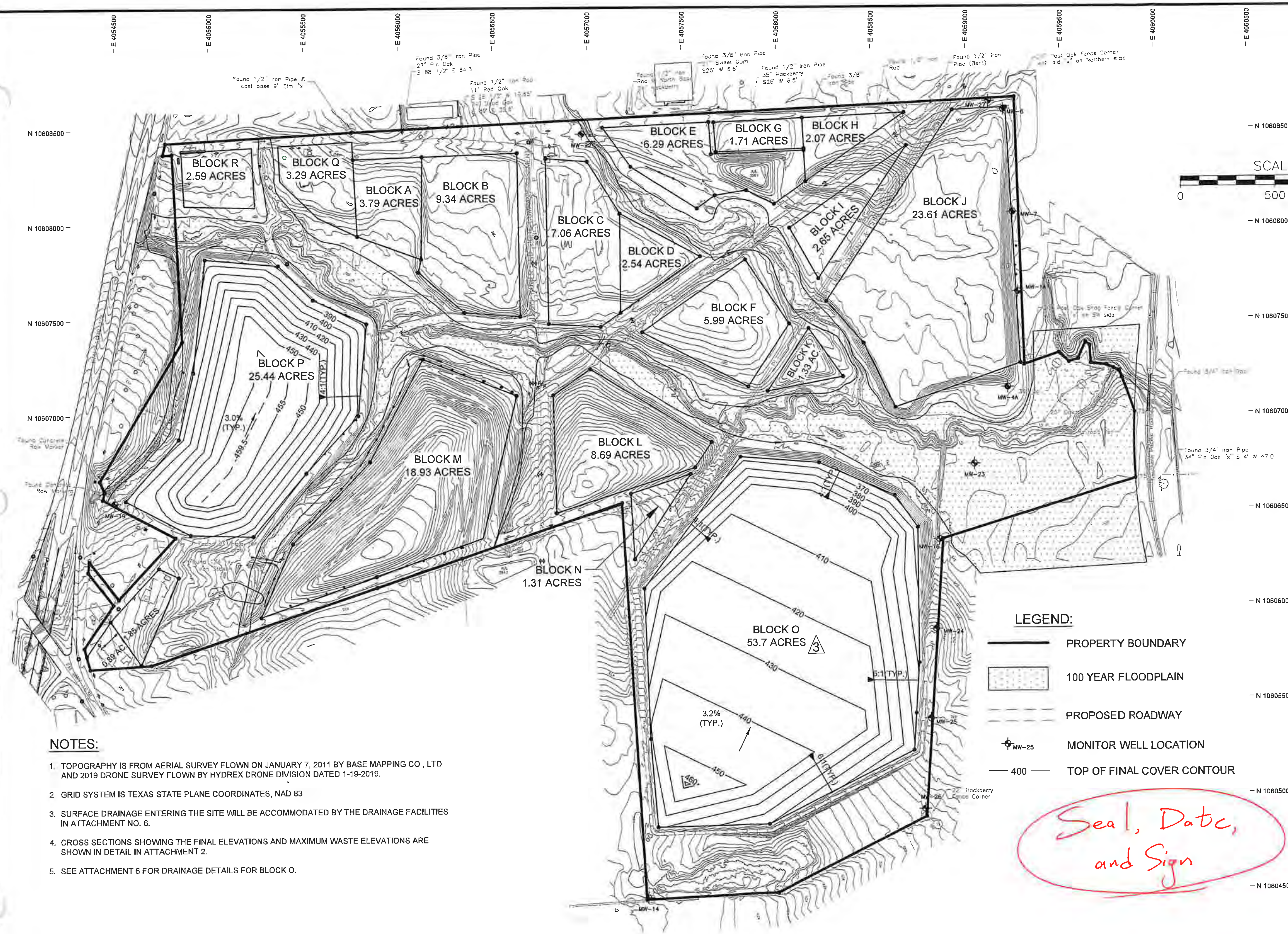
These channels have been designed for the 25 year, 24 hour peak flowrate. Block O is the only block that requires installation of a let-down structure. The maximum area to be directed to any one let-down structure is 24.6 acres. Let-down structures will be constructed down the external embankment side slope with a maximum slope of 25 percent. The let-down structure lining will have erosion protection including a 6 inch gabion and geomembrane lining, or other TCEQ approved material with a minimum permissible shear stress greater than 20 lbs/sq. ft. According to TxDOT Manual, Permissible Shear Stresses for Various Linings, 6 inch gabions have a permissible shear stress of 35 psf. The table does not include permissible shear stresses for geomembrane. Geomembrane lining is significantly more resistant to shear forces than gabions, so assuming a permissible shear stress equal to that of gabions, 35 psf, is a conservative assumption. Let down structures will discharge to stone rip-rap pads as detailed on Figure III-6A.3.

DELETE SPACES

Calculations for these let-down structures are included in Appendix III-6A-1.

1.1.2.3 Silt Fence

Silt fence is a temporary barrier fence of non-woven textile material which is water permeable but will trap water-borne sediment. The silt fence reduces runoff velocity and allows the deposition of transported sediment to occur. Silt fencing shall consist of posts with pervious synthetic filter fabric (polypropylene, nylon, polyester or other suitable fabric) stretched across the posts. The fabric should contain UV inhibitors and stabilizers for increased product life with a removal capability of approximately 80 percent.



LEGEND:

▬▬	PROPERTY BOUNDARY
(dotted)	100 YEAR FLOODPLAIN
— — —	PROPOSED ROADWAY
⌖ MW-25	MONITOR WELL LOCATION
— 400 —	TOP OF FINAL COVER CONTOUR

Seal, Date, and Sign

NOTES:

1. TOPOGRAPHY IS FROM AERIAL SURVEY FLOWN ON JANUARY 7, 2011 BY BASE MAPPING CO., LTD AND 2019 DRONE SURVEY FLOWN BY HYDREX DRONE DIVISION DATED 1-19-2019.
2. GRID SYSTEM IS TEXAS STATE PLANE COORDINATES, NAD 83
3. SURFACE DRAINAGE ENTERING THE SITE WILL BE ACCOMMODATED BY THE DRAINAGE FACILITIES IN ATTACHMENT NO. 6.
4. CROSS SECTIONS SHOWING THE FINAL ELEVATIONS AND MAXIMUM WASTE ELEVATIONS ARE SHOWN IN DETAIL IN ATTACHMENT 2.
5. SEE ATTACHMENT 6 FOR DRAINAGE DETAILS FOR BLOCK O.

FOR PERMITTING PURPOSES ONLY

REV	DATE	DESCRIPTION	BY
1	6/2011	REVISED BLOCKS P&O GRADES	SCS
2	8/2019	REVISED BLOCKS P&O GRADES	SCS
3	12/2023	REVISED BLOCK O FINAL COVER GRADES.	SCS

TEXAS BOARD OF PROFESSIONAL ENGINEERS REG. NO. F-3407

DRAWING TITLE: III.11.G ATTACHMENT 7 - FINAL CONTOUR MAP

PROJECT TITLE: LANDFILL RECONFIGURATION PERMIT MODIFICATION

CLIENT: CITY OF NACOGDOCHES LANDFILL
PERMIT NO. MSW-720
NACOGDOCHES, NACOGDOCHES COUNTY, TEXAS

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT CONSULTING ENGINEERS
12651 BRIAR FOREST, SUITE 205, HOUSTON, TX 77077
PH (281) 397-6747 FAX NO. (281) 293-7878

PROJ. NO. 16209005.02 | DWN. BY: RLD | Q/A RVW BY: JRM
DSN. BY: RLD | CHK. BY: JKR | APP. BY: JKR

CADD FILE: DWG 7A – FINAL CONTOUR MAP–REV

DATE: 6–2011

SCALE: AS SHOWN

DRAWING NO. 7A

Nacogdoches
the oldest town in Texas

CITY OF NACOGDOCHES LANDFILL
NACOGDOCHES COUNTY, TEXAS
TCEQ PERMIT NO. MSW-720

PART III - SITE DEVELOPMENT PLAN
ATTACHMENT 10
SOIL AND LINER QUALITY CONTROL PLAN

UPDATE

Prepared for:

CITY OF NACOGDOCHES

FOR PERMITTING PURPOSES ONLY

STATE OF TEXAS
JEFFREY K. REED
80103
LICENSED
PROFESSIONAL ENGINEER
1/19/24

Prepared by:

SCS ENGINEERS
TBPE Registration No. F-3407
Houston Office
12651 Briar Forest, Suite 205
Houston, Texas 77077
281/293-8494

Revision 0 – July 2013
Revision 1 – January 2014
Revision 2 – January 2020
Revision 3 – January 2024
SCS Project No. 16209006.26

Revision 4 - May 2024

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TBPE Reg. # F-3407
STATE OF TEXAS
JEFFREY K. REED
80108
LICENSED PROFESSIONAL ENGINEER
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Appendices

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APPENDIX 10D

SAMPLE UNDERDRAIN AND BALLASTING CALCULATIONS

UPDATE

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STATE OF TEXAS
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PROFESSIONAL ENGINEER

8/15/13
inclusive of pgs 10D-1 to 10D-11.

Revision ~~2~~ 3

May 2024

General Information:

1. Portions of the proposed excavation for Block O at the City of Nacogdoches Landfill, specifically Phases 3 and 6, will be below the seasonal high groundwater table (SHWT) within the Welches Formation. Based on review of the SHWT map (Attachment 10, Figure 10-1), portions of the sideslope and the western quarter of the floor of Phase 3, as well as portions of the sideslope and the entire floor of Phase 6 will be constructed below the SHWT. Although, the excavation for these cells will be founded in either Layer 1, which includes sandy clays and clays, and/or Layer 2, which includes a glauconitic clayey silt; for this calculations, it is assumed that the impacted sideslope and/or floor areas of Phases 3 and 6 will be founded in the higher permeable glauconitic clayey silt, which is the water bearing zone at the landfill. Since this water bearing zone will come into contact with the underdrain, the hydraulic conductivity for this layer was used in all calculations for conservativeness.

2. Geologic and hydrogeological characteristics of the site are described Attachment 4 - Geology Report, as well as Attachment 5 - Groundwater Characterization Report, Appendix III-5-Sup-D, *Preliminary Groundwater Characterization Study at the City of Nacogdoches Landfill* (January 1995, Golder Associates, Inc.), Appendix D. This latter document includes the slug test permeability results for the glauconitic clayey silt. Based on review of the slug test results, four piezometers installed near Block O exhibited a permeability of 9.1×10^{-6} cm/s to 1.5×10^{-4} cm/s, with an average of the three higher values of 2.12×10^{-4} cm/s. Additionally, this calculation assumes that the water bearing unit is a gravity flow aquifer.

3. Based on review of the SHWT map, groundwater flow around Block O is from southwest to northeast, and could exhibit a maximum hydrostatic head of 2 to 6 feet (i.e., near the west toe of slope) in Phase 3 and 6 to 12 feet in Phase 6. The calculations presented below are based on a maximum hydrostatic head of 12 feet, and sizing criteria for the floor and sideslope underdrain systems associated with Block O, Phase 6. As summarized at the end of these calculations, both the floor and sideslope underdrain systems will be installed for Phase 6, but due to the direction of groundwater flow at the site and minimal hydrostatic head anticipated on the Phase 3 liner system, only a sideslope toe drain will be necessary for Phase 3.

Method of Analysis:

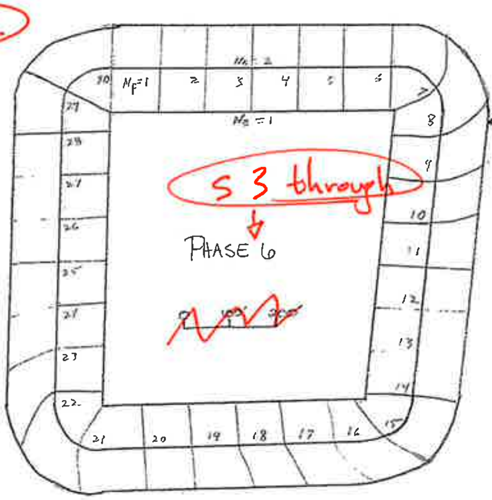
1. Use a flow net to determine underdrain flows at the floor of Phase 6.
2. Summarize data for Phase 6 and estimate the hydrostatic uplift based on the revised SHWT map.
3. Use a confined flow analysis assuming a single source slot, fully penetrating the source aquifer to design the sideslope underdrain.
4. Evaluate the required underdrain design (spacing) based on maximum drainage lengths to ensure that the entire system will work as designed.
5. Evaluate that the non-woven geotextiles incorporated into the underdrain meet or exceed the required properties for retention, hydraulic conductivity, and porosity.

References:

1. Cedergren, Harry, *Seepage, Drainage, and Flow Nets, Third edition*, 1989.
2. Departments of the Army, Navy, and Air Force (NAVFAC P-418), *Dewatering and Groundwater Control*, November 1983.
3. Koerner, R.M., *Designing With Geosynthetics, Third Edition*, 1994.
4. GSE Lining Technology Inc., Product Data Sheet "GSE Nonwoven Geotextiles", 2007.
5. GSE Lining Technology Inc., GSE Drainage Design Manual, 3rd Edition, Appendix A, 100-hour Transmissivity Data for Selected Projects.

Solution:

A) **First design the cell floor underdrain** using a plan view flow net to determine inflow. Based upon the updated SHWT map (Attachment 10, Figure 10-2, the maximum head on the floor of Phase 6, located in the southwest corner, is approximately 12 feet.



200' Point of No Influence

$N_f = 30$, where N_f is the number of flow lines selected. These are equally spaced to define the shape. Lines were added roughly parallel at the corners to allow for final net areas to be more closely square.

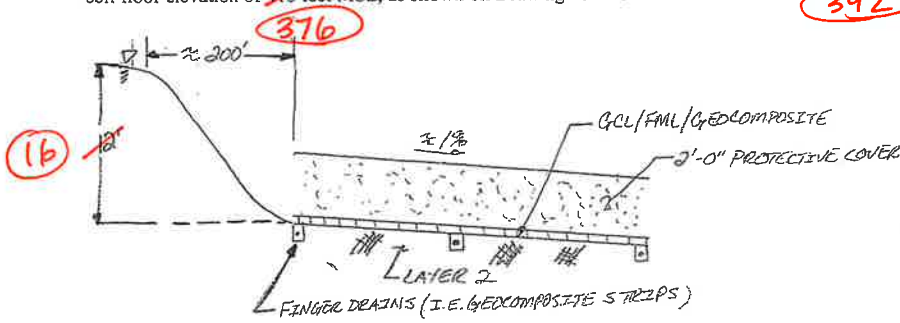
$N_e = 2$, where N_e equals the number of equipotential drops from the cell limits to the "point of no influence." In this analysis there are two equipotential drops, including the cell boundary and 100 foot from the cell boundary. Two lines were selected to provide for roughly "square" areas within the flow net (length and width of the sides should be approximately equal). The 200-foot point of no influence was selected because it was assumed that the underdrain would pump at a rate such that drawdown occurs within 200-feet of the cell boundary (see sketch on next page).

To calculate the flow to the excavation, use NAVFAC, Figure 4-27, Equation (5), Page 4-31.

$Q_T = kH''S_f/2$

where:
- Q_T = Total flow
- k = Permeability of aquifer = 2.12E-04 cm/sec or 4.17E-04 ft/min
- $H'' = H^2 - H_o^2$, where H_o is negligible, and therefore is assumed to be zero
- H = max. head on Phase 6 floor = 12 feet
- $S_f = N_f/N_e$ = 15

The 12-foot maximum head is representative of the seasonal high groundwater elevation of 422 feet MSL for Phase 6, as shown on Figure 10-1, and a cell floor elevation of 410 feet MSL, as shown on Drawing 10D-1.

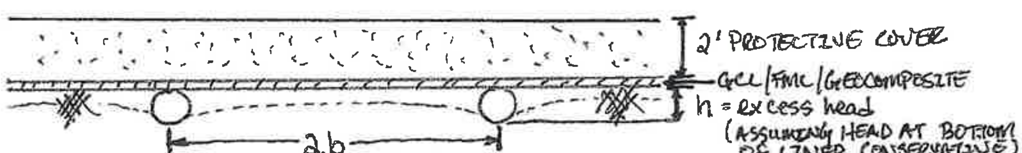


Q_T =	3.37 gallons/minute	(this includes a conversion of 7.48 gallons/cubic foot)
	4,854.67 gallons/day	

The overall infiltration rate through the floor area, $q = Q_T$/Area   Area = 389,450 square feet (Area of Phase 6 floor)
8.9 acres

q = 1.67E-03 feet/day

B) **Design floor underdrain** using Equation. 9.2, Page 344 from Cedergren. This analysis will determine the required underdrain spacing to relieve uplift pressure on the bottom of the liner (see drawing below).



From Cedergren: $\frac{q}{k} = \frac{(h)^2}{(b)^2}$

where:
- q = infiltration rate = 1.67E-03 feet/day
- k = permeability = 2.12E-04 cm/sec or 6.01E-01 ft/day
- b = 1/2 of underdrain spacing
- h = head offset between drains = 2.9 feet (see below for calculation)

to calculate h as follows = h is equal to the weight of the liner and protective cover above the underdrain with a factor of safety of 1.2. Since a GCL will be installed, do not account for liner thickness. Do not provide credit for the minimum 1-foot protective pad over the underdrain (to protect it during liner construction).

h = (2 ft)(110 pcf)/(1.2)(62.4 pcf) = 2.9 feet of water

Next, solving for the parameter "b" above to set the spacing: $$(b)^2 = \frac{(h)^2 k}{q}$$

based on the parameters above then: 3,113 $feet^2 = b^2$
or b = 55.8 feet
and 2b = 111.6 feet

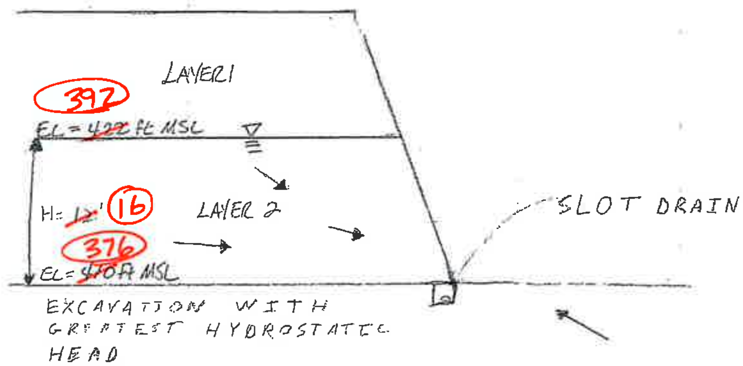
UPDATE

Therefore, an floor underdrain spacing of 111.6 feet or less is needed to meet the design conditions for Phase 6. For design purposes, an underdrain spacing on the floor of the excavation of 100 feet center to center will be specified.

s 3 through

C) **Design the Sideslope Underdrain**

First, analyze the sideslope seepage.



To calculate the flow to the slot drain, use NAVFAC, Figure 4-1, Equation (3), Page 4-2.

$$Q = \frac{kx}{2L}(H^2 - h_o^2)$$

where: k = permeability = 2.12E-04 cm/sec or 6.01E-01 ft/day
x = slot drain length (we will find a flow per length so no value for this yet)
H = maximum head = 16 12 feet
h_o is defined on NAVFAC, Figure 4.1, Page 4-2, and calculated using Figure 4.2, Page 4-3.
h_o = 4.8 feet
L = point where drawdown occurs (see calculation below)

To determine "L", the point where drawdown occurs, use NAVFAC, Figure 4-23, equation (1), Page 4-24, where R is shown as L (they are the same value for drawdown radius of influence).

$$R = L = C(H - h_w)\sqrt{k}$$

where: L = radius of influence, equivalent to point where drawdown occurs
C = coefficient of flow = 2 (for a single line of well points)
H = maximum head = 16 12 feet
$h_w = h_e = H_o + H_S$, and is determined using Figure 4.2, Page 4-3, where H_S equals 0.5,
h_e = 5.3 feet
k = permeability = 2.12E+00 (expressed in units of 10^{-4} cm/sec)

Therefore, L = 19.5 feet

UPDATE

Solving for Q above using L — **Q = 1.86 cf/day per foot length**

q = infiltration rate = Q/Area (note that area here is equal to the maximum head multiplied by 3 to compensate for the 3H:1V slope)

therefore; q = 5.17E-02 feet/day

UPDATE

UPDATE

CITY OF NACOGDOCHES LANDFILL
TCEQ PERMIT NO. MSW-720
UNDERDRAIN CALCULATIONS

D) Determine the Underdrain Spacing Along the Sideslope

Using the same equation that was used to space the underdrain for the cell floor we will use the following equation: UPDATE

$$(b)^2 = \frac{(h)^2 k}{q}$$

where: q = infiltration rate = ~~5.17E-02~~ feet/day
k = permeability = ~~2.12E-04~~ cm/sec or ~~6.01E-01~~ ft/day
b = 1/2 of underdrain spacing
h = excess head between drains = 2.9 feet

Based on the parameters above then: ~~100~~ feet^2 = b^2
or b = ~~10.0~~ feet
and 2b = ~~20.0~~ feet

UPDATE

≤ 3 through

Therefore, an underdrain spacing of ~~20~~ feet or less is needed to meet the design conditions for Phase 6. For design purposes, an underdrain spacing on the sideslope of the excavation of 20 feet ~~center to center below~~ the seasonal high water level will be specified for the west and south sideslope of Phase 6. 3, 5, and

E) Next, Size the Underdrain Components on the cell floor (now that the Spacing has been Established Between the Underdrain Elements)

Starting with the bottom underdrain (note, although the sketch in Section B depicts equally spaced pipes, the flow conduit is arbitrary, provided such conduit [i.e., geocomposite strip] has sufficient cross-sectional area to convey the groundwater infiltration rate):

UPDATE

i) Under item B) at the bottom of page 2 of these calculations a spacing of 100 feet center to center was established for the bottom underdrain.
ii) Under item A) at the top of page 2 of these calculations the infiltration rate into the bottom underdrain = ~~1.67E-03~~ feet/day
iii) The maximum geocomposite drainage layer length along the bottom underdrain = 310 feet in Phase 6 (i.e., between floor drains)

Using each of these maximums, the required drain capacity is calculated as follows:

UPDATE

Underdrain Spacing [from B) above] = 100 ft c-c
Q_{REQD} = (q)(Area of infiltration) = (~~1.67E-03~~ ft/day)(100 ft c-c)(310 feet)(7.48 gallons/ft^3) = ~~386.43~~ gallons/day

UPDATE

Assume the use of a 15-foot wide ~~geocomposite consisting~~ of a geonet with a geotextile heat bonded to each side to transmit this groundwater to floor drains. The east-west running underdrain components have a slope of approximately 0.01 ft/ft. For the double-sided geocomposite assume a transmissivity of 1 x 10^{-3} m^2/sec **(Ref 5, GSE Frabrinet HF)**, ~~based on a~~ gradient of 0.01 and overburden pressure of 1,000 psf.

UPDATE

Compare the geocomposite capacity to the Q_{REQD} ~~386~~ gallons/day

For the geocomposite, Q_T = Tiw where: Q_T = Flow in geocomposite under laboratory conditions
T = transmissivity = 1.0E-03 m^2/sec **(Ref. 5 GSE Fabrinet HF)**
i = gradient = 0.01 (ft/ft) (minimum floor slope)
width = 15 ft = 4.572 meters

Q_T = 1,044 gallons/day

$Q_{ALL} = Q_T/FS$ where: Q_T= Flow in geocomposite under laboratory conditions
Q_{ALL}= Allowable flow taking into consideration factors of safety
FS = 2, for intrusion and creep deformation

UPDATE

Therefore Q_{ALL}= 521.81 gallons/day which is > ~~386.43 gallons/day~~

Therefore, the geocomposite shall be a 250-mil geonet with 8 oz/sy non-woven geotextiles adhered to both sides with a minimum transmissivity of 1 x 10^{-3} m^2/s at a gradient of 0.01 and overburden pressure of 1,000 psf. Geocomposite strips shall be 15-foot wide at 100 foot c-c spacing along the cell floor of Phase 6.

UPDATE UPDATE

F) **Next, Size the Sideslope Underdrain Components (now that the Spacing has been Established)**

UPDATE

i) Under item D) in the bottom of page 3 of these calculations a spacing of 50 feet center to center was established for the ~~sideslope underdrain.~~
ii) Under item C) at the bottom of page 3 of these calculations the infiltration rate into the sidewall underdrain = ~~5.17E-02~~ feet/day
iii) The maximum geocomposite drainage layer length along the sideslope underdrain = 60 feet (horizontal projection in Cell 48)
(It should be noted that only the portion of the sideslope below the seasonal high groundwater table need be considered here)

Using each of these maximums, the required drain capacity is calculated as follows:

UPDATE

Underdrain Spacing [from D) above] = 20 ft c-c
Q_{REQD} = (q)(Area of infiltration) = ~~(5.17E-02 ft/day)~~(20 ft c-c)(60 feet)(7.48 gallons/ft^3) = ~~464~~ gallons/day

UPDATE

For the geocomposite, Q_T = Tiw where: Q_T = Flow in geocomposite under laboratory conditions
T = transmissivity = 5.0E-04 m^2/sec **(Ref. 5 GSE Fabrinet HF)**
i = gradient = 0.33 (3H:1V sideslope)
width = 3 ft = 0.9144 meters

Q_T = 3,479 gallons/day

$Q_{ALL} = Q_T/FS$ where: Q_T= Flow in geocomposite under laboratory conditions
Q_{ALL}= Allowable flow taking into consideration factors of safety
FS = 2, for intrusion and creep deformation

Therefore Q_{ALL}= 1,739.36 gallons/day which is > ~~464 gallons/day~~

UPDATE

Therefore, the geocomposite shall be a 250-mil geonet with 8 oz/sy ~~non-woven geotextiles~~ adhered to both sides with a minimum transmissivity of 5 x 10^{-4} m^2/s at a gradient of 0.33 and overburden pressure of 1,000 psf. Geocomposite strips shall be 3-foot wide at 20 foot c-c spacing along the cell sideslope of Phase 6, below the seasonal high water table.

s 3, 5, and

G) **Toe and Floor Drain Design**

1.7%

i) The maximum floor drain length = 640 feet
ii) The minimum slope of toe drain = ~~0.016~~ equivalent of ~~1.6%~~, where toe or floor drains parallel to the west sideslop of Phase 6
iii) Use 6" perforated HDPE Pipe, Manning's n = 0.009
iv) Infiltration for the floor = ~~1.67E-03~~ feet/day from the middle of page 2
v) Infiltration for sideslope = ~~5.17E-02~~ feet/day from the bottom of page 3

UPDATE

Flow in floor or toe drains, evaluate maximum Q_{MAX} between floor and sideslope, where $Q_{TD} = q_i A_i$

where: Q_{MAX} = Maximum flow to a floor or toe drain (gallons per minute)
q_{floor} = Infiltration into floor (feet/day) = ~~1.67E-03~~ UPDATE
A_{floor} = Floor Area (ft^2) = ~~389,450~~ (conservatively assume the entire floor drains to a single drain)
$q_{sideslope}$ = Infiltration into sideslope (feet/day) = ~~5.17E-02~~
$A_{sideslope}$ = Sideslope Area (ft^2) = 122,000 (conservatively assume the entire west sideslope of Phase 3 and 6 drain to a single toe drain)

Q_{MAX} = 47,221 gallons/day = ~~32.8 gallons per minute~~

UPDATE 1.7%

Next, using the Manning's equation, determine the capacity of a 6", HDPE SDR 11 pipe on a ~~1.6%~~ grade and compare to Q_{MAX}.

Manning's equation is:

$$V = \frac{(1.486)(r)^{2/3}\ (s)^{1/2}}{n}$$

where: V = velocity in pipe (ft/sec)
n = Manning's number for HDPE = 0.009
s = slope (ft/ft) = ~~0.016~~
r = hydraulic radius (ft)= diameter/4 = ((5.373/12)/4) for SDR 11 HDPE Pipe = 0.112

Using the above parameters, V = ~~4.86~~ feet per second

UPDATE

UPDATE

UPDATE

UPDATE

Prep'd By: RRK
Chk'd By: JKR
Date: 8/14/13

$Q_{CAPACITY} = (a)(V)$ where: $Q_{CAPACITY}$ = Flow capacity of pipe in gallons per minute

a = Pipe cross-sectional area (ft^2) = $\pi D^2/4$ = 0.157 ft^2

assume half of area for conservativeness = 0.079 ft^2

V = Velocity from above calculation = ~~4.86~~ ft/sec

UPDATE

therefore $Q_{CAPACITY}$ = ~~171.6~~ gallons per minute

UPDATE

Since either drain only requires a maximum flow of ~~32.8~~ gallons per minute,
but the capacity when flowing half full is ~~171.6~~ gallons per minute, therefore, the 6-inch toe drain pipe is acceptable.

H. Evaluate that the non-woven geotextiles incorporated into the underdrain meet or exceed the required properties for retention, hydraulic conductivity, and porosity for the specified design conditions:

i. Non-Woven Geotextile (8 oz/sy) located on the top and bottom of the geocomposite.
ii. Non-Woven Geotextile (~~12~~ (8) oz/sy) to be installed around granular drainage aggregate ~~located in the chimney drains and leachate collection sump~~.

Retention:

The apparent opening size (O_{95}) was determined **(Ref 4)**:

8 oz/sy Non-Woven Geotextile:	O_{95} <	0.18	mm
~~**12 oz/sy Non-Woven Geotextile:**~~	~~O_{95} <~~	~~0.15~~	~~mm~~

AASHTO's Task Force # 25 report as referenced on pp. 101 of Reference 2 recommends that the following criteria be used to check the geotextile retention properties:

- For soil ≤50% passing the No. 200 sieve: O_{95} < 0.59mm (i.e., AOS of the fabric ≥No. 30 sieve); and
- For soil > 50% passing the No. 200 sieve: O_{95} < 0.30mm (i.e., AOS of the fabric ≥the No. 50 sieve).

Onsite soils representative of Layer 1 and 2 are classified as clays, sandy clays, clayey silt, sandy silts, and sand seams. Onsite soils are expected to have greater than 50% passing the No. 200 sieve. Therefore, since the O_{95} or AOS of the 8 oz/sy ~~and 12 oz/sy~~ non-woven geotextile is less than 0.30 mm, it meets the retention criteria for the soil formations present at the site.

Hydraulic Conductivity (k):

$$q_{allow} = q_{ult} [(1/FS_{SCB} \times FS_{CR} \times FS_{IN} \times FS_{CC} \times FS_{BC})]$$ **(Ref. 3, pp. 159)**

Where:
- q_{allow} = allowable flow rate
- q_{ult} = ultimate flow rate
- FS_{SCB} = factor-of-safety for soil clogging and binding
- FS_{CR} = factor-of-safety for creep reduction of void space
- FS_{IN} = factor-of-safety for adjacent materials intruding into the geotextile's void space
- FS_{CC} = factor-of-safety for chemical clogging
- FS_{BC} = factor-of-safety for biological clogging

8 oz/sy Non-Woven Geotextile:	q_{ult}=	0.3	cm/sec	**(Ref. 4)**
~~**12 oz/sy Non-Woven Geotextile:**~~	~~q_{ult}=~~	~~0.29~~	~~cm/sec~~	~~**(Ref. 4)**~~
	FS_{SCB} =	7.50		**(Ref. 3, pp. 160)**
	FS_{CR} =	1.25	**These factors-of-safety are averages of the recommended values for underdrain filters.**	
	FS_{IN} =	1.10		
	FS_{CC} =	1.35		
	FS_{BC} =	3.00		

Calculated factor-of-safety = 41.77 (i.e., for both weights of non-woven geotextile)

8 oz/sy Non-Woven Geotextile:	q_{allow}=	7.18E-03	cm/s
~~**12 oz/sy Non-Woven Geotextile:**~~	~~q_{allow}=~~	~~6.94E-03~~	~~cm/s~~

The hydraulic conductivity is considered acceptable, since after applying average partial factors-of-safety for underdrain filters, the hydraulic conductivity of the filter is greater than the average hydraulic conductivity of the soil formation, and as such will not impede flow into the underdrain.

UPDATE

UPDATE

Porosity:

Both non-woven geotextiles should have enough openings, that the performance of the non-woven geotextiles will not be significantly impaired in the event of blockage of some openings. Giroud recommends a non-woven geotextile porosity of greater than 30%. As per Giroud, the porosity of a non-woven geotextile can be calculated using the following equation.

$$n = 1-[m/\rho t] \times 100$$ **(Ref. 3, pp. 128)**

Where:
- n = geotextile porosity, %
- m = geotextile mass per unit area, lb/sf
- t = geotextile thickness, ft
- ρ = density of filaments, lb/cf

	8 oz/sy	12 oz/sy
m =	0.06	0.08
t =	0.007	0.01
ρ =	58.68	58.68
n =	**85.8**	**85.8**

> 30%, therefore, ok

SUMMARY OF RESULTS

Calculations were performed for design conditions for Phase 3 and 6 at the City of Nacogdoches Landfill. During design of the construction plans and prior to installation of the underdrain components, manufacturer's product data will be reviewed to confirm that the selected materials meet or exceed the properties of the materials required by this calculation (i.e., thickness, transmissivity, non-woven geotextile properties, etc.).

BOTTOM UNDERDRAIN SYSTEM

The finger drains (geocomposite strips) spaced at 100 ft. c-c were designed for the cell floor of Phase 6. These drains will consist of minimum 15-foot wide 250-mil double-sided geocomposite strips (with 8 oz/sy non-woven geotextile heat bonded to each side) with a minimum transmissivity of 1×10^{-3} m²/s at a gradient of 0.01 and overburden pressure of 1,000 psf. These geocomposite strips will be connected to free-flowing floor drains, which drain to an underdrain sump.

SIDESLOPE UNDERDRAIN SYSTEM

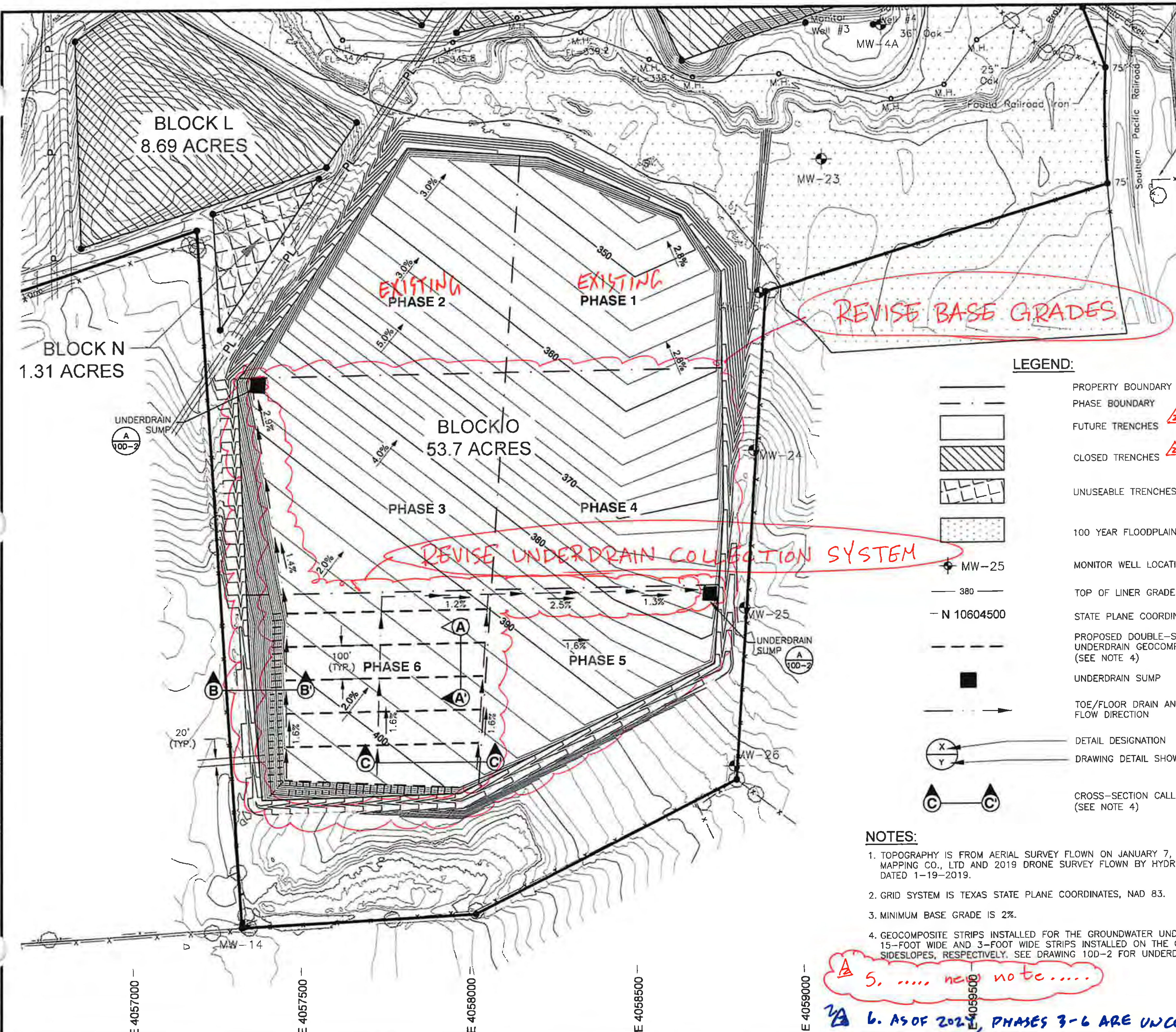
The finger drains (geocomposite strips) spaced at 20 ft. c-c were designed for the cell sideslope of Phase 6. These drains will consist of minimum 3-foot wide 250-mil double-sided geocomposite strips (with 8 oz/sy non-woven geotextile heat bonded to each side) with a minimum transmissivity of 5×10^{-4} m²/s at a gradient of 0.33 and overburden pressure of 1,000 psf. It should be noted that in Phase 6, geocomposite strips will only be necessary on the sideslopes of Phase 6, and will be installed on sideslopes that have greater than 6 feet of hydrostatic head. For areas of the sideslopes with less than 6 feet of head, groundwater will be controlled by the toe drain installed in Phase 3 and 6, as shown on Drawing 10D-1. The geocomposite strips installed on the sideslope of Phase 6 will be connected to a free-flowing toe drain located at the toe of the west sideslope of Phases 3 and 6 that will drain to an sump located in Phase 3.

TOE AND FLOOR DRAIN

Toe and floor drains a minimum of 1-foot wide and 1.5-feet deep with a 1.6% grade will be built in Phase 3 and 6 leading to underdrain sumps. The trench will contain a minimum 6-inch SDR 11 perforated pipe surrounded by gravel (1/2 to 2-inch). The toe drains, floor drain, and underdrain sump aggregate will be wrapped with a 12 oz/sy non-woven geotextile.

UNDERDRAIN SUMP PUMP AND CONTROLS

The underdrain sump will be equipped with a 10 gpm (minimum) permanent submersible pump and controls. This pump size will be consistent with the maximum infiltration rate into the cell, as calculated in Section A of these calculations. The pump will be equipped with a pressure transducer or equivalent water level sensor to the pump "on" and "off" based on groundwater levels with the sump. The pump "on" level will be set to 24 inches above the bottom of the sump, and the pump "off" level will be set at a depth of 6 inches above the bottom of the sump or the manufactures recommended minimum depth to prevent damage to the pump. The pump control panel will also be equipped with a high-level indicator light, which will indicate when the groundwater depth in the sump exceeds 24 inches. See Drawing 10D-2 for underdrain sizing criteria.



N

0 300 600
SCALE IN FEET

– N 10607000
– N 10606500
– N 10606000
– N 10605500
– N 10605000
– N 10604500

LEGEND:

——	PROPERTY BOUNDARY
— · —	PHASE BOUNDARY
(box)	FUTURE TRENCHES 2 (SEE NOTE 5 AND 6)
(hatched box)	CLOSED TRENCHES 2 (SEE NOTE 5)
(box)	UNUSEABLE TRENCHES 2 (REMOVED FROM PLAN)
(dotted box)	100 YEAR FLOODPLAIN
MW-25	MONITOR WELL LOCATION
— 380 —	TOP OF LINER GRADE
— N 10604500	STATE PLANE COORDINATE
— — —	PROPOSED DOUBLE-SIDED UNDERDRAIN GEOCOMPOSITE (SEE NOTE 4)
■	UNDERDRAIN SUMP
— · · →	TOE/FLOOR DRAIN AND FLOW DIRECTION
X / Y	DETAIL DESIGNATION DRAWING DETAIL SHOWN ON
C — C'	CROSS-SECTION CALL OUT (SEE NOTE 4)

NOTES:

1. TOPOGRAPHY IS FROM AERIAL SURVEY FLOWN ON JANUARY 7, 2011 BY BASE MAPPING CO., LTD AND 2019 DRONE SURVEY FLOWN BY HYDREX DRONE DIVISION DATED 1-19-2019.
2. GRID SYSTEM IS TEXAS STATE PLANE COORDINATES, NAD 83.
3. MINIMUM BASE GRADE IS 2%.
4. GEOCOMPOSITE STRIPS INSTALLED FOR THE GROUNDWATER UNDERDRAIN SHALL BE 15-FOOT WIDE AND 3-FOOT WIDE STRIPS INSTALLED ON THE CELL FLOOR AND SIDESLOPES, RESPECTIVELY. SEE DRAWING 10D-2 FOR UNDERDRAIN SYSTEM DETAILS.

2 5. ..... new note .....

2 6. AS OF 2024, PHASES 3-6 ARE UNCONSTRUCTED.

10D-9

FOR PERMITTING PURPOSES ONLY

UPDATE

STATE OF TEXAS
JEFFREY K. REED
80103
LICENSED PROFESSIONAL ENGINEER
9/30/19

2 05/2024 ..... SCS

REV	DATE	DESCRIPTION	BY
1	8/2019	REVISE BLOCK O	SCS

TEXAS BOARD OF PROFESSIONAL ENGINEERS REG. NO. F-3407

DRAWING TITLE: UNDERDRAIN LAYOUT PLAN

PROJECT TITLE: LANDFILL RECONFIGURATION PERMIT MODIFICATION

CLIENT: CITY OF NACOGDOCHES LANDFILL
PERMIT NO. MSW-720
NACOGDOCHES, NACOGDOCHES COUNTY, TEXAS

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT CONSULTING ENGINEERS
12651 BRIAR FOREST, SUITE 205, HOUSTON, TX 77077
PH (281) 397-6747 FAX NO. (281) 293-7676

PROJ. NO. 16209006.02 | DSN. BY: RRK | DWN. BY: JJJ | CHK. BY: JKR | Q/A RVW BY: RRK | APP. BY: JKR

CADD FILE: UNDERDRAIN PLAN

DATE: 08/2013

SCALE: AS SHOWN

DRAWING NO. 10D-1

Nacogdoches
the oldest town in Texas

CITY OF NACOGDOCHES LANDFILL
NACOGDOCHES COUNTY, TEXAS
TCEQ PERMIT NO. MSW-720

PART III - SITE DEVELOPMENT PLAN
ATTACHMENT 10, APPENDIX 10E
GEOSYNTHETIC CLAY LINER - ALTERNATE LINER DESIGN DEMONSTRATION

Prepared for:

CITY OF NACOGDOCHES
4602 NW Stallings Drive
Nacogdoches, TX 75964

Prepared By:

SCS ENGINEERS
TBPE Registration No. F-3407
Houston Office
12651 Briar Forrest Drive
Houston, Texas 77077
281/293-8494

UPDATE

STATE OF TEXAS
JEFFREY K. REED
80103
LICENSED
PROFESSIONAL ENGINEER
1/19/24

Revision 0 - July 2013
Revision 1 – September 2019
Revision 2 – January 2024
SCS Project No. 16209006.26

Revision 3 - May 2024

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APPENDICES

UPDATE

1/19/24

STATE OF TEXAS
JEFFREY K. REED
80103
LICENSED
PROFESSIONAL ENGINEER

SCS Engineers
TBPE Reg. # F-3407

WRONG COVER REPLACED WITH CORRECT

APPENDIX 10E-2

HELP MODEL ANALYSIS

(Includes Pages 10E-2-1 through 10E-2-23)

UPDATE

SCS Engineers
TBPE Reg. # F-3407

STATE OF TEXAS
JEFFREY K. REED
80103
LICENSED
PROFESSIONAL ENGINEER

1/19/24

inclusive of pages 10E-2-1 to 10E-2-23

UPDATE

UPDATE

UPDATED

Prep'd By: ~~BRK~~ RJG
Date: ~~6/17/13~~

CITY OF NACOGDOCHES LANDFILL
BLOCK O - HELP MODEL SUMMARY SHEET
GCL ALTERNATE LINER DEMONSTRATION

		ACTIVE	INTERIM	CLOSED
GENERAL INFORMATION	Model Duration (Years)	30	30	30
	Ground Cover	BARE	FAIR	GOOD
	SCS Runoff Curve No.	85	85	85
	Model Area (acre)	1	1	1
	Runoff Area (%)	0	100	100
	Maximum Leaf Area Index	0.0	2.0	3.5
	Evaporative Zone Depth (inch)	6	12	6
EROSION LAYER (Texture = 11)	Thickness (in)			6
	Porosity (vol/vol)			0.4640
	Field Capacity (vol/vol)			0.3100
	Wilting Point (vol/vol)			0.1870
	Init. Moisture Content (vol/vol)			0.4535
	Hyd. Conductivity (cm/s)			6.4E-05
FLEXIBLE MEMBRANE LINER (Texture = 36)	Thickness (in)			0.04
	Hyd. Conductivity (cm/s)			4.0E-13
	Pinhole Density (holes/acre)			1
	Install. Defects (holes/acre)			4
	Placement Quality			GOOD
INFILTRATION LAYER (Texture = 0)	Thickness (in)			18
	Porosity (vol/vol)			0.4270
	Field Capacity (vol/vol)			0.4180
	Wilting Point (vol/vol)			0.3670
	Init. Moisture Content (vol/vol)			0.4094
	Hyd. Conductivity (cm/s)			1.0E-05
INTERMEDIATE / DAILY COVER (Texture = 11)	Thickness (in)	6	12	6
	Porosity (vol/vol)	0.4640	0.4640	0.4640
	Field Capacity (vol/vol)	0.3100	0.3100	0.3100
	Wilting Point (vol/vol)	0.1870	0.1870	0.1870
	Init. Moisture Content (vol/vol)	0.3709	~~0.3443~~ rev	0.3100
	Hyd. Conductivity (cm/s)	6.4E-05	6.4E-05	6.4E-05
WASTE (Texture = 18)	Thickness (in)	120	~~684~~ rev	~~684~~ rev
	Porosity (vol/vol)	0.6710	0.6710	0.6710
	Field Capacity (vol/vol)	0.2920	0.2920	0.2920
	Wilting Point (vol/vol)	0.0770	0.0770	0.0770
	Init. Moisture Content (vol/vol)	0.3054	~~0.2946~~ rev	0.2920
	Hyd. Conductivity (cm/s)	1.0E-03	1.0E-03	1.0E-03
PROTECTIVE COVER (Texture = 11)	Thickness (in)	24	24	24
	Porosity (vol/vol)	0.4640	0.4640	0.4640
	Field Capacity (vol/vol)	0.3100	0.3100	0.3100
	Wilting Point (vol/vol)	0.1870	0.1870	0.1870
	Init. Moisture Content (vol/vol)	0.3466	0.3433	0.3100
	Hyd. Conductivity (cm/s)	6.4E-05	6.4E-05	6.4E-05
LEACHATE COLLECTION (Texture = 0)	Thickness (in)	0.20	0.19	0.19
	Porosity (vol/vol)	0.8500	0.8500	0.8500
	Field Capacity (vol/vol)	0.0100	0.0100	0.0100
	Wilting Point (vol/vol)	0.0050	0.0050	0.0050
	Init. Moisture Content (vol/vol)	0.0255	~~0.0046~~ rev	~~0.0305~~ (no change 0.0107)
	Hyd. Conductivity (cm/s)	16.00	5.00	5.00
	Slope (%)	2.8	2.8	2.8
	Slope Length (ft)	325	325	325
FLEXIBLE MEMBRANE LINER (Texture = 35)	Thickness (in)	0.06	0.06	0.6
	Hyd. Conductivity (cm/s)	2.0E-13	2.0E-13	2.0E-13
	Pinhole Density (holes/acre)	1	1	1
	Install. Defects (holes/acre)	4	4	4
	Placement Quality	GOOD	GOOD	GOOD
GEOSYNTHETIC CLAY LINER (Texture = 0)	Thickness (in)	0.24	0.24	0.24
	Porosity (vol/vol)	0.7500	0.7500	0.7500
	Field Capacity (vol/vol)	0.7470	0.7470	0.7470
	Wilting Point (vol/vol)	0.4000	0.4000	0.4000
	Init. Moisture Content (vol/vol)	0.7500	0.7500	0.7500
	Hyd. Conductivity (cm/s)	5.0E-09	5.0E-09	5.0E-09
PRECIPITATION	Average Annual (in)	45.1	45.1	45.1
RUNOFF	Average Annual (in)	0.0	3.5	14.0
EVAPOTRANSPIRATION	Average Annual (in)	26.7	31.2	31.1
PERCOLATION	Average Annual (in)	3.31E-06	~~3.86E-06~~ rev	~~1.36E-06~~ rev

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**          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:    m:\help307\nacog\30YR_AVG.D4
TEMPERATURE DATA FILE:      m:\help307\nacog\30YR_AVG.D7
SOLAR RADIATION DATA FILE:  m:\help307\nacog\30YR_AVG.D13
EVAPOTRANSPIRATION DATA:    m:\help307\nacog\INTERIM.D11
SOIL AND DESIGN DATA FILE:  m:\help307\nacog\INT_CCL.D10
OUTPUT DATA FILE:           m:\help307\nacog\INT_CCL.OUT


TIME:  11:35     DATE:  5/ 1/2013


******************************************************************************

     TITLE:  Interim, 57-ft Waste, 2.8% Slope, 325-ft Drainage Length with CCL

******************************************************************************


     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  11
        THICKNESS                          =    12.00     INCHES
        POROSITY                           =     0.4640 VOL/VOL
        FIELD CAPACITY                     =     0.3100 VOL/VOL
        WILTING POINT                      =     0.1870 VOL/VOL
        INITIAL SOIL WATER CONTENT         =     0.3443 VOL/VOL
        EFFECTIVE SAT. HYD. COND.          =   0.639999998000E-04 CM/SEC
     NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  3.00
            FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.
```

EXISTING MODEL PAGES 10E-2-11 to 10E-2-27 REPLACED WITH NEW MODEL PAGES 10E-2-11 to 10E-2-23

```
                         LAYER 2
                         --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
             MATERIAL TEXTURE NUMBER 18
  THICKNESS                  =   684.00    INCHES
  POROSITY                   =     0.6710 VOL/VOL
  FIELD CAPACITY             =     0.2920 VOL/VOL
  WILTING POINT              =     0.0770 VOL/VOL
  INITIAL SOIL WATER CONTENT =     0.2946 VOL/VOL
  EFFECTIVE SAT. HYD. COND.  =   0.100000005000E-02 CM/SEC


                         LAYER 3
                         --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
             MATERIAL TEXTURE NUMBER 11
  THICKNESS                  =    24.00    INCHES
  POROSITY                   =     0.4640 VOL/VOL
  FIELD CAPACITY             =     0.3100 VOL/VOL
  WILTING POINT              =     0.1870 VOL/VOL
  INITIAL SOIL WATER CONTENT =     0.3433 VOL/VOL
  EFFECTIVE SAT. HYD. COND.  =   0.639999998000E-04 CM/SEC


                         LAYER 4
                         --------

            TYPE 2 - LATERAL DRAINAGE LAYER
             MATERIAL TEXTURE NUMBER 0
  THICKNESS                  =     0.19    INCHES
  POROSITY                   =     0.8500 VOL/VOL
  FIELD CAPACITY             =     0.0100 VOL/VOL
  WILTING POINT              =     0.0050 VOL/VOL
  INITIAL SOIL WATER CONTENT =     0.0400 VOL/VOL
  EFFECTIVE SAT. HYD. COND.  =    5.00000000000     CM/SEC
  SLOPE                      =     2.80    PERCENT
  DRAINAGE LENGTH            =   325.0     FEET
```

REPLACED

```
                         LAYER 5
                         --------

            TYPE 4 - FLEXIBLE MEMBRANE LINER
             MATERIAL TEXTURE NUMBER 35
 THICKNESS                    =     0.06     INCHES
 POROSITY                     =     0.0000 VOL/VOL
 FIELD CAPACITY               =     0.0000 VOL/VOL
 WILTING POINT                =     0.0000 VOL/VOL
 INITIAL SOIL WATER CONTENT   =     0.0000 VOL/VOL
 EFFECTIVE SAT. HYD. COND.    =   0.199999996000E-12 CM/SEC
 FML PINHOLE DENSITY          =     1.00     HOLES/ACRE
 FML INSTALLATION DEFECTS     =     4.00     HOLES/ACRE
 FML PLACEMENT QUALITY        =   3 - GOOD


                         LAYER 6
                         --------

             TYPE 3 - BARRIER SOIL LINER
             MATERIAL TEXTURE NUMBER 0
 THICKNESS                    =     0.24     INCHES
 POROSITY                     =     0.7500 VOL/VOL
 FIELD CAPACITY               =     0.7470 VOL/VOL
 WILTING POINT                =     0.4000 VOL/VOL
 INITIAL SOIL WATER CONTENT   =     0.7500 VOL/VOL
 EFFECTIVE SAT. HYD. COND.    =   0.499999997000E-08 CM/SEC


          GENERAL DESIGN AND EVAPORATIVE ZONE DATA
          ----------------------------------------

     NOTE:  SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

    SCS RUNOFF CURVE NUMBER            =    85.00
    FRACTION OF AREA ALLOWING RUNOFF   =   100.0    PERCENT
    AREA PROJECTED ON HORIZONTAL PLANE =    1.000   ACRES
    EVAPORATIVE ZONE DEPTH             =   12.0     INCHES
    INITIAL WATER IN EVAPORATIVE ZONE  =    4.132   INCHES
    UPPER LIMIT OF EVAPORATIVE STORAGE =    5.568   INCHES
    LOWER LIMIT OF EVAPORATIVE STORAGE =    2.244   INCHES
    INITIAL SNOW WATER                 =    0.000   INCHES
    INITIAL WATER IN LAYER MATERIALS   =  214.037   INCHES
    TOTAL INITIAL WATER                =  214.037   INCHES
    TOTAL SUBSURFACE INFLOW            =    0.00    INCHES/YEAR
```

REPLACED

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
NACOGDOCHES TEXAS

STATION LATITUDE = 31.37 DEGREES
MAXIMUM LEAF AREA INDEX = 2.00
START OF GROWING SEASON (JULIAN DATE) = 55
END OF GROWING SEASON (JULIAN DATE) = 336
EVAPORATIVE ZONE DEPTH = 12.0 INCHES
AVERAGE ANNUAL WIND SPEED = 11.30 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY = 69.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY = 69.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY = 62.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY = 69.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR HOUSTON TEXAS

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
4.45	3.17	3.58	3.13	5.29	4.18
2.60	3.08	4.08	4.13	4.54	4.44

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR HOUSTON TEXAS

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
51.40	54.50	61.00	68.70	74.90	80.60
83.10	82.60	78.40	69.70	60.10	54.00

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR HOUSTON TEXAS
AND STATION LATITUDE = 29.39 DEGREES

REPLACED

****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 30

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	4.83	3.29	3.27	2.87	4.23	3.67
	2.91	2.99	4.09	3.65	5.36	3.91
STD. DEVIATIONS	2.78	1.90	2.12	1.75	2.50	3.50
	1.39	1.77	1.70	2.64	2.94	1.93
RUNOFF						
TOTALS	0.401	0.140	0.172	0.179	0.552	0.358
	0.052	0.104	0.147	0.332	0.768	0.252
STD. DEVIATIONS	0.744	0.256	0.423	0.328	0.768	0.727
	0.125	0.226	0.193	0.521	0.774	0.374
EVAPOTRANSPIRATION						
TOTALS	2.369	2.523	2.774	2.822	3.015	2.885
	2.845	2.808	3.390	2.083	1.683	2.025
STD. DEVIATIONS	0.454	0.590	1.025	1.349	1.230	2.012
	1.256	1.455	1.281	0.891	0.292	0.237
LATERAL DRAINAGE COLLECTED FROM LAYER 4						
TOTALS	1.4923	1.4139	1.8096	1.3655	0.8411	0.5874
	0.5474	0.2949	0.1100	0.1874	0.4628	1.0951
STD. DEVIATIONS	0.8576	0.8038	1.1902	1.1460	0.9151	0.5666
	0.6165	0.4351	0.1534	0.2758	0.5737	0.7217
PERCOLATION/LEAKAGE THROUGH LAYER 6						
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

REPLACED

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 5

AVERAGES	0.0197	0.0205	0.0239	0.0187	0.0111	0.0080
	0.0072	0.0039	0.0015	0.0025	0.0063	0.0145
STD. DEVIATIONS	0.0113	0.0117	0.0157	0.0157	0.0121	0.0077
	0.0081	0.0058	0.0021	0.0036	0.0078	0.0095

****

****

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 30

	INCHES	CU. FEET	PERCENT
PRECIPITATION	45.09 (6.729)	163658.6	100.00
RUNOFF	3.517 (1.6114)	12768.24	7.802
EVAPOTRANSPIRATION	31.222 (2.6898)	113336.70	69.252
LATERAL DRAINAGE COLLECTED FROM LAYER 4	10.20750 (3.91099)	37053.215	22.64056
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.00000 (0.00000)	0.014	0.00001
AVERAGE HEAD ON TOP OF LAYER 5	0.011 (0.004)		
CHANGE IN WATER STORAGE	0.138 (3.4408)	500.37	0.306

****

REPLACED

****

PEAK DAILY VALUES FOR YEARS 1 THROUGH 30

	(INCHES)	(CU. FT.)
PRECIPITATION	4.62	16770.600
RUNOFF	2.340	8495.6143
DRAINAGE COLLECTED FROM LAYER 4	0.19509	708.19135
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.000000	0.00014
AVERAGE HEAD ON TOP OF LAYER 5	0.080	
MAXIMUM HEAD ON TOP OF LAYER 5	0.158	
LOCATION OF MAXIMUM HEAD IN LAYER 4 (DISTANCE FROM DRAIN)	3.2 FEET	
SNOW WATER	0.70	2542.1436
MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.4517	
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.1870	

*** 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.

****

REPLACED

****

FINAL WATER STORAGE AT END OF YEAR 30

LAYER	(INCHES)	(VOL/VOL)
1	3.6990	0.3083
2	204.9276	0.2996
3	9.3218	0.3884
4	0.0440	0.2317
5	0.0000	0.0000
6	0.1800	0.7500
SNOW WATER	0.000	

****
****

REPLACED

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              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:      m:\help307\nacog\30YR_AVG.D4
TEMPERATURE DATA FILE:        m:\help307\nacog\30YR_AVG.D7
SOLAR RADIATION DATA FILE:    m:\help307\nacog\30YR_AVG.D13
EVAPOTRANSPIRATION DATA:      m:\help307\nacog\FINAL.D11
SOIL AND DESIGN DATA FILE:    m:\help307\nacog\FIN_CCL.D10
OUTPUT DATA FILE:             m:\help307\nacog\FIN_CCL.OUT


TIME:  11:36      DATE:   5/ 1/2013


******************************************************************************

     TITLE:  Closed, 2.8% Slope, 325-foot Drainage Length with CCL

******************************************************************************


     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 11
          THICKNESS                    =     6.00    INCHES
          POROSITY                     =     0.4640 VOL/VOL
          FIELD CAPACITY               =     0.3100 VOL/VOL
          WILTING POINT                =     0.1870 VOL/VOL
          INITIAL SOIL WATER CONTENT   =     0.4535 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.639999998000E-04 CM/SEC
        NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY   4.63
               FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.
```

REPLACED

```
                    LAYER 2
                    -------

        TYPE 4 - FLEXIBLE MEMBRANE LINER
          MATERIAL TEXTURE NUMBER 36
THICKNESS                  =    0.04   INCHES
POROSITY                   =    0.0000 VOL/VOL
FIELD CAPACITY             =    0.0000 VOL/VOL
WILTING POINT              =    0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT =    0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.399999993000E-12 CM/SEC
FML PINHOLE DENSITY        =    1.00   HOLES/ACRE
FML INSTALLATION DEFECTS   =    4.00   HOLES/ACRE
FML PLACEMENT QUALITY      =  3 - GOOD


                    LAYER 3
                    -------

        TYPE 1 - VERTICAL PERCOLATION LAYER
          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 =    0.4094 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.999999975000E-05 CM/SEC


                    LAYER 4
                    -------

        TYPE 1 - VERTICAL PERCOLATION LAYER
          MATERIAL TEXTURE NUMBER 11
THICKNESS                  =    6.00   INCHES
POROSITY                   =    0.4640 VOL/VOL
FIELD CAPACITY             =    0.3100 VOL/VOL
WILTING POINT              =    0.1870 VOL/VOL
INITIAL SOIL WATER CONTENT =    0.3100 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.639999998000E-04 CM/SEC
```

REPLACED

LAYER 5

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18

THICKNESS	=	684.00 INCHES
POROSITY	=	0.6710 VOL/VOL
FIELD CAPACITY	=	0.2920 VOL/VOL
WILTING POINT	=	0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2920 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000005000E-02 CM/SEC

LAYER 6

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 11

THICKNESS	=	24.00 INCHES
POROSITY	=	0.4640 VOL/VOL
FIELD CAPACITY	=	0.3100 VOL/VOL
WILTING POINT	=	0.1870 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3100 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.639999998000E-04 CM/SEC

LAYER 7

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	0.19 INCHES
POROSITY	=	0.8500 VOL/VOL
FIELD CAPACITY	=	0.0100 VOL/VOL
WILTING POINT	=	0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0107 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	5.00000000000 CM/SEC
SLOPE	=	2.80 PERCENT
DRAINAGE LENGTH	=	325.0 FEET

REPLACED

LAYER 8

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   =     4.00     HOLES/ACRE
FML PLACEMENT QUALITY      =  3 - GOOD
```

LAYER 9

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 0

```
THICKNESS                  =     0.24     INCHES
POROSITY                   =     0.7500 VOL/VOL
FIELD CAPACITY             =     0.7470 VOL/VOL
WILTING POINT              =     0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT =     0.7500 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.499999997000E-08 CM/SEC
```

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

```
SCS RUNOFF CURVE NUMBER              =    85.00
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    =     2.721   INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE   =     2.784   INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE   =     1.122   INCHES
INITIAL SNOW WATER                   =     0.000   INCHES
INITIAL WATER IN LAYER MATERIALS     =   219.300   INCHES
TOTAL INITIAL WATER                  =   219.300   INCHES
TOTAL SUBSURFACE INFLOW              =     0.00    INCHES/YEAR
```

REPLACED

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
NACOGDOCHES TEXAS

STATION LATITUDE	=	31.37 DEGREES
MAXIMUM LEAF AREA INDEX	=	3.50
START OF GROWING SEASON (JULIAN DATE)	=	55
END OF GROWING SEASON (JULIAN DATE)	=	336
EVAPORATIVE ZONE DEPTH	=	6.0 INCHES
AVERAGE ANNUAL WIND SPEED	=	11.30 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	69.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	69.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	62.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	69.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR HOUSTON TEXAS

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
4.45	3.17	3.53	3.13	5.29	4.18
2.60	3.08	4.08	4.13	4.54	4.44

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR HOUSTON TEXAS

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
51.40	54.50	61.00	68.70	74.90	80.60
83.10	82.60	78.40	69.70	60.10	54.00

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR HOUSTON TEXAS
AND STATION LATITUDE = 29.39 DEGREES

REPLACED

****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 30

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	4.83	3.29	3.27	2.87	4.23	3.67
	2.91	2.99	4.09	3.65	5.36	3.91
STD. DEVIATIONS	2.78	1.90	2.12	1.75	2.50	3.50
	1.39	1.77	1.70	2.64	2.94	1.93
RUNOFF						
TOTALS	2.481	1.152	0.662	0.357	1.140	0.831
	0.124	0.175	0.399	1.169	3.259	2.227
STD. DEVIATIONS	2.614	1.443	1.309	0.728	1.503	1.757
	0.349	0.413	0.650	1.723	2.669	1.753
EVAPOTRANSPIRATION						
TOTALS	2.314	2.506	2.909	2.885	3.040	2.883
	2.826	2.809	3.478	2.081	1.479	1.851
STD. DEVIATIONS	0.334	0.510	1.046	1.361	1.276	2.004
	1.247	1.475	1.245	0.918	0.245	0.200
PERCOLATION/LEAKAGE THROUGH LAYER 2						
TOTALS	0.0084	0.0058	0.0037	0.0015	0.0015	0.0012
	0.0004	0.0005	0.0017	0.0034	0.0083	0.0095
STD. DEVIATIONS	0.0028	0.0026	0.0024	0.0013	0.0013	0.0016
	0.0007	0.0007	0.0015	0.0025	0.0025	0.0021
LATERAL DRAINAGE COLLECTED FROM LAYER 7						
TOTALS	0.0084	0.0059	0.0037	0.0015	0.0015	0.0012
	0.0004	0.0005	0.0017	0.0034	0.0082	0.0096
STD. DEVIATIONS	0.0028	0.0026	0.0024	0.0013	0.0013	0.0016
	0.0007	0.0007	0.0015	0.0025	0.0025	0.0021
PERCOLATION/LEAKAGE THROUGH LAYER 9						
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

REPLACED

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 2

AVERAGES	3.8446	2.8787	1.6275	0.6795	0.6574	0.5567
	0.1797	0.2131	0.7706	1.5356	3.9236	4.3583
STD. DEVIATIONS	1.3390	1.3304	1.1158	0.5922	0.5903	0.7440
	0.3155	0.3285	0.6873	1.1473	1.2137	1.0120

DAILY AVERAGE HEAD ON TOP OF LAYER 8

AVERAGES	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0001	0.0001
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

****

****

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 30

	INCHES	CU. FEET	PERCENT
PRECIPITATION	45.09 (6.729)	163658.6	100.00
RUNOFF	13.976 (5.1218)	50733.25	30.999
EVAPOTRANSPIRATION	31.061 (2.7502)	112750.86	68.894
PERCOLATION/LEAKAGE THROUGH LAYER 2	0.04595 (0.00676)	166.816	0.10193
AVERAGE HEAD ON TOP OF LAYER 2	1.769 (0.268)		
LATERAL DRAINAGE COLLECTED FROM LAYER 7	0.04596 (0.00675)	166.818	0.10193
PERCOLATION/LEAKAGE THROUGH LAYER 9	0.00000 (0.00000)	0.005	0.00000
AVERAGE HEAD ON TOP OF LAYER 8	0.000 (0.000)		
CHANGE IN WATER STORAGE	0.002 (0.5686)	7.59	0.005

****

REPLACED

~~PEAK DAILY VALUES FOR YEARS 1 THROUGH 30~~

	(INCHES)	(CU. FT.)
~~PRECIPITATION~~	~~4.62~~	~~16770.600~~
~~RUNOFF~~	~~4.085~~	~~14827.0752~~
~~PERCOLATION/LEAKAGE THROUGH LAYER 2~~	~~0.000415~~	~~1.50594~~
~~AVERAGE HEAD ON TOP OF LAYER 2~~	~~6.000~~	
~~DRAINAGE COLLECTED FROM LAYER 7~~	~~0.00041~~	~~1.49786~~
~~PERCOLATION/LEAKAGE THROUGH LAYER 9~~	~~0.000000~~	~~0.00003~~
~~AVERAGE HEAD ON TOP OF LAYER 8~~	~~0.000~~	
~~MAXIMUM HEAD ON TOP OF LAYER 8~~	~~0.005~~	
~~LOCATION OF MAXIMUM HEAD IN LAYER 7 (DISTANCE FROM DRAIN)~~	~~0.0 FEET~~	
~~SNOW WATER~~	~~0.70~~	~~2542.1436~~
~~MAXIMUM VEG. SOIL WATER (VOL/VOL)~~	~~0.4640~~	
~~MINIMUM VEG. SOIL WATER (VOL/VOL)~~	~~0.1870~~	

~~*** 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.~~

REPLACED

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FINAL WATER STORAGE AT END OF YEAR 30

LAYER	(INCHES)	(VOL/VOL)
1	2.7840	0.4640
2	0.0000	0.0000
3	7.3688	0.4094
4	1.8600	0.3100
5	199.7280	0.2920
6	7.4400	0.3100
7	0.0020	0.0104
8	0.0000	0.0000
9	0.1800	0.7500
SNOW WATER	0.000	

****
****

REPLACED

CITY OF NACOGDOCHES LANDFILL
NACOGDOCHES COUNTY, TEXAS
TCEQ PERMIT NO. MSW 720

SITE DEVELOPMENT PLAN PART III

ATTACHMENT 12
FINAL CLOSURE PLAN

Prepared for:

City of Nacogdoches
P.O.Box 635030
Nacogdoches, Texas 75963

Prepared by:

CAS Engineering Services, Inc.
December 4, 2006

Revised by:

SCS ENGINEERS
TEXAS REGISTRATION NUMBER F-3407
Revision 1, December 2014
Revision 2, September 2019
Revision 3, January 2024
Revision 4, May 2024

UPDATE

STATE OF TEXAS
JEFFREY K. REED
80103
LICENSED
PROFESSIONAL ENGINEER
1/19/24

FOR PERMITTING
PURPOSES ONLY

CITY OF NACOGDOCHES LANDFILL
NACOGDOCHES COUNTY, TEXAS

PART III, SITE DEVELOPMENT PLAN
ATTACHMENT 12, APPENDIX C

LINER AND FINAL COVER STABILITY ANALYSIS

Prepared for:

CITY OF NACOGDOCHES
P.O. Box 635030
Nacogdoches, Texas 75963
(936) 559-2502

UPDATE

1/19/24

Prepared By:

SCS ENGINEERS
TBPE Registration No. F-3407
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281-293-8494

Revision 0 – June 2011
Revision 1 – July 2013
Revision 2 – September 2019/January 2020
Revision 3 – January 2024
SCS Project No. 16209006.26

Revision 4 – May 2024

Table of Contents

UPDATE

SCS Engineers
TBPE Reg. # F-3407

1/19/24

STATE OF TEXAS
JEFFREY K. REED
80103
LICENSED
PROFESSIONAL ENGINEER

INITIAL SUBMITTAL REDLINE/STRIKEOUT PAGE C-1-1 TO C-1-117 TO BE REPLACED WITH NOD1 REDLINE/STRIKEOUT PAGES C-1-1 TO C-1-72

APPENDIX C-1
WASTE SLOPE STABILITY CALCULATIONS AND RESULTS

UPDATE

SCS Engineers
TBPE Reg. # F-3407

9/30/19

STATE OF TEXAS
JEFFREY K. REED
80103
LICENSED
PROFESSIONAL ENGINEER

inclusive of pgs. C-1-1 to C-1-98.

SCS Engineers	WASTE SLOPE STABILITY-GM/CCL 12/23		
	Proj. No. 16209006.~~02~~ 26	Made By: JKR	Date: 6/16/2011 rev ~~1/20~~
	Project: City of Nacogdoches Landfill	Checked By: JRM	Sheet 1 of 2

OBJECTIVE: Estimate the factor of safety against sliding for interior and exterior waste slopes.

GIVEN: Based on a review of the designed grades, the following worst-case conditions were identified:

Floor Grade	2.0% - 5%	
Maximum Interior Waste Slopes	33.0%	18.4 degrees
Maximum Waste Height		57.5 ~~50~~ feet (Block O), 77 feet (Block P)
Liner System Evaluated (from top to bottom):		24" Protective Cover consisting of on-site soils Geocomposite Drainage Layer 60-mil HDPE Geomembrane 24" Compacted Clay Liner (CCL) [Block P and Block O, Cell 1 and 2 liner system. Alternate Liner for Block O, Cells 3-6]

Based on a review of available data, the following parameters were assigned to the referenced materials.

Material	Strength Parameters		Unit Weight (pcf)		Reference
	Φ (deg)	C (psf)	moist	saturated	
Waste	33	500	65	75	Eid, et al. (2000)
Protective Cover	20	200	100	115	Est. for clay
Protective Cover/Geocomposite Interface	26	0	---	---	*
SS Geocomposite/Smooth Geomembrane Interface	8	0	---	---	*
DS Geocomposite/Textured Geomembrane Interface	28	0	---	---	*
Smooth Geomembrane/ CCL Interface	11	300	---	---	**
Textured Geomembrane/ CCL Interface	20	50	---	---	*
CCL/Subgrade Interface	20	200	100	115	Est. for clay

Notes:

* Unpublished testing data by Golder Associates, Inc. (attached)

** Based on shear strength parameters, the critical interface will be the SS geocomposite (geonet side) and smooth geomembrane.

METHOD: PCStabl5M3, Purdue University, 1985
Analyze the critical condition for block and circular failure surfaces.

RESULTS: See Tables 1 and 2, Appendix C-1

CONCLUSIONS: Using the estimated strength parameters and worst-case slopes, the analysis indicates that the interim and final waste slopes will remain stable under the configurations presented in Tables 1 and 2 for a FML/CCL liner.

SCS Engineers	WASTE SLOPE STABILITY-GM/GCL 12/23		
	Proj. No. 16209006.~~11~~ 26	Made By: JKR	Date: 7/15/13 rev ~~1/20~~
	Project: City of Nacogdoches Landfill	Checked By: JRM	Sheet 2 of 2

OBJECTIVE: Estimate the factor of safety against sliding for interior and exterior waste slopes.

GIVEN: Based on a review of the designed grades, the following worst-case conditions were identified:

Floor Grade	2.0% - 5%	
Maximum Interior Waste Slopes	33.0%	18.4 degrees
Maximum Waste Height		~~50~~ 57.5 feet (Block O)
Liner System Evaluated (from top to bottom):	24" Protective Cover consisting of on-site soils Geocomposite Drainage Layer 60-mil HDPE Geomembrane Reinforced Geosynthetic Clay Liner (GCL) [Alternate Block O, Cells 3-6 Liner system]	

Based on a review of available data, the following parameters were assigned to the referenced materials.

Material	Strength Parameters		Unit Weight (pcf)		Reference
	Φ (deg)	C (psf)	moist	saturated	
Waste	33	500	65	75	Eid, et al. (2000)
Protective Cover	20	200	100	115	Est. for clay
Protective Cover/Geocomposite Interface	26	0	---	---	*
SS Geocomposite/Smooth Geomembrane Interface	8	0	---	---	*
DS Geocomposite/Textured Geomembrane Interface	28	0	---	---	*
Smooth Geomembrane/ GCL Interface	10	60	---	---	**
Textured Geomembrane/ GCL Interface	20	140	---	---	**
GCL/Subgrade Interface	24	140	---	---	**

Notes:

* Unpublished testing data by Golder Associates, Inc. (attached)

** Direct shear testing data by CETCO Lining Technologies Group. (attached)

** Based on shear strength parameters, the critical interface will be the SS geocomposite (geonet side) and smooth geomembrane.

METHOD: PCStabl5M3, Purdue University, 1985
Analyze the critical condition for block and circular failure surfaces.

RESULTS: See Tables 1 and 2, Appendix C-1

CONCLUSIONS: Using the estimated strength parameters and worst-case slopes, and given the worst case friction interface remains unchanged for either a FML/CCL or a FML/GCL liner, the analysis indicates that the

Table 1.
Waste Interim Slope Stability Analysis

Scenario	Section	File name	Failure Mode	Loading Condition	Factor of Safety
1 Single-sided GC, FML-Smooth on base floor, FML-Tex on sideslope	Section CC': 3:1 slope with no benches; waste height ~~50'~~ 46.2'	2310 CCS~~200~~	Circle	Static	2.95 ~~2.90~~
		2310 CBS~~200~~	Block		2.73 ~~2.77~~
2 Single-sided GC, FML-Smooth on base floor, FML-Tex on sideslope	Section CC': 3:1 slope with no benches; waste height ~~50'~~ 46.2'	2320 CCE~~200~~	Circle	Seismic = 0.04g	2.54 ~~2.50~~
		2320 CBE~~200~~	Block		2.34 ~~2.40~~
3 Single-sided GC, FML-Smooth on base floor, FML-Tex on sideslope	Section CC': 4:1 slope with no benches; waste height ~~50'~~ 46.2	2330 CCS~~300~~	Circle	Static	3.54 ~~3.46~~
		2330 CBS~~300~~	Block		3.36 ~~3.24~~
4 Single-sided GC, FML-Smooth on base floor, FML-Tex on sideslope	Section CC': 4:1 slope with no benches; waste height ~~50'~~ 46.2	2340 CCE~~300~~	Circle	Seismic = 0.04g	2.92 ~~2.86~~
		2340 CBE~~300~~	Block		2.76 ~~2.71~~

Table 2.
Mass Waste Final Slope Stability Analysis

Scenario	Section	File name	Failure Mode	Slope Modeled/Loading Condition	Factor of Safety
1 Single-sided GC, FML-Smooth on base floor, FML-Tex on sideslope	Section AA': 4:1 final slope with no benches; waste height ~~50'~~ 57.5'	2310 ACS~~300~~	Circle	Localized exterior waste slope / Static	3.68 ~~3.89~~
		2310 ABS~~300~~	Block		3.35 ~~3.55~~
2 Single-sided GC, FML-Smooth on base floor, FML-Tex on sideslope	Section AA': 4:1 final slope with no benches; waste height ~~50'~~ 57.5'	2320 ACE~~300~~	Circle	Localized exterior waste slope / Seismic = 0.04g	3.10 ~~3.25~~
		2320 ABE~~300~~	Block		2.83 ~~2.94~~
3 Single-sided GC, FML-Smooth on base floor, FML-Tex on sideslope	Section AA': 4:1 final slope with no benches; waste height ~~50'~~ 57.5'	2330 ABS~~400~~	Block	Global exterior waste slope / Static	13.39 ~~9.65~~
		2330 ABE~~400~~	Block	Global exterior waste slope / Seismic = 0.04g	5.76 ~~5.07~~
4 Single-sided GC, FML-Smooth on base floor, FML-Tex on sideslope	Section BB': 4:1 final slope with no benches; waste height ~~50'~~ 56.3'	2340 BCS~~300~~	Circle	Localized exterior waste slope / Static	4.74 ~~3.44~~
		2340 BBS~~300~~	Block		3.79 ~~2.90~~
5 Single-sided GC, FML-Smooth on base floor, FML-Tex on sideslope	Section BB': 4:1 final slope with no benches; waste height ~~50'~~ 56.3'	2350 BCE~~300~~	Circle	Localized exterior waste slope / Seismic = 0.04g	3.78 ~~2.92~~
		2350 BBE~~300~~	Block		2.99 ~~2.44~~
6 Single-sided GC, FML-Smooth on base floor, FML-Tex on sideslope	Section BB': 4:1 final slope with no benches; waste height ~~50'~~ 56.3'	2360 BBS~~400~~	Block	Global exterior waste slope / Static	9.43 ~~6.98~~
		2360 BBE~~400~~	Block	Global exterior waste slope / Seismic = 0.04g	5.00 ~~4.29~~

Scenario	Section	File name	Failure Mode	Slope Modeled/Loading Condition	Factor of Safety
7 Single-sided GC, FML-Smooth on base floor, FML-Tex on sideslope	Section DD': 4:1 final slope with no benches; waste height 77'	DCS100	Circle	Localized exterior waste slope / Static	3.85
		DBS100	Block		3.48
8 Single-sided GC, FML-Smooth on base floor, FML-Tex on sideslope	Section DD': 4:1 final slope with no benches; waste height 77'	DCE100	Circle	Localized exterior waste slope / Seismic = 0.04g	3.12
		DBE100	Block		2.82
~~8~~ 9 Single-sided GC, FML-Smooth on base floor, FML-Tex on sideslope	Section DD': 4:1 final slope with no benches; waste height 77'	DBS200	Block	Global exterior waste slope / Static	3.93
		DBE200	Block	Global exterior waste slope / Seismic = 0.04g	3.02

Figure 1. Section Location Plan for Section ~~CC'~~ AA'

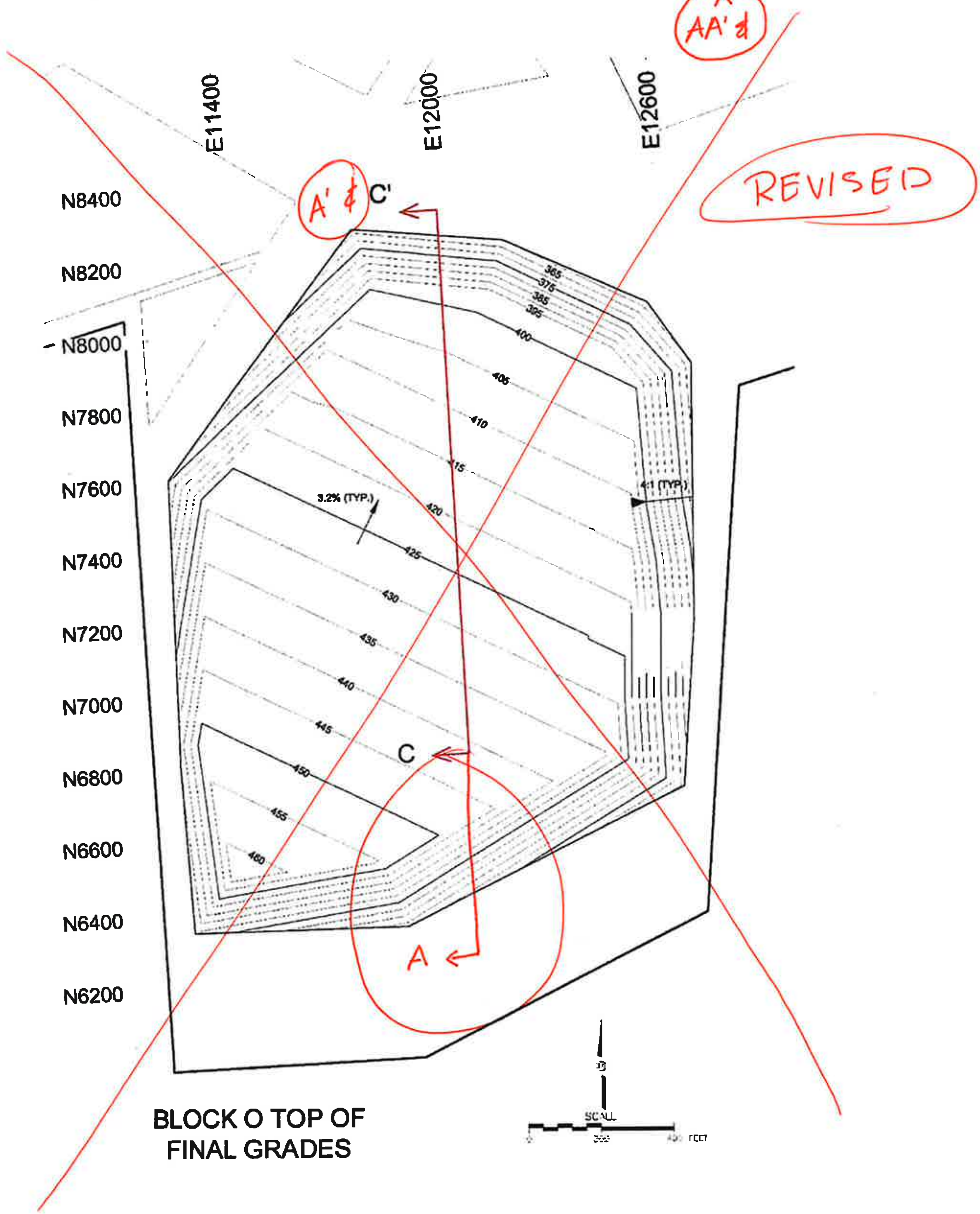


Figure 2. Section Profiles for Section AA' & CC'

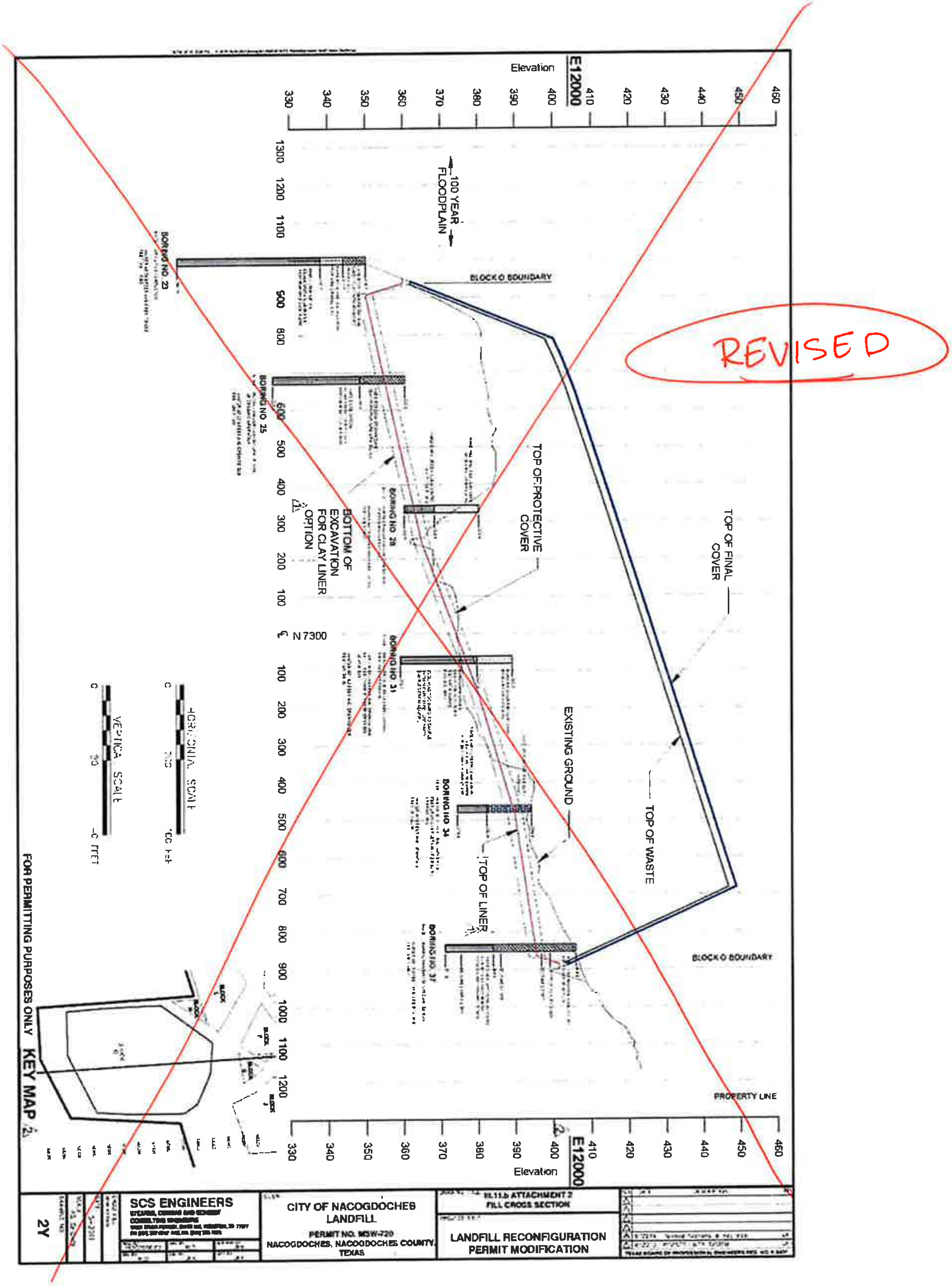


Figure 3. Section Location Plan (section AA' & BB')

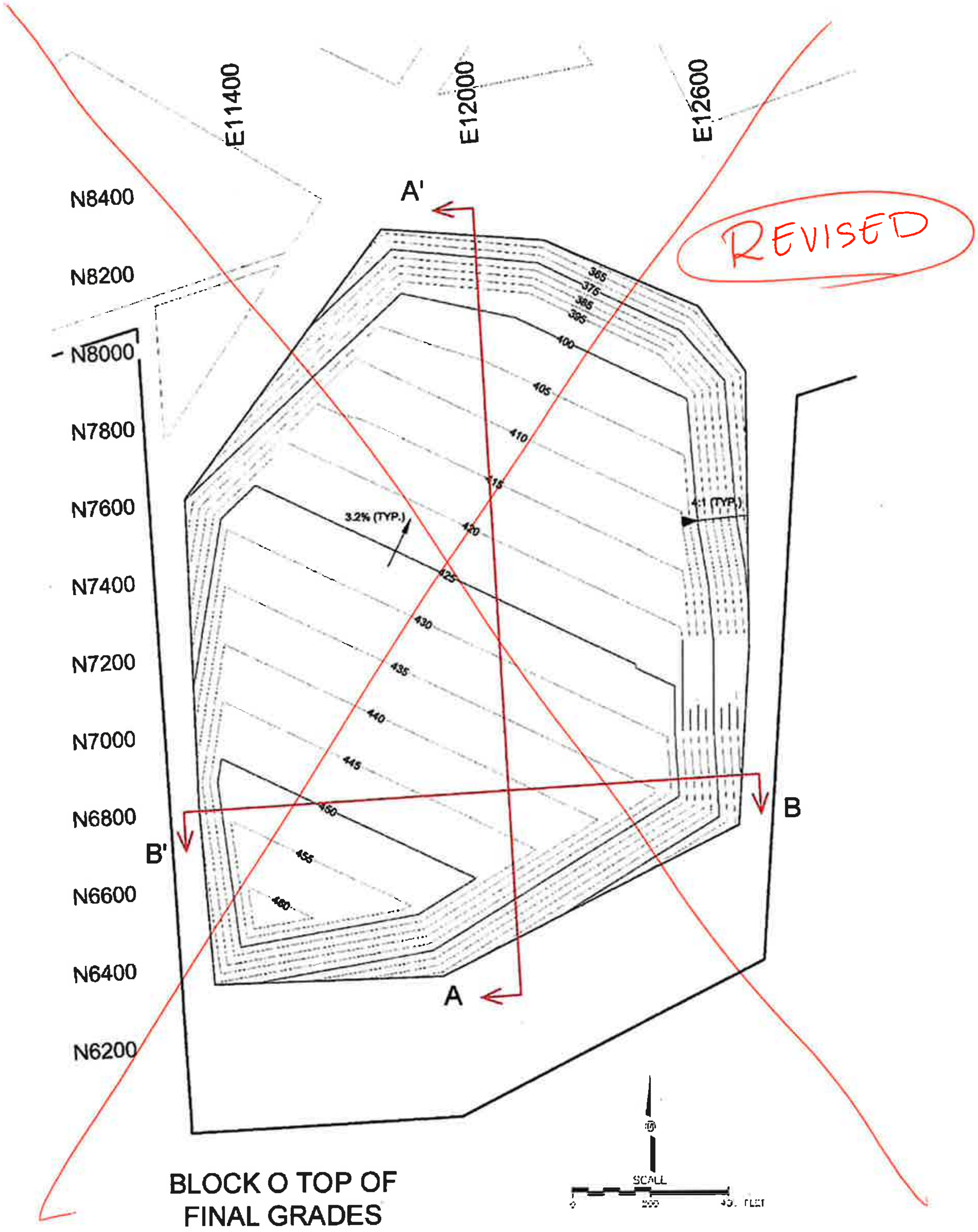
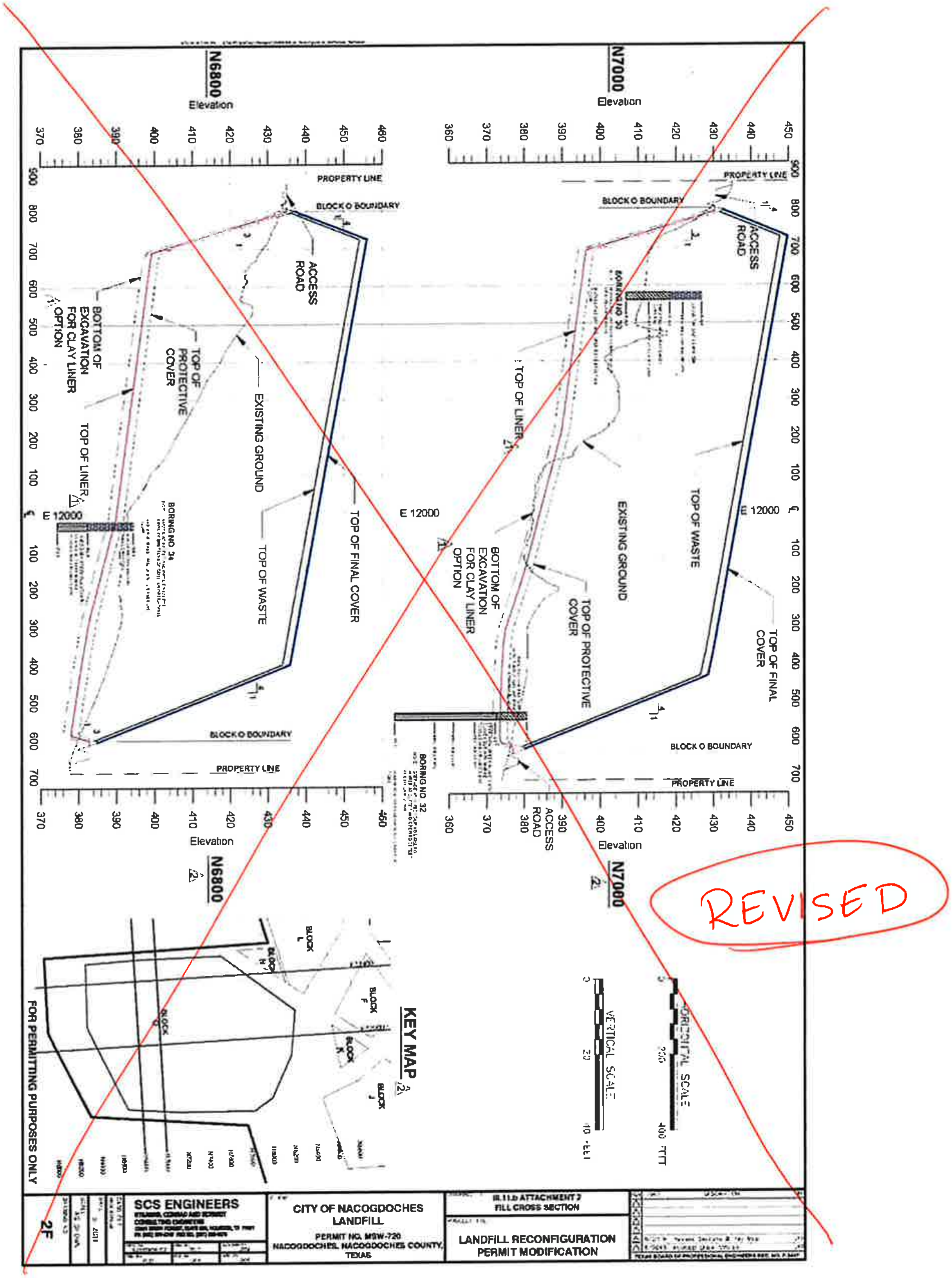
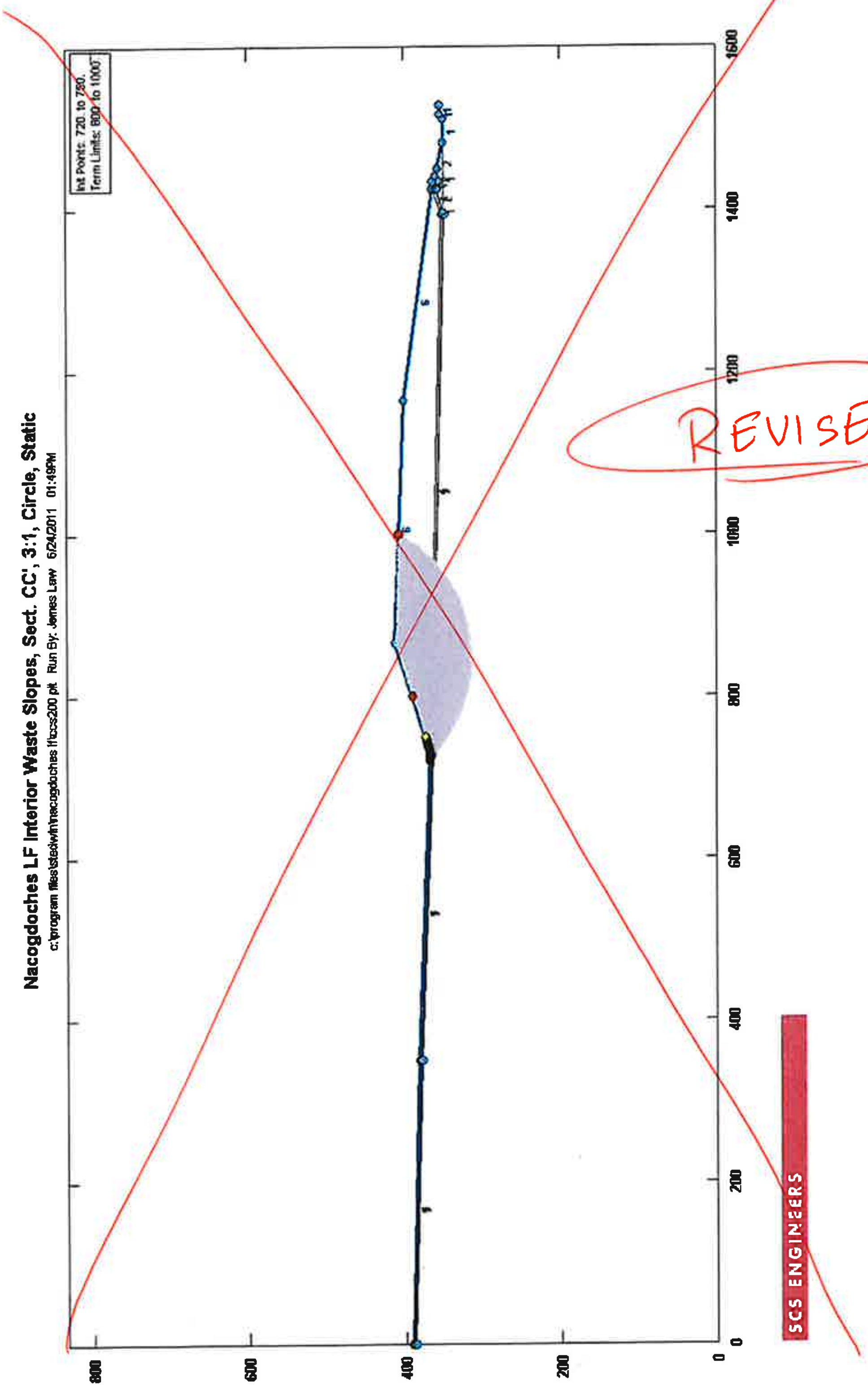


Figure 4. Section Profile BB'



Revision ~~3~~ 4

~~January~~ May 2024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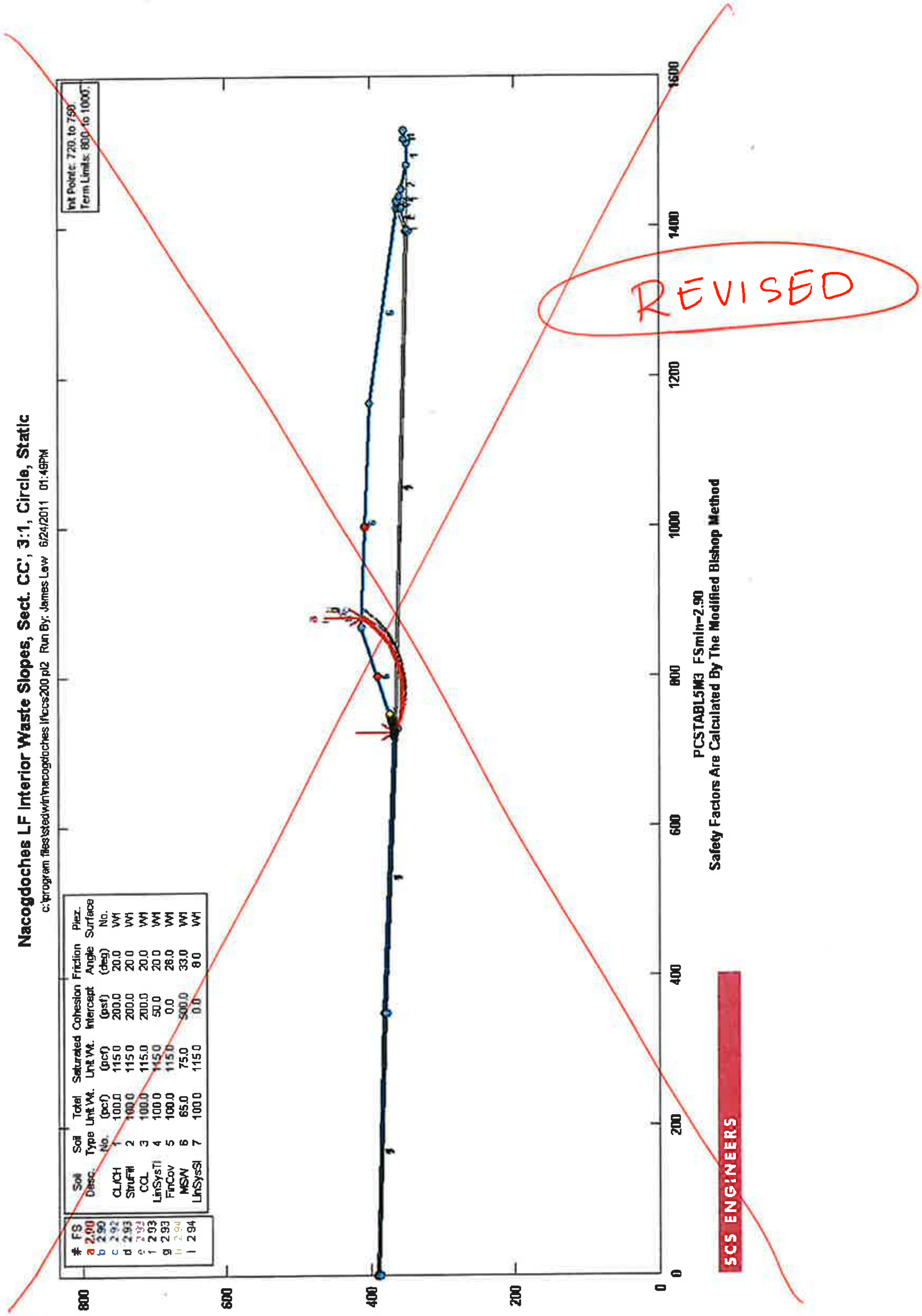
c:\program files\stedwin\nacogdoches lf\cc3s200.pl Run By: James Law 6/24/2011 01:49PM
Init Points: 720 to 750.
Term Limits: 800 to 1000
0
200
400
600
800
1000
1200
1400
1600
SCS ENGINEERS

REVISED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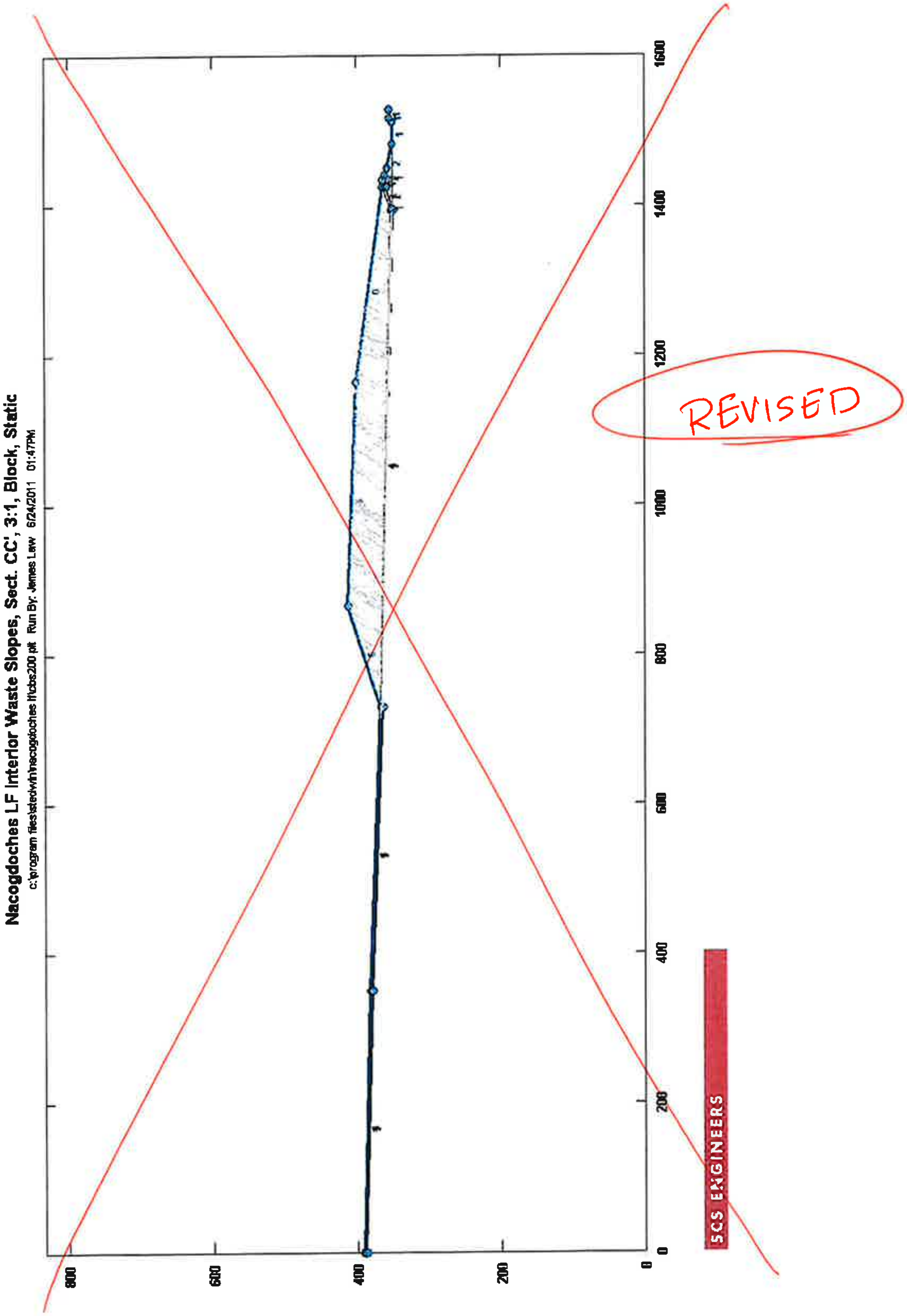
Safety Factors Are Calculated By The Modified Bishop Method
SCS ENGINEERS
REVISED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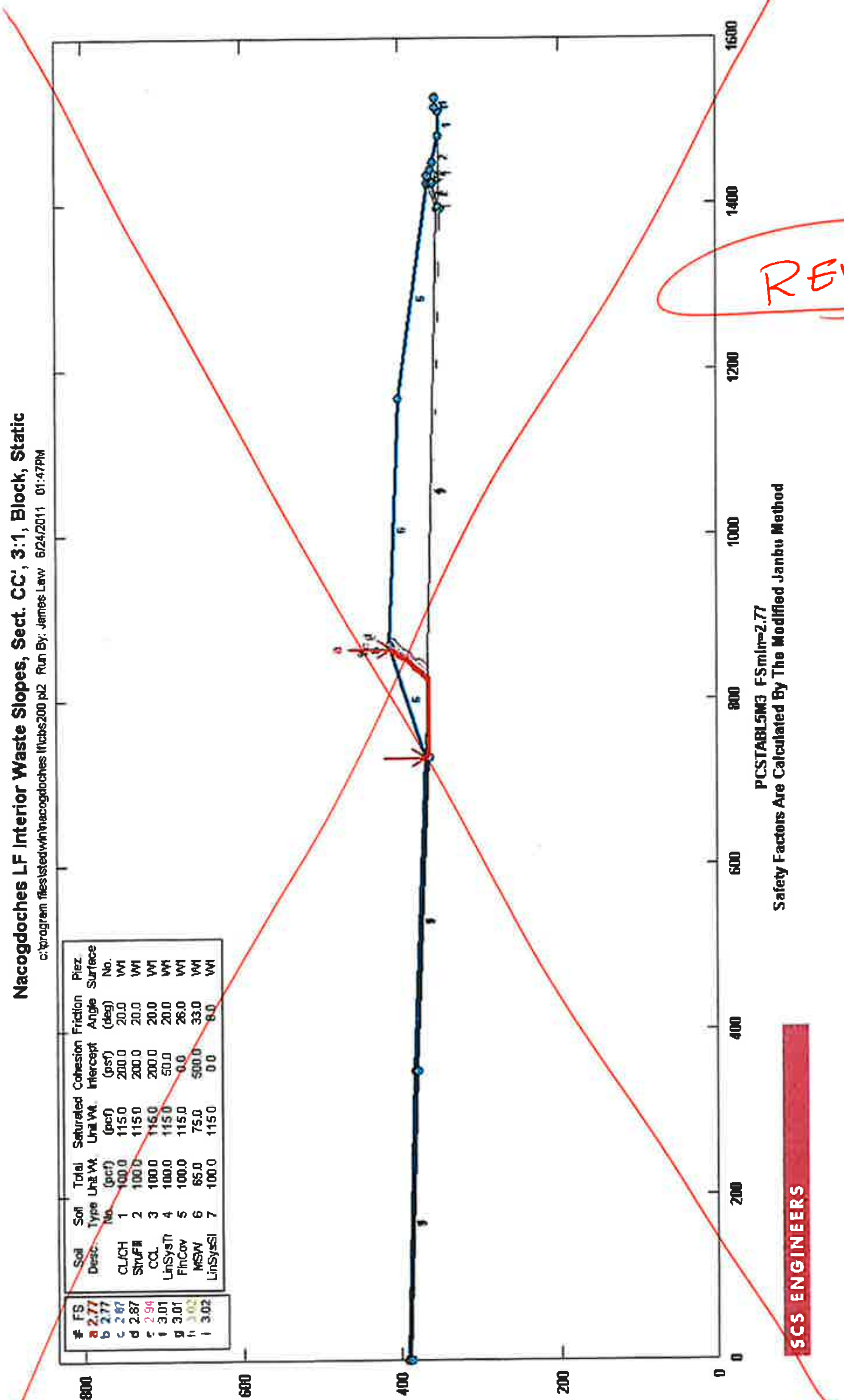
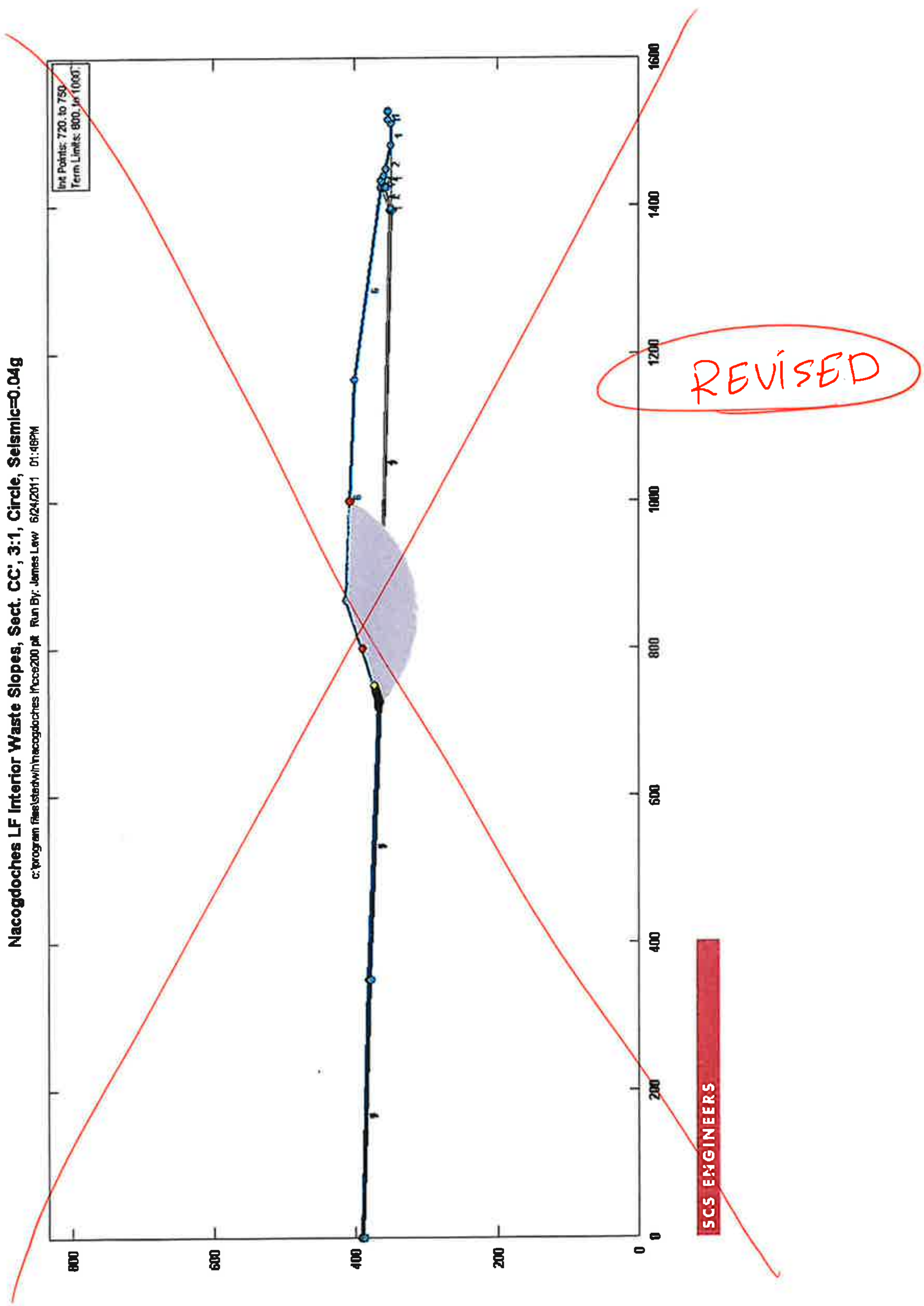
1600
SCS ENGINEERS
REVISED



Revision ~~3~~ 4

May ~~January~~ 2024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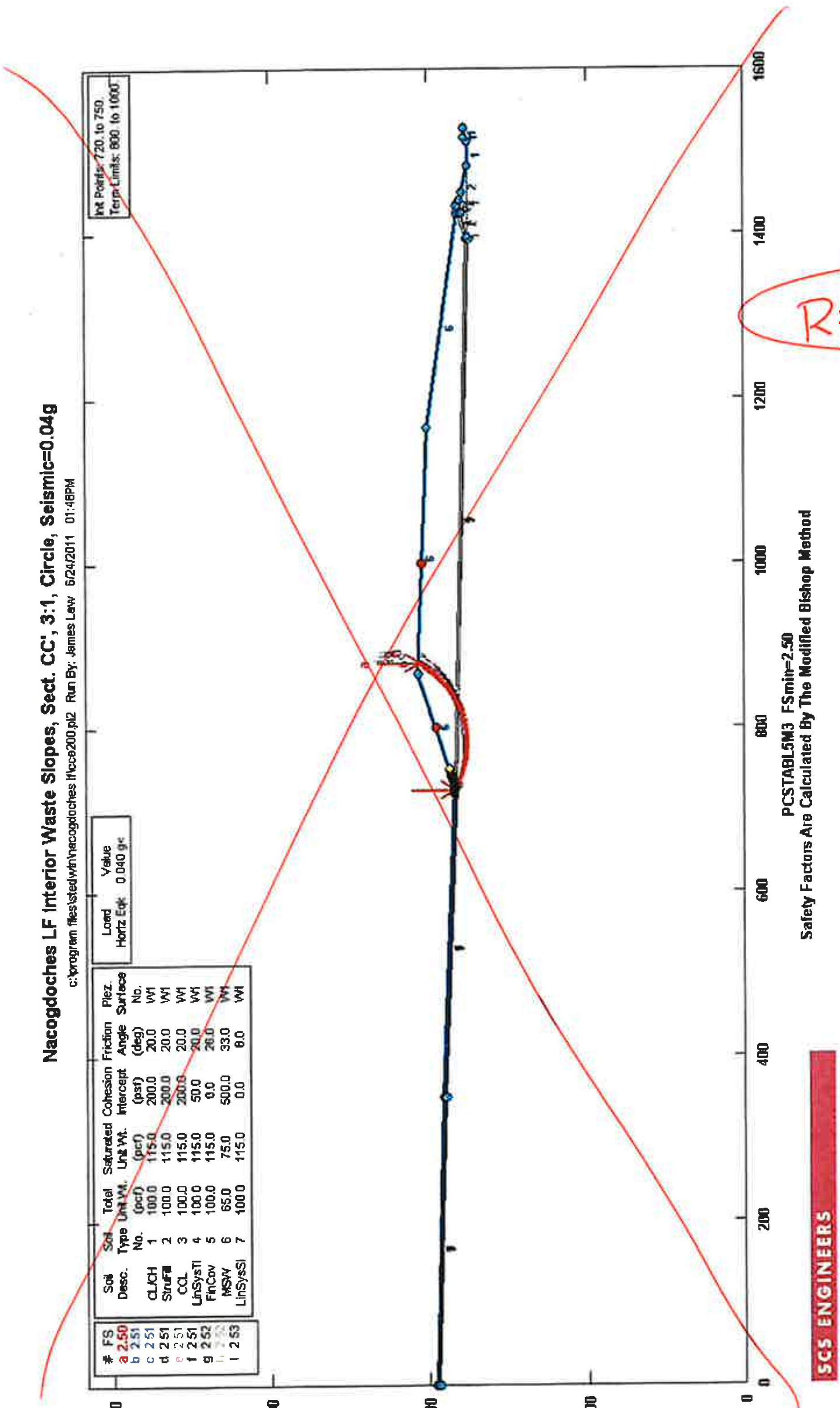
Term Limits: 800. to 1000.
0
200
400
600
800
1000
1200
1400
1600
SCS ENGINEERS
REVISED


Nacogdoches LF Interior Waste Slopes, Sect. CC', 3:1, Circle, Seismic=0.04g
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FS
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b 2.51
c 2.51
d 2.51
e 2.51
f 2.51
g 2.52
h 2.52
i 2.53
Soil Desc. | Soil Type No. | Total Unit Wt. (pcf) | Saturated Unit Wt. (pcf) | Cohesion Intercept (psf) | Friction Angle (deg) | Piez. Surface No.
CL/CH 1 100.0 115.0 200.0 20.0 W1
StruFill 2 100.0 115.0 200.0 20.0 W1
CCL 3 100.0 115.0 200.0 20.0 W1
LinSysTl 4 100.0 115.0 50.0 20.0 W1
FinCov 5 100.0 115.0 0.0 26.0 W1
MSW 6 65.0 75.0 500.0 33.0 W1
LinSysSl 7 100.0 115.0 0.0 8.0 W1
Load Value
Horiz Eqk 0.040 g<
Init Points: 720. to 750.
Term Limits: 800. to 1000.
0
200
400
600
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1200
1400
1600
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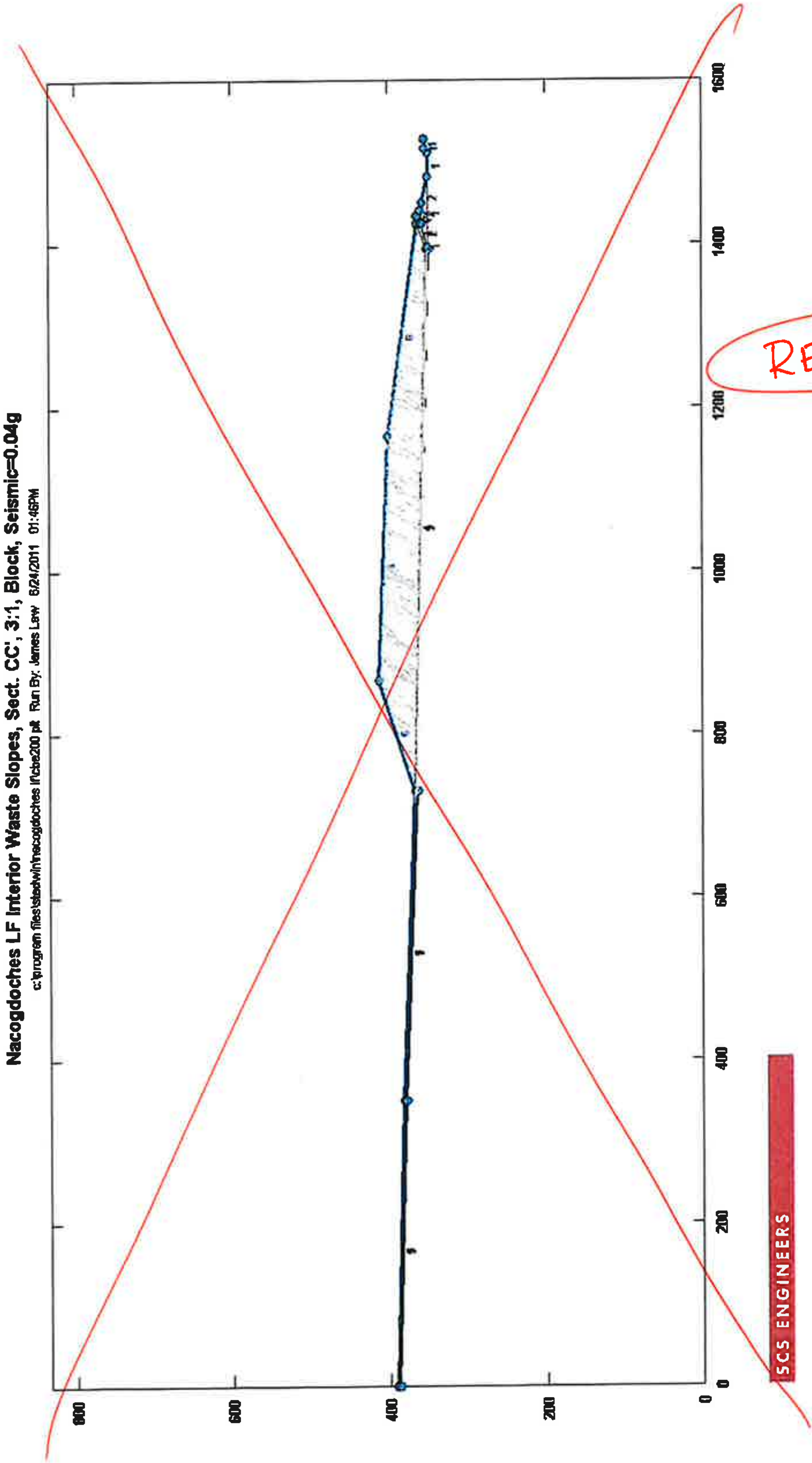
Safety Factors Are Calculated By The Modified Bishop Method
SCS ENGINEERS
REVISED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Run By: James Law 6/24/2011 01:46PM
0
200
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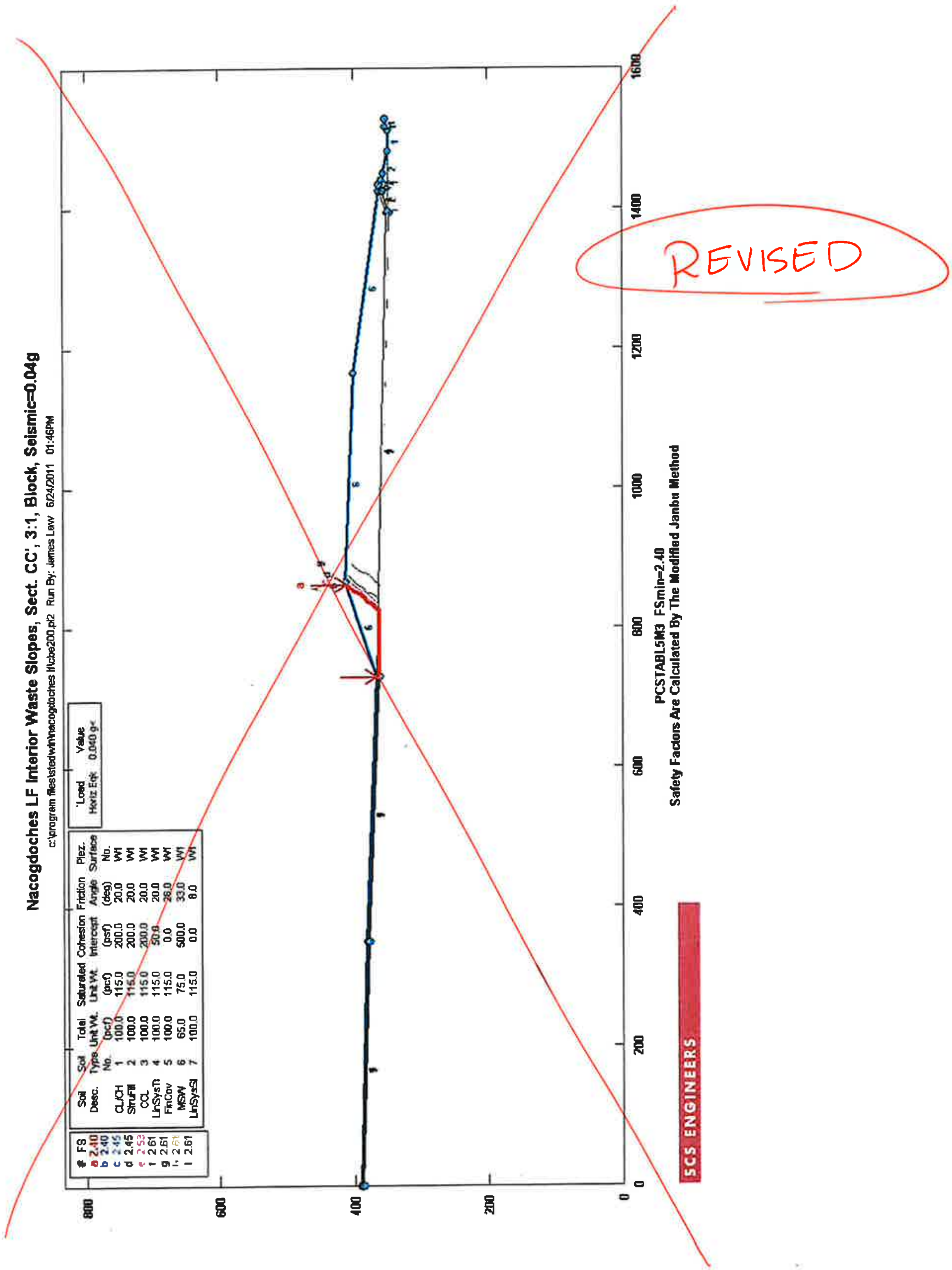
1200
1400
1600
SCS ENGINEERS

REVISED


Nacogdoches LF Interior Waste Slopes, Sect. CC'; 3:1, Block, Seismic=0.04g
c:\program files\stedwin\nacogdoches lf\cbe200.pl2 Run By: James Law 6/24/2011 01:46PM
FS
a 2.40
b 2.40
c 2.45
d 2.45
e 2.53
f 2.61
g 2.61
h 2.61
i 2.61
Soil Desc. | Soil Type No. | Total Unit Wt. (pcf) | Saturated Unit Wt. (pcf) | Cohesion Intercept (psf) | Friction Angle (deg) | Piez. Surface No.
CL/CH 1 100.0 115.0 200.0 20.0 W1
StruFill 2 100.0 115.0 200.0 20.0 W1
CCL 3 100.0 115.0 200.0 20.0 W1
LinSysTi 4 100.0 115.0 50.0 20.0 W1
FinCov 5 100.0 115.0 0.0 26.0 W1
MSW 6 65.0 75.0 500.0 33.0 W1
LinSysSl 7 100.0 115.0 0.0 8.0 W1
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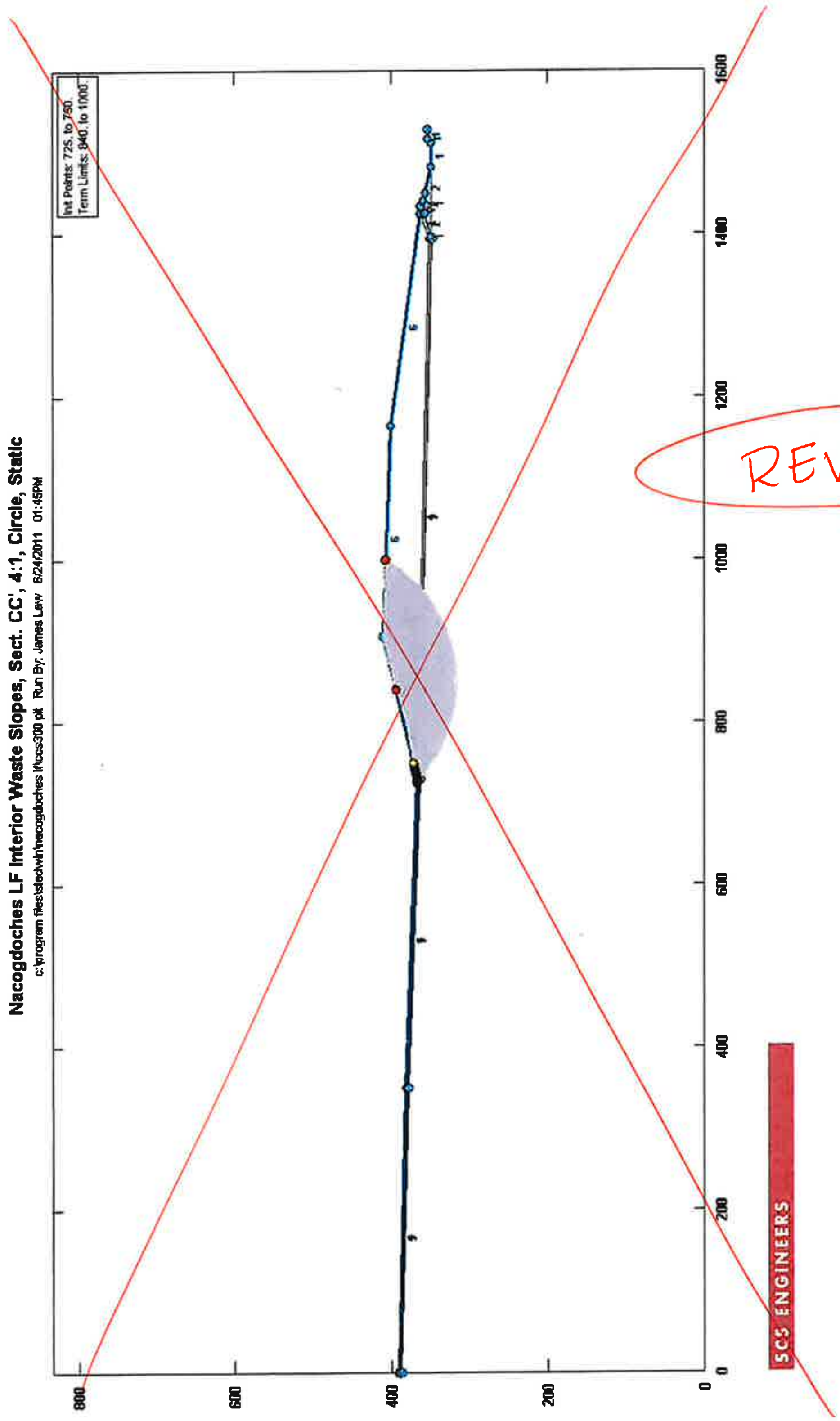
Horiz Eqk 0.040 g<
PCSTABL5M3 FSmin=2.40
Safety Factors Are Calculated By The Modified Janbu Method
SCS ENGINEERS
REVISED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c:\program files\stedwin\nacogdoches lf\ccs300 pl Run By: James Lew 6/24/2011 01:45PM
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Term Limits: 840. to 1000.
0
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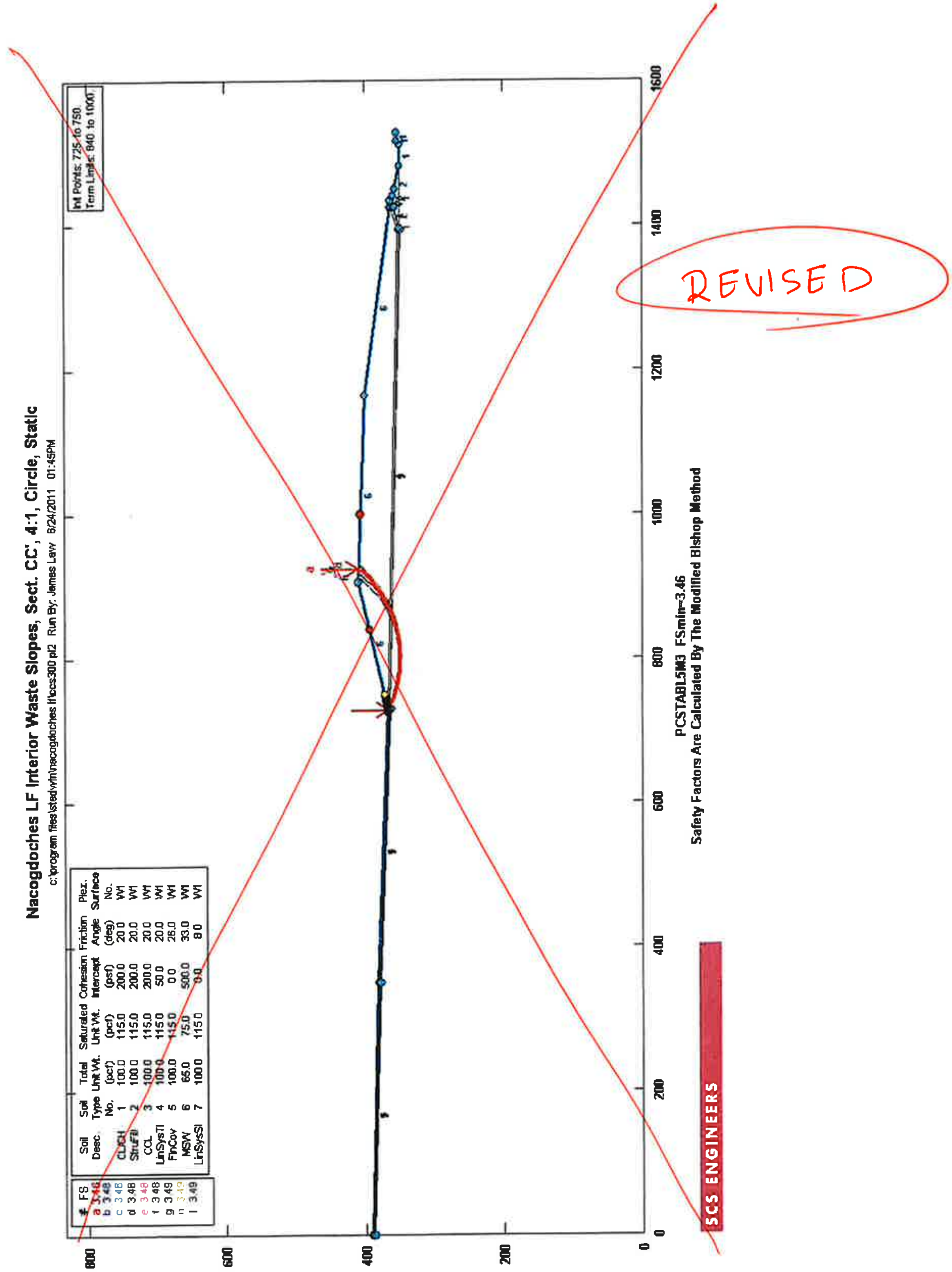
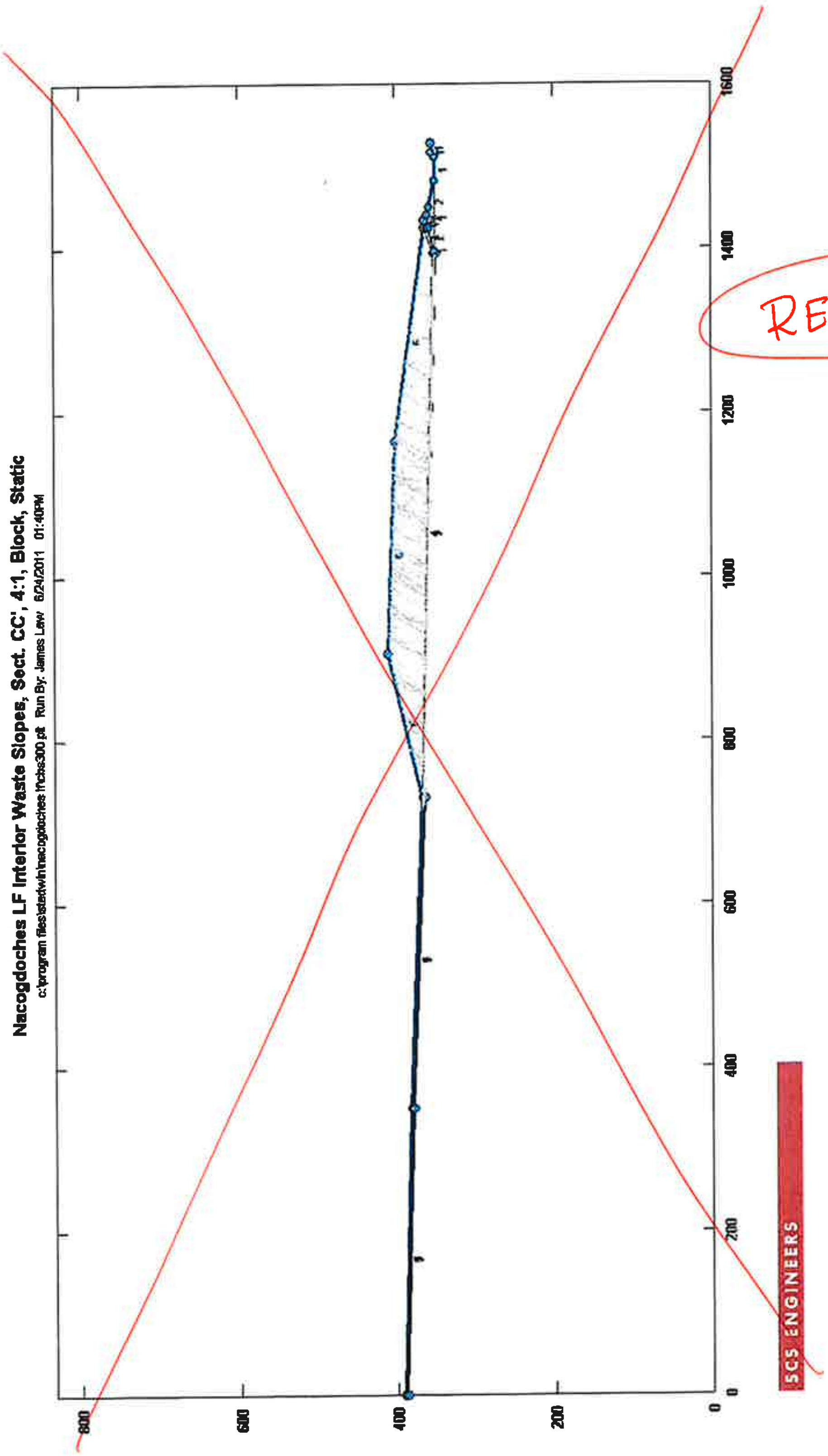
800
1000
1200
1400
1600
SCS ENGINEERS
REVISED



Revision ~~3~~ 4

~~January~~ May 2024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1000
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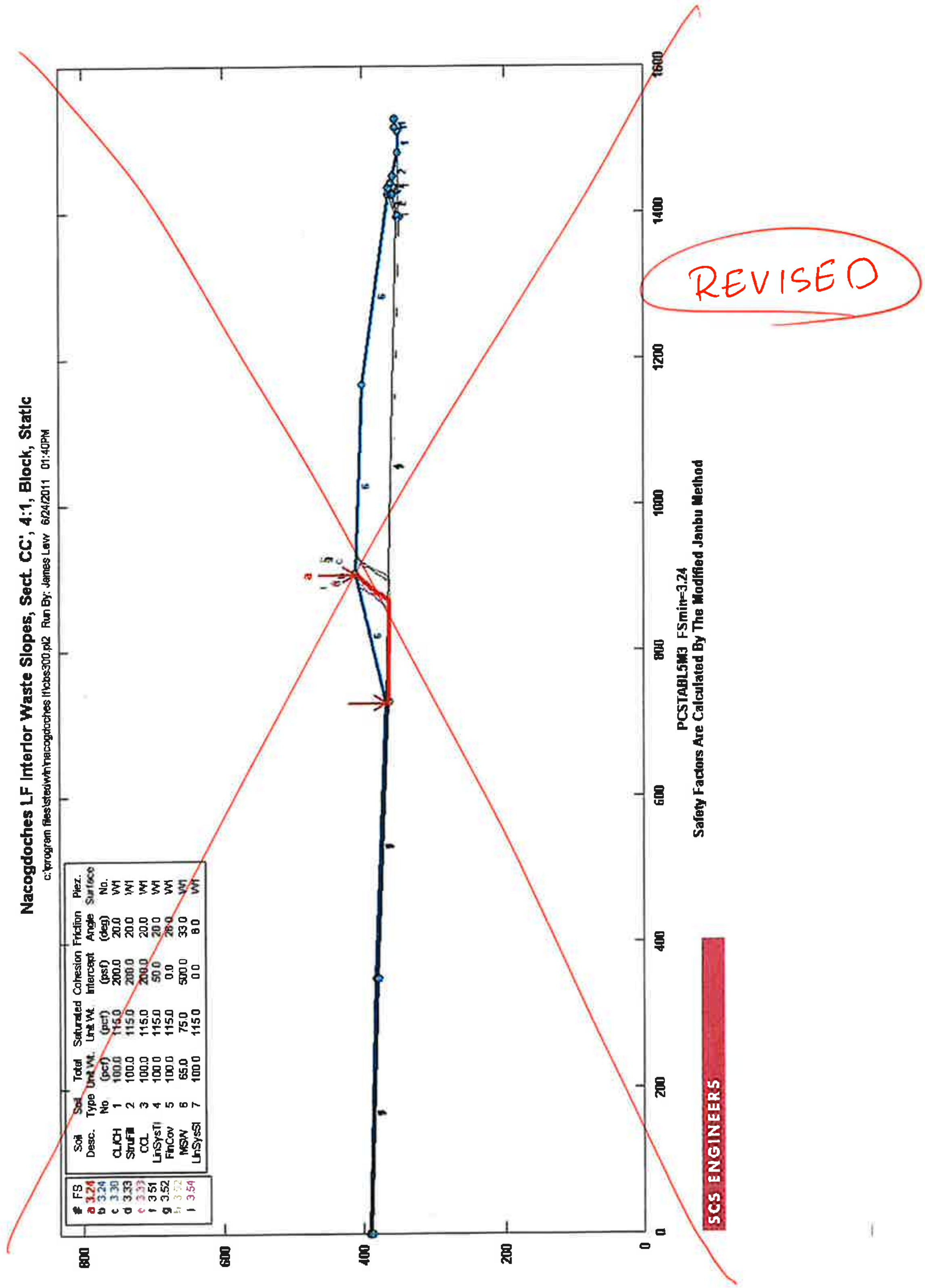
1400
1600
SCS ENGINEERS

REVISED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FS
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b 3.24
c 3.30
d 3.33
e 3.33
f 3.51
g 3.52
h 3.52
i 3.54
Soil Desc. | Soil Type No | Total Unit Wt. (pcf) | Saturated Unit Wt. (pcf) | Cohesion Intercept (psf) | Friction Angle (deg) | Piez. Surface No.
CL/CH 1 100.0 115.0 200.0 20.0 W1
StruFill 2 100.0 115.0 200.0 20.0 W1
CCL 3 100.0 115.0 200.0 20.0 W1
LinSysTi 4 100.0 115.0 50.0 20.0 W1
FinCov 5 100.0 115.0 0.0 28.0 W1
MSW 6 65.0 75.0 500.0 33.0 W1
LinSysSt 7 100.0 115.0 0.0 8.0 W1
0
200
400
600
800
1000
1200
1400
1600
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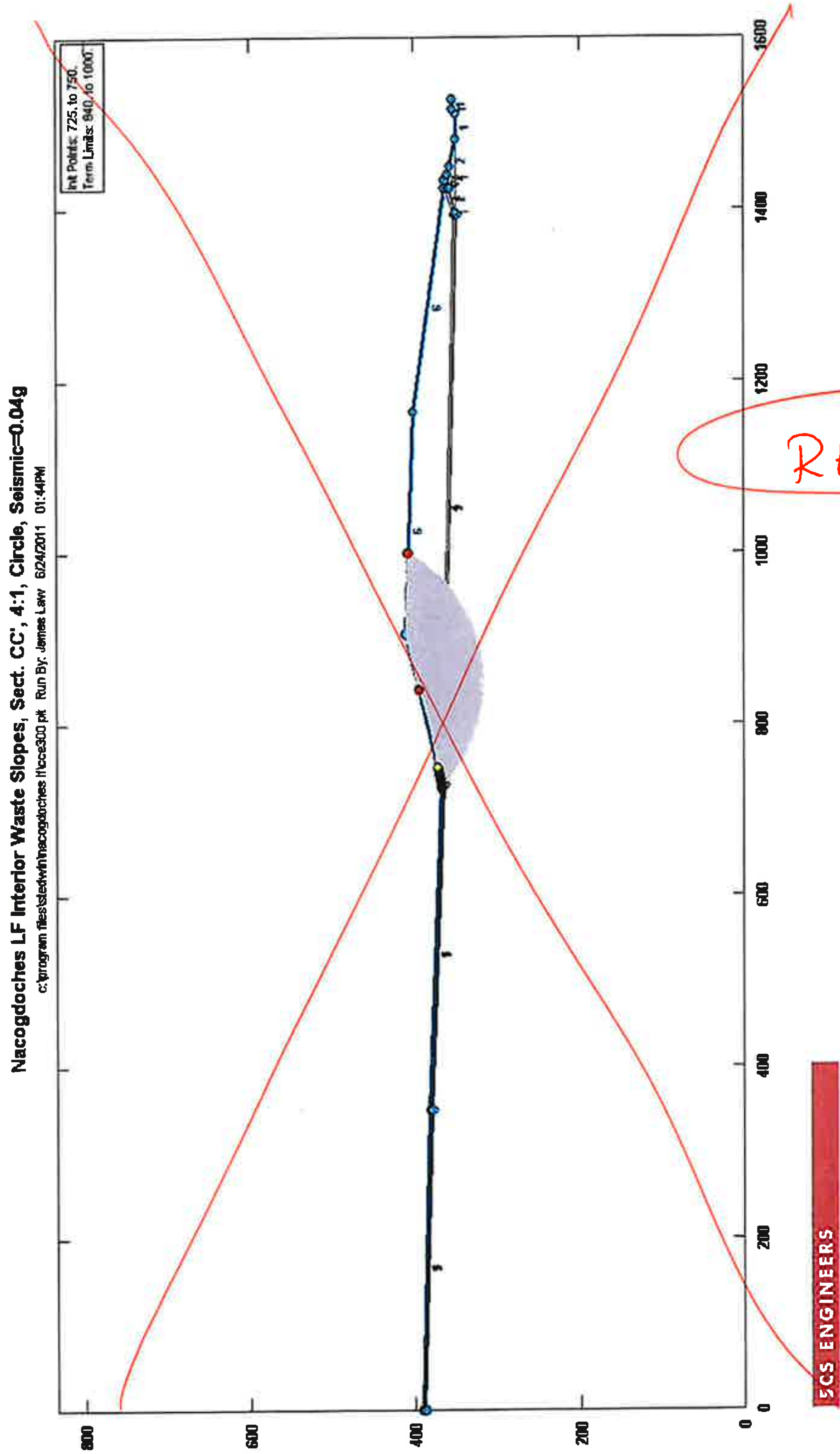
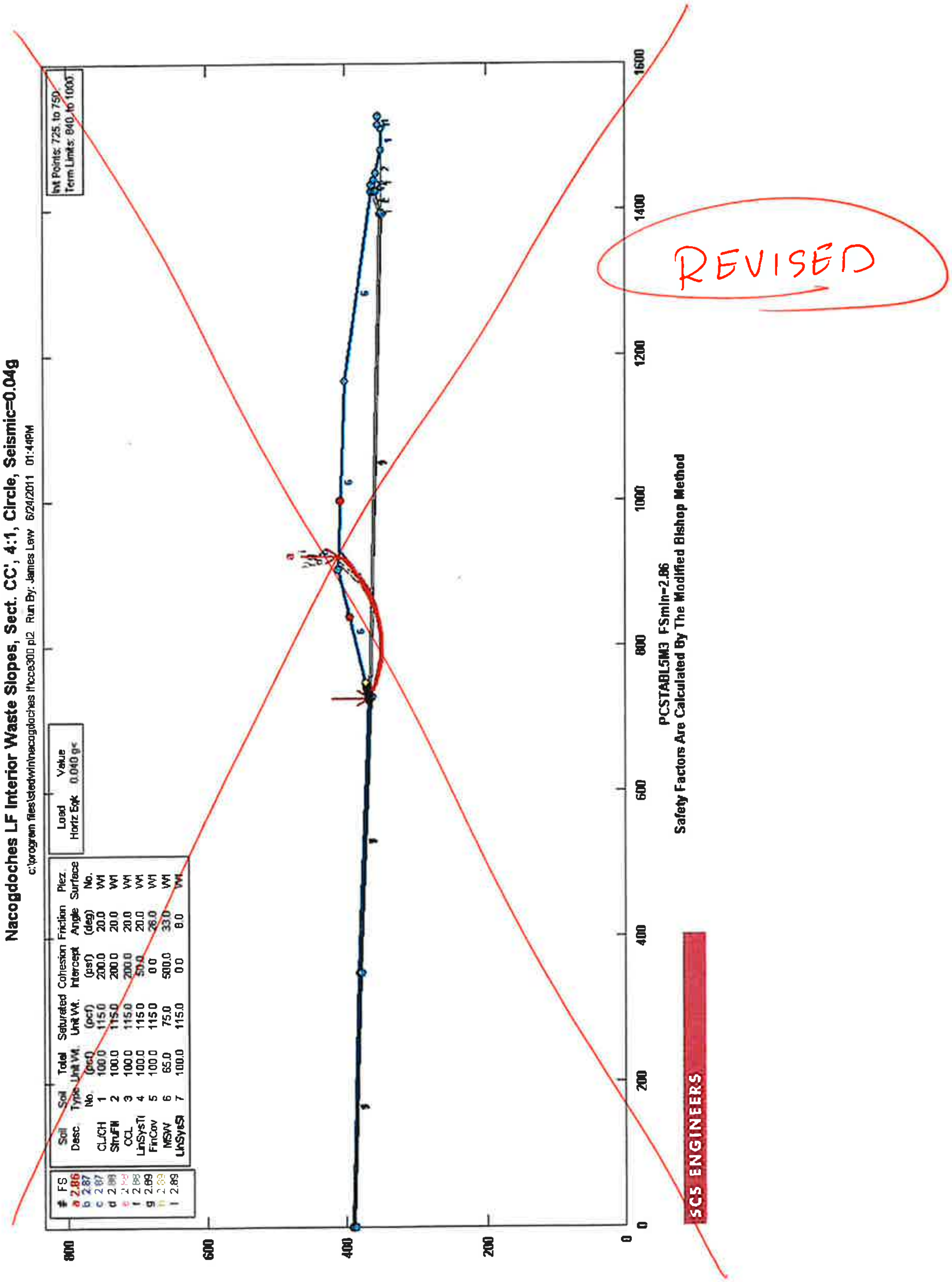
Safety Factors Are Calculated By The Modified Janbu Method
SCS ENGINEERS
REVISED

SCS ENGINEERS



REVISED

SCS ENGINEERS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a	2.86	CL/CH	1	100.0	115.0	200.0	20.0	W1
b	2.87	StruFill	2	100.0	115.0	200.0	20.0	W1
c	2.87	CCL	3	100.0	115.0	200.0	20.0	W1
d	2.88	LinSysTi	4	100.0	115.0	50.0	20.0	W1
e	2.88	FinCov	5	100.0	115.0	0.0	28.0	W1
f	2.88	MSW	6	65.0	75.0	500.0	33.0	W1
g	2.89	LinSysSl	7	100.0	115.0	0.0	8.0	W1
h	2.89							
i	2.89							
Load Value
Horiz Eqk 0.040 g<
Init Points: 725. to 750.
Term Limits: 840. to 1000.
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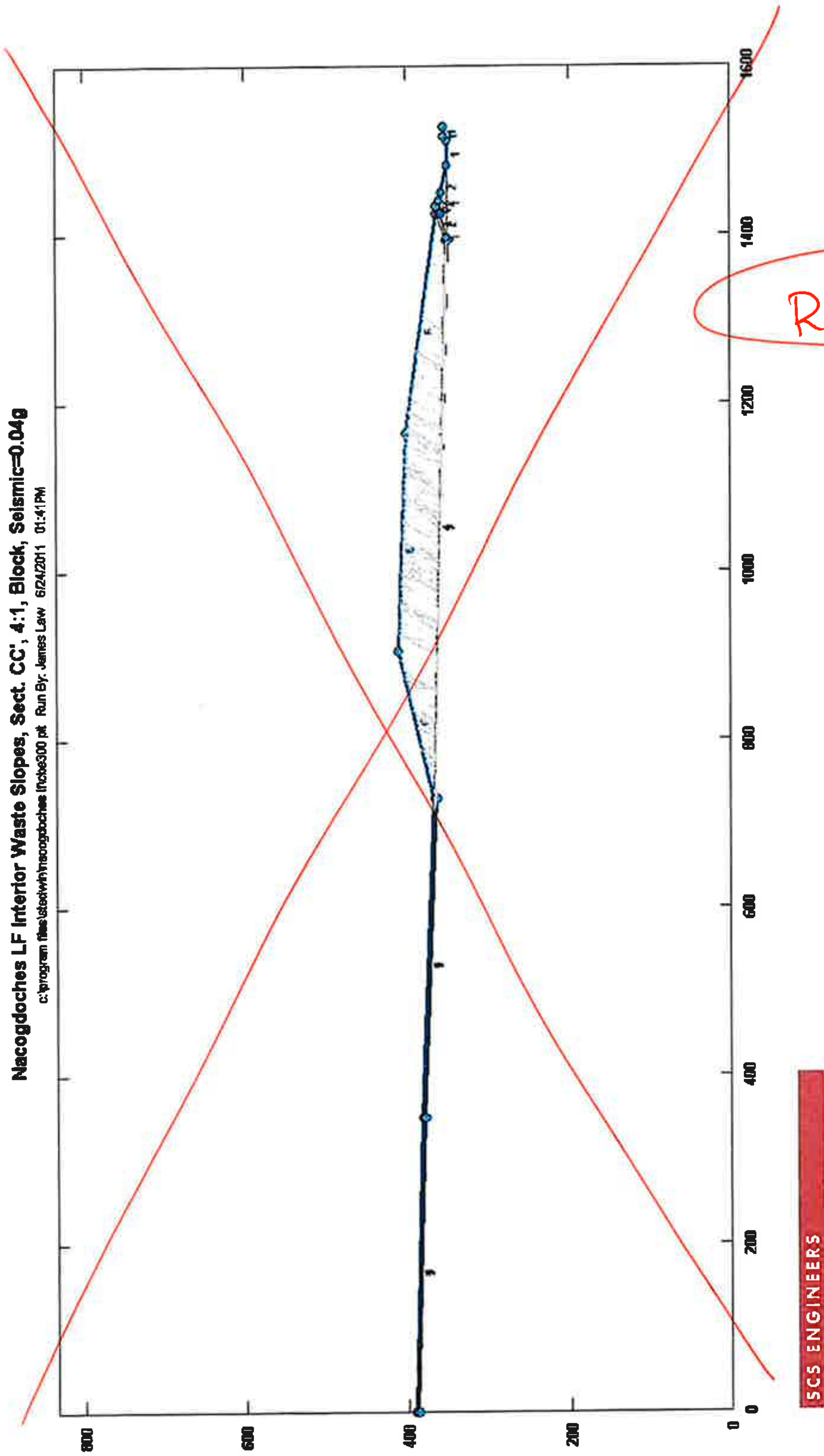
Safety Factors Are Calculated By The Modified Bishop Method
REVISED
SCS ENGINEERS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Run By: James Law 6/24/2011 01:41PM
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1000
1200
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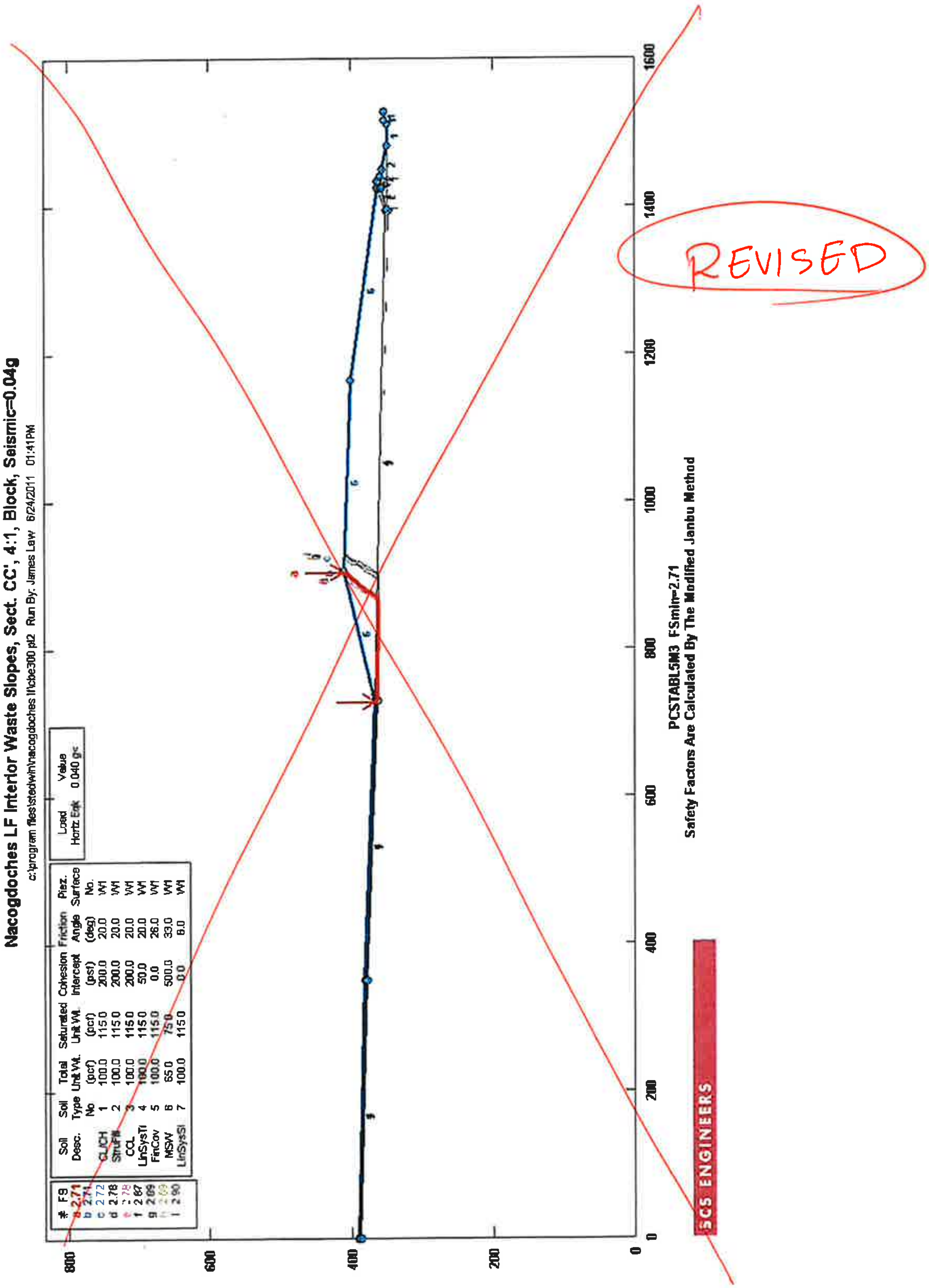
REVISED
SCS ENGINEERS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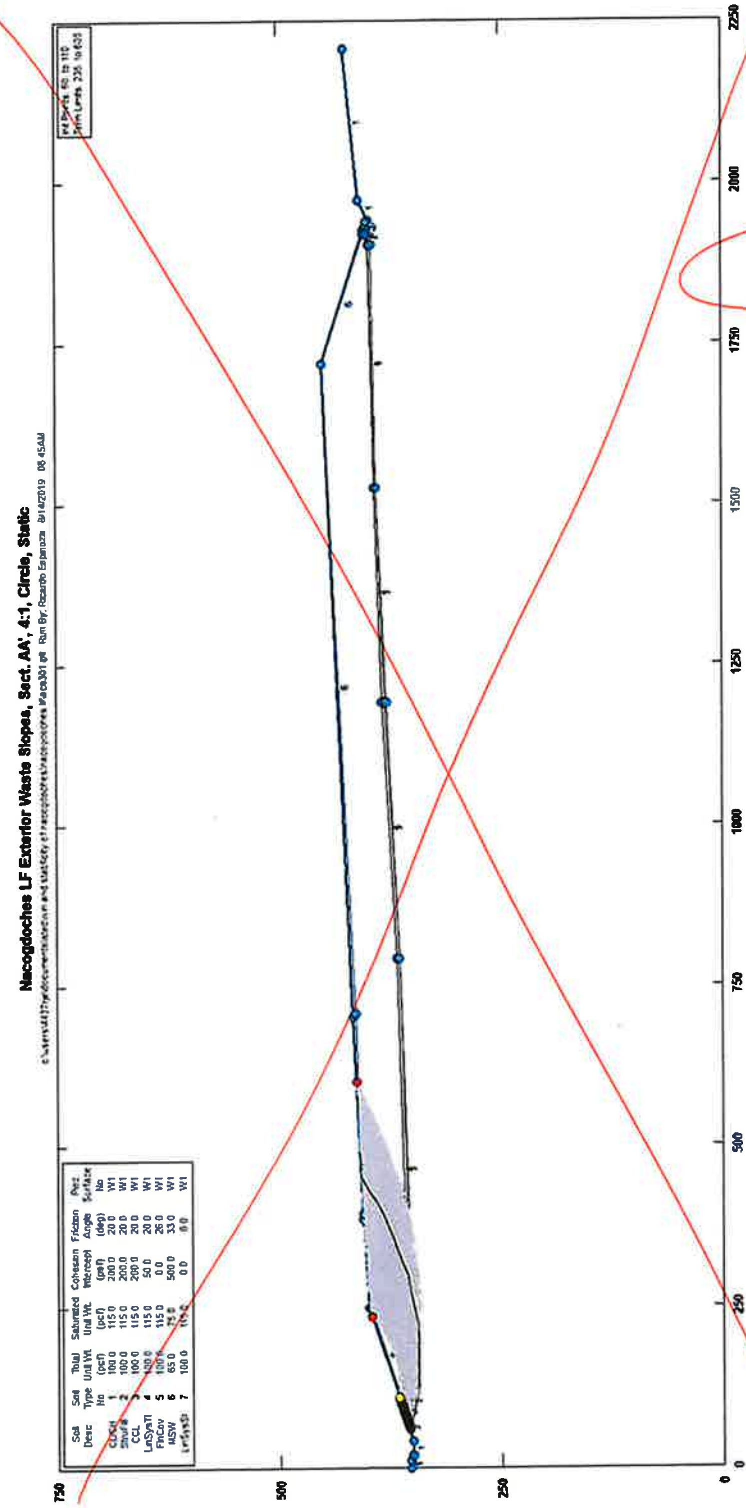
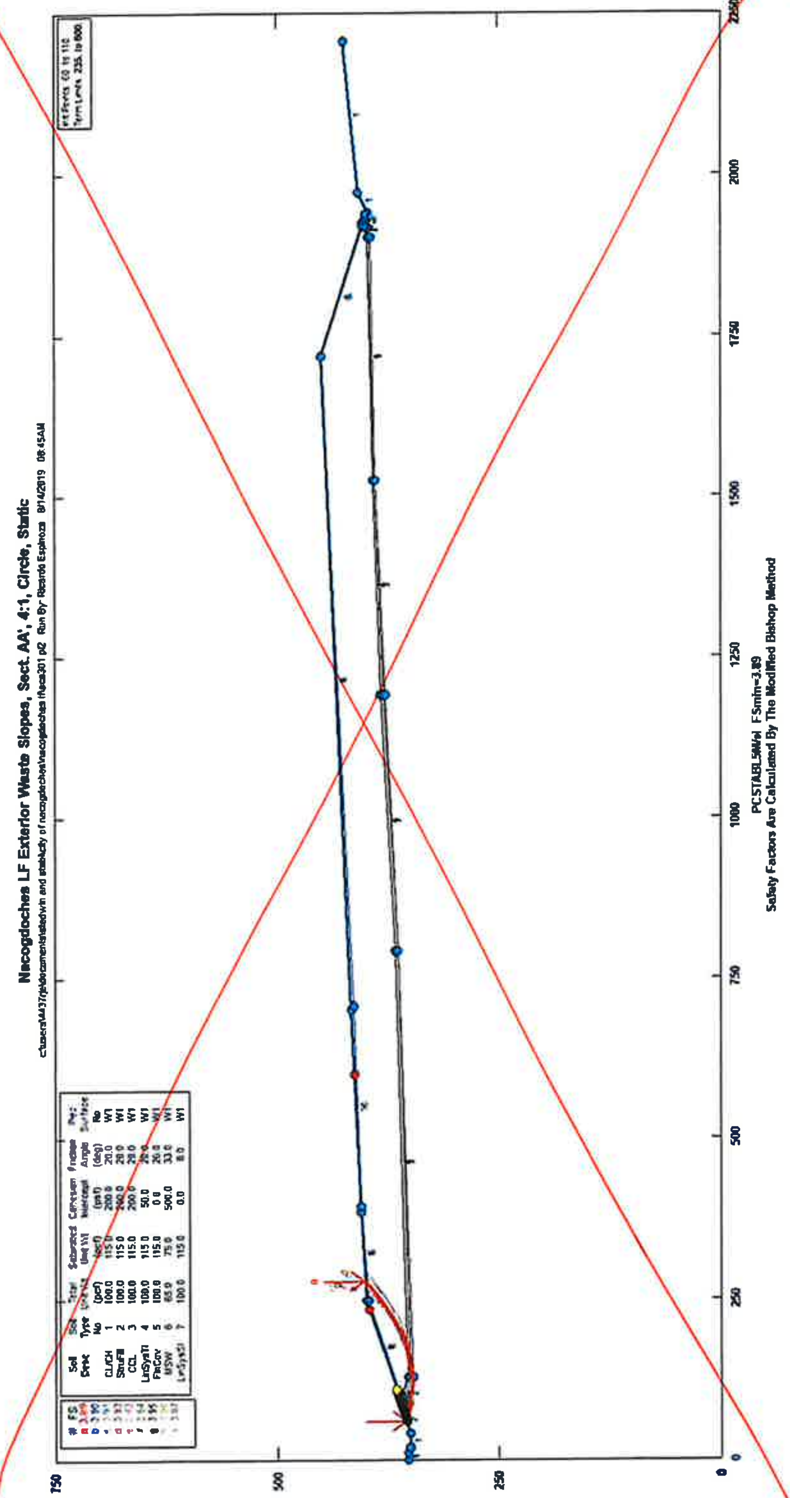
Safety Factors Are Calculated By The Modified Janbu Method
Load Value
Horiz Eqk 0.040 g<
REVISED
SCS ENGINEERS


Nacogdoches LF Exterior Waste Slopes, Sect. AA', 4:1, Circle, Static
0
250
500
750
1000
1250
1500
1750
2000
2250

REVISED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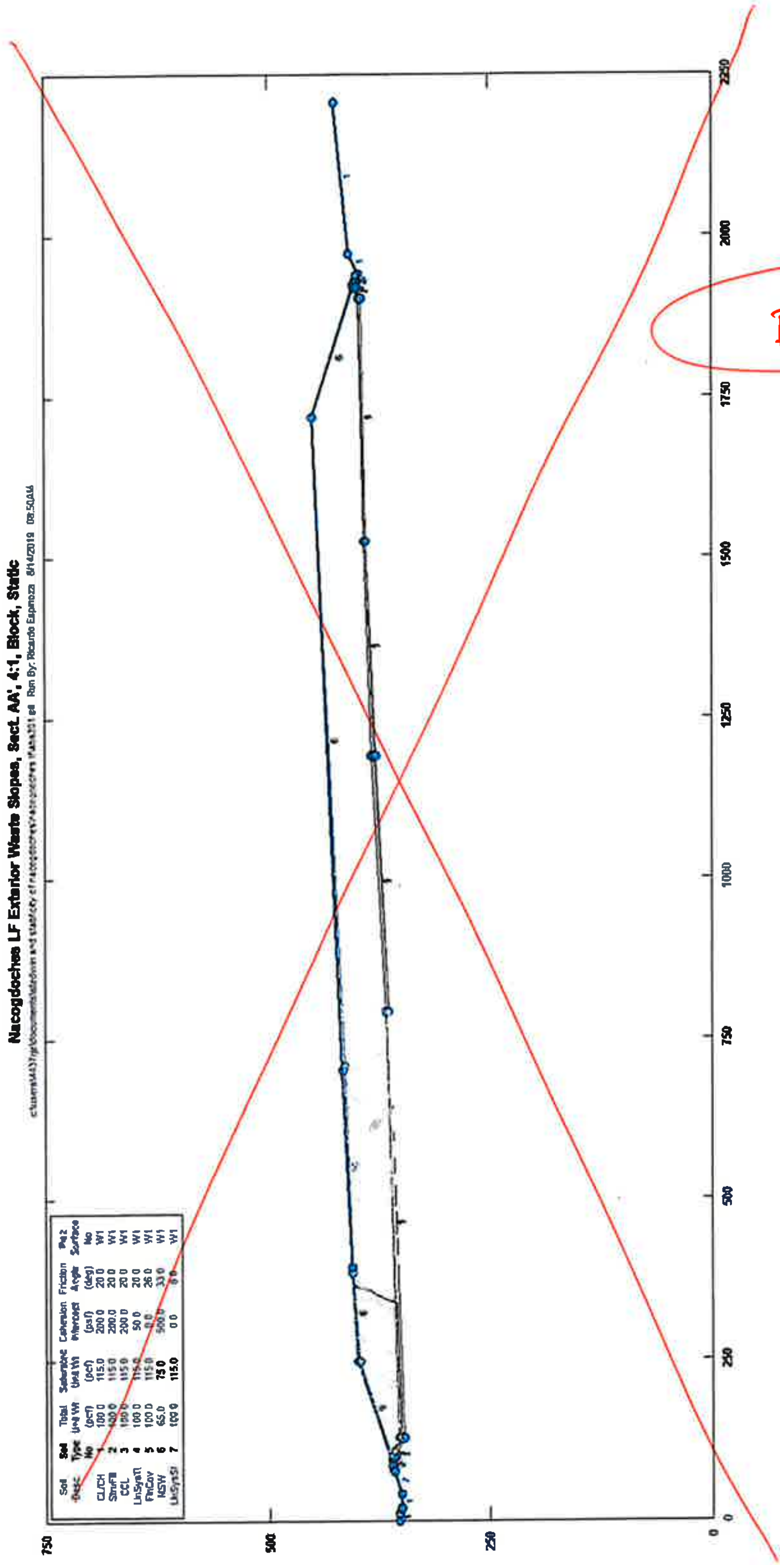
PCSTABL5M/si FSmin=3.89
Safety Factors Are Calculated By The Modified Bishop Method

~~REVISED~~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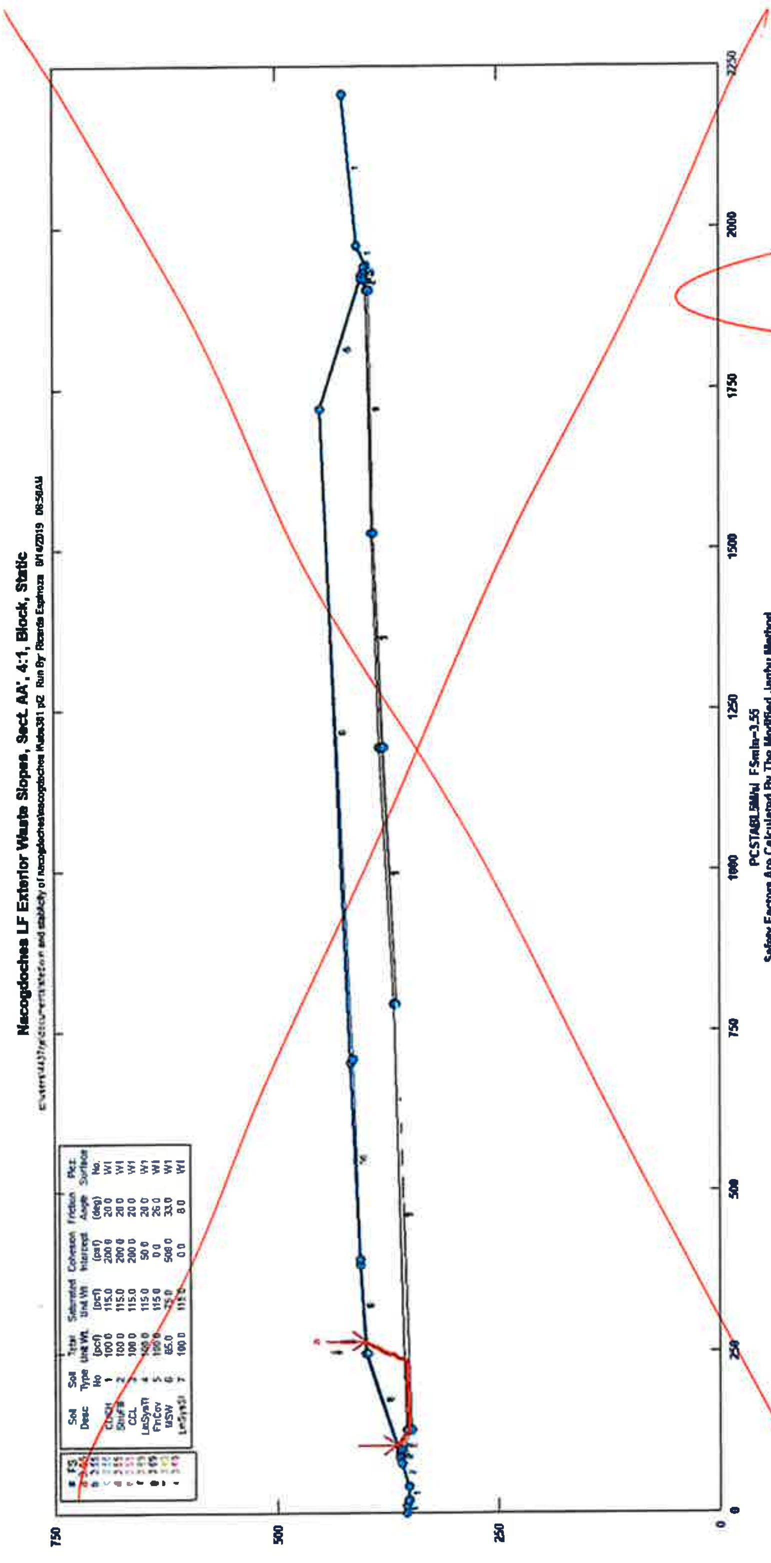
REVISED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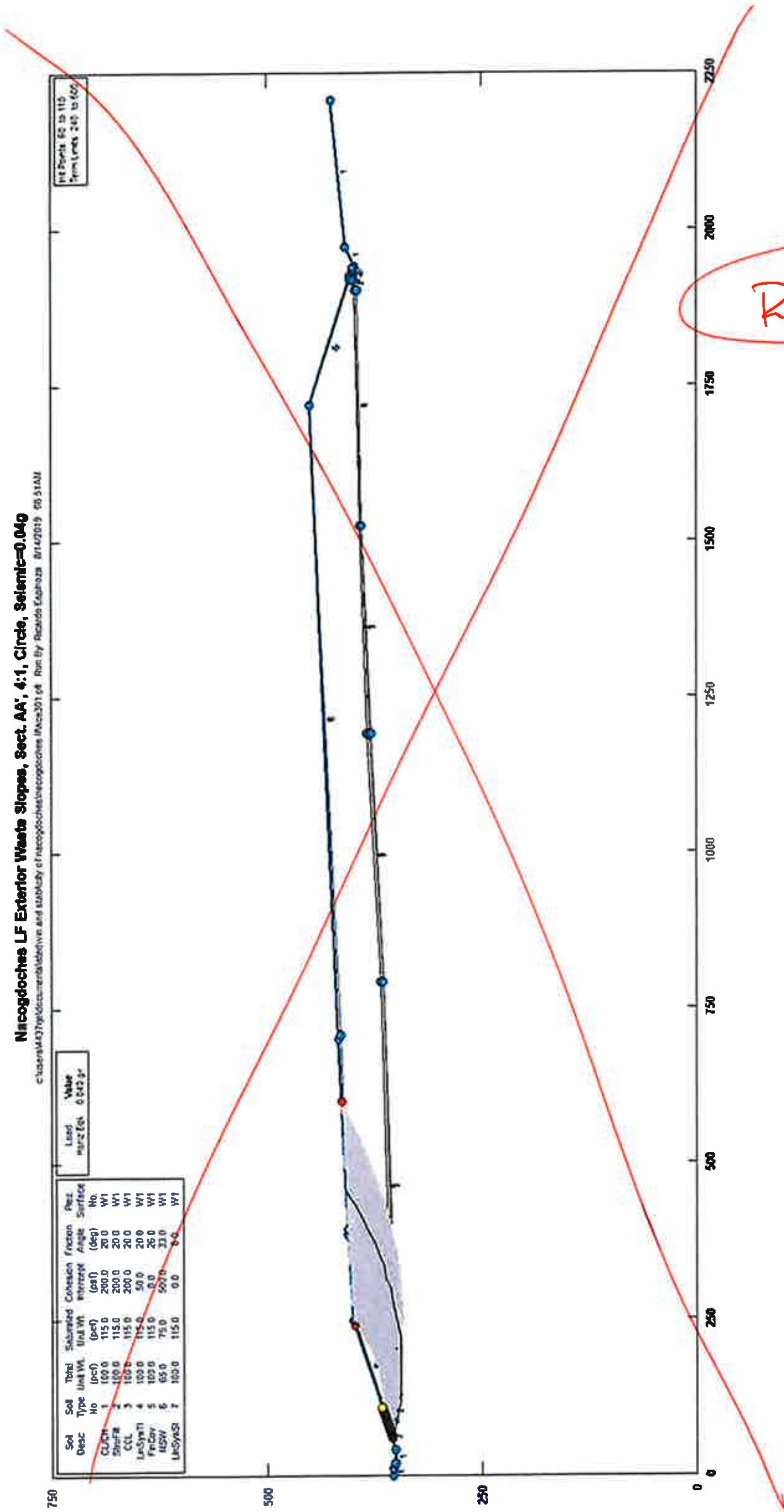
Safety Factors Are Calculated By The Modified Janbu Method

REVISED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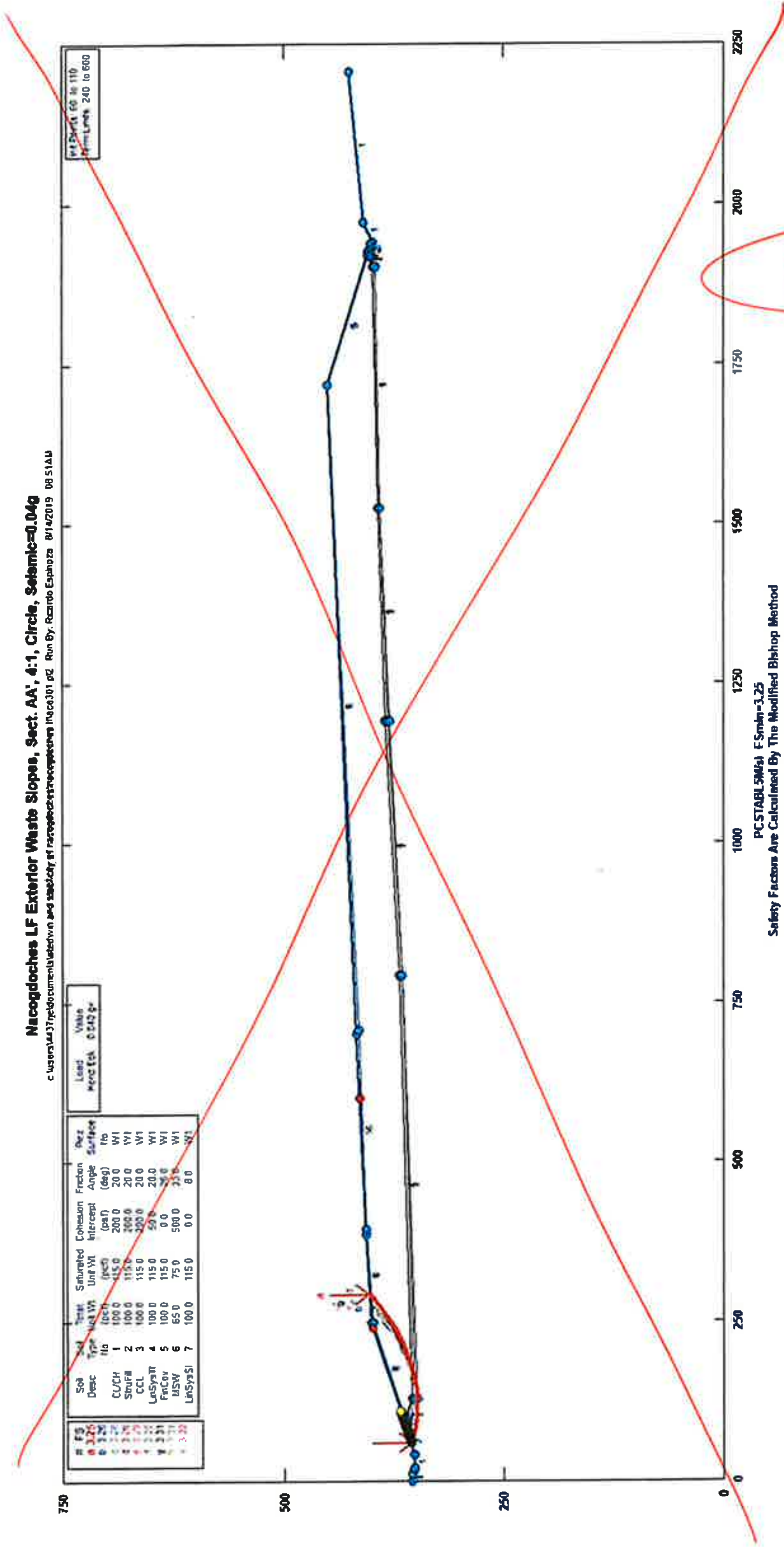
REVISED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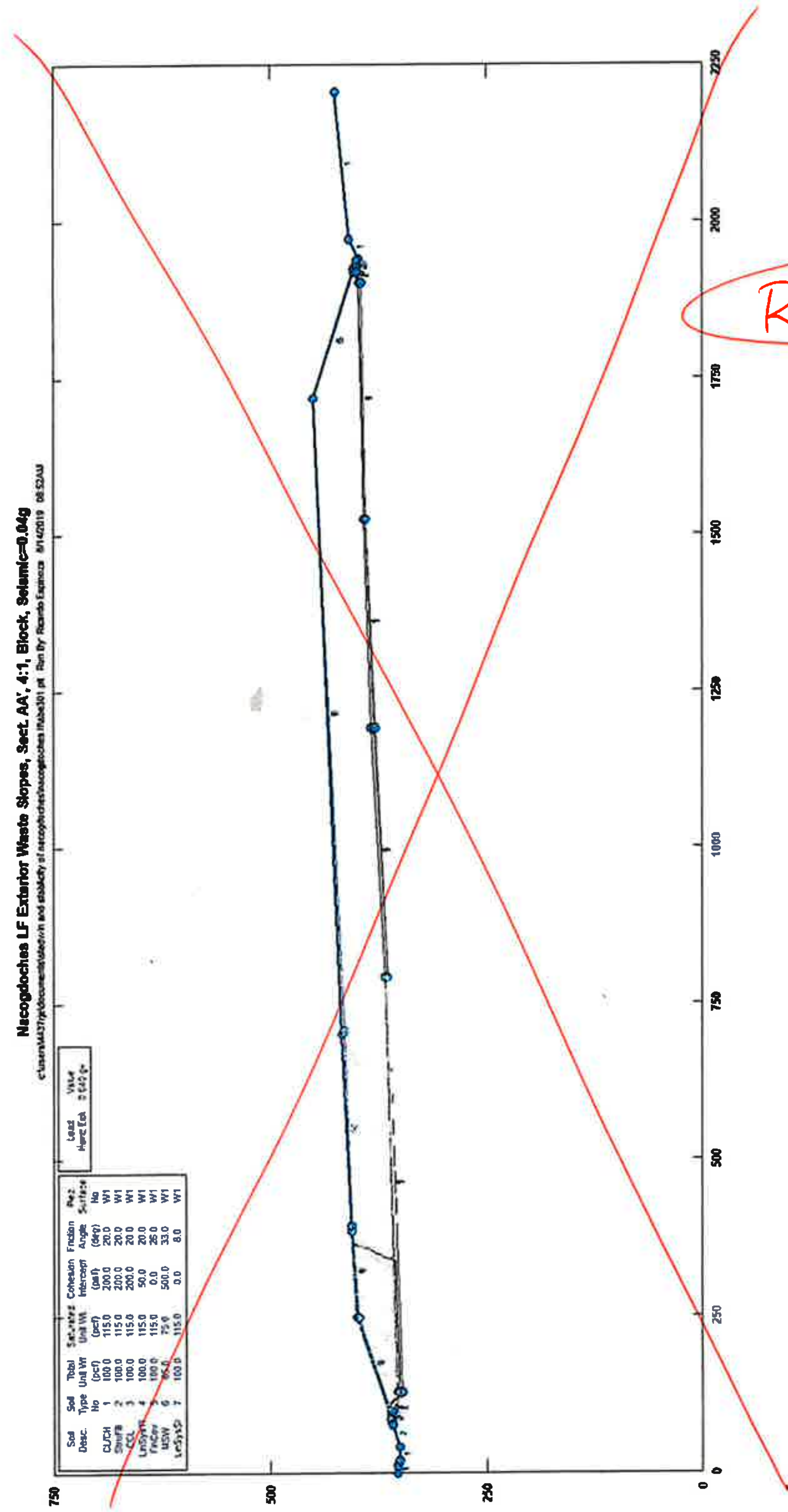
Safety Factors Are Calculated By The Modified Bishop Method
REVISED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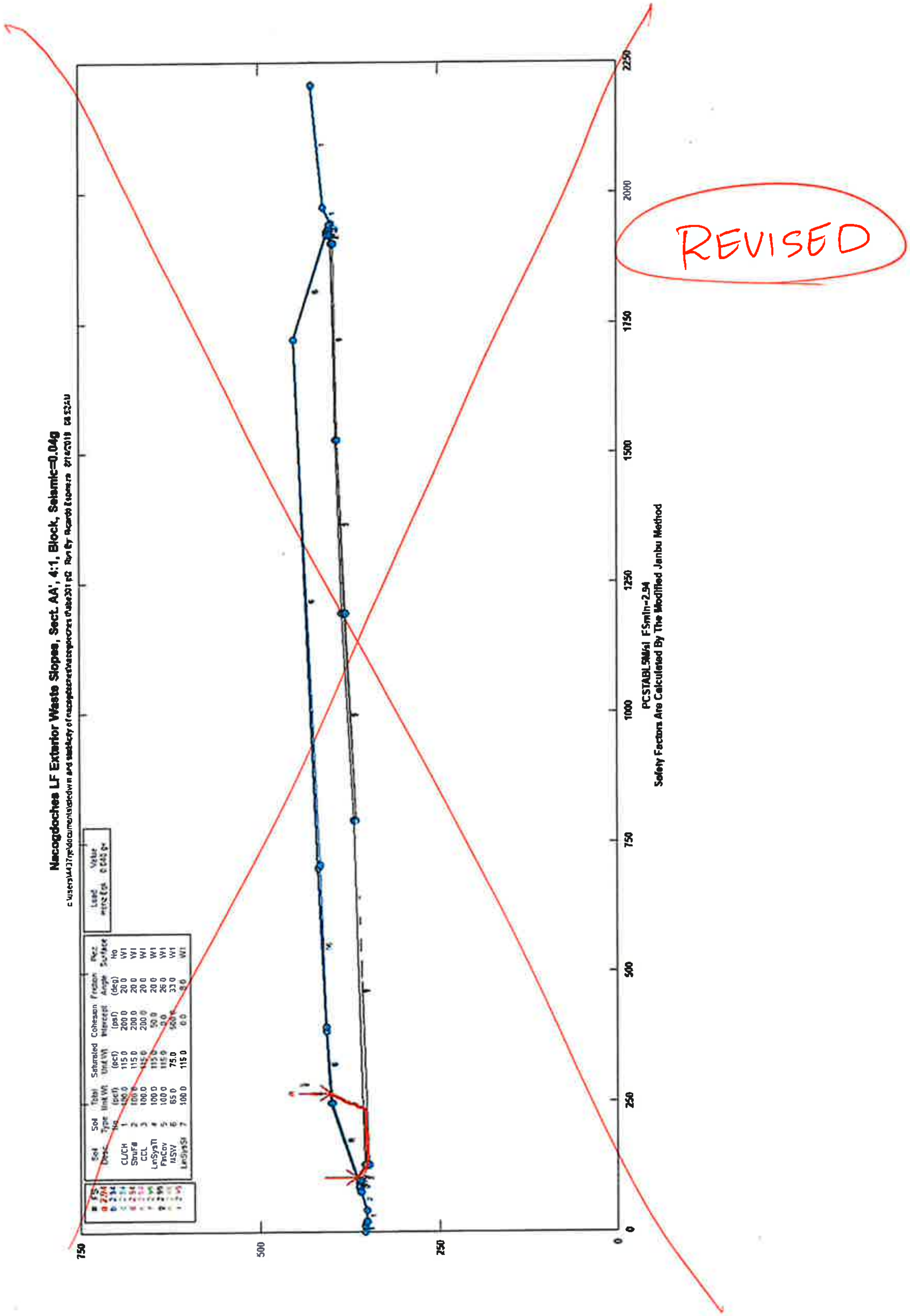
REVISED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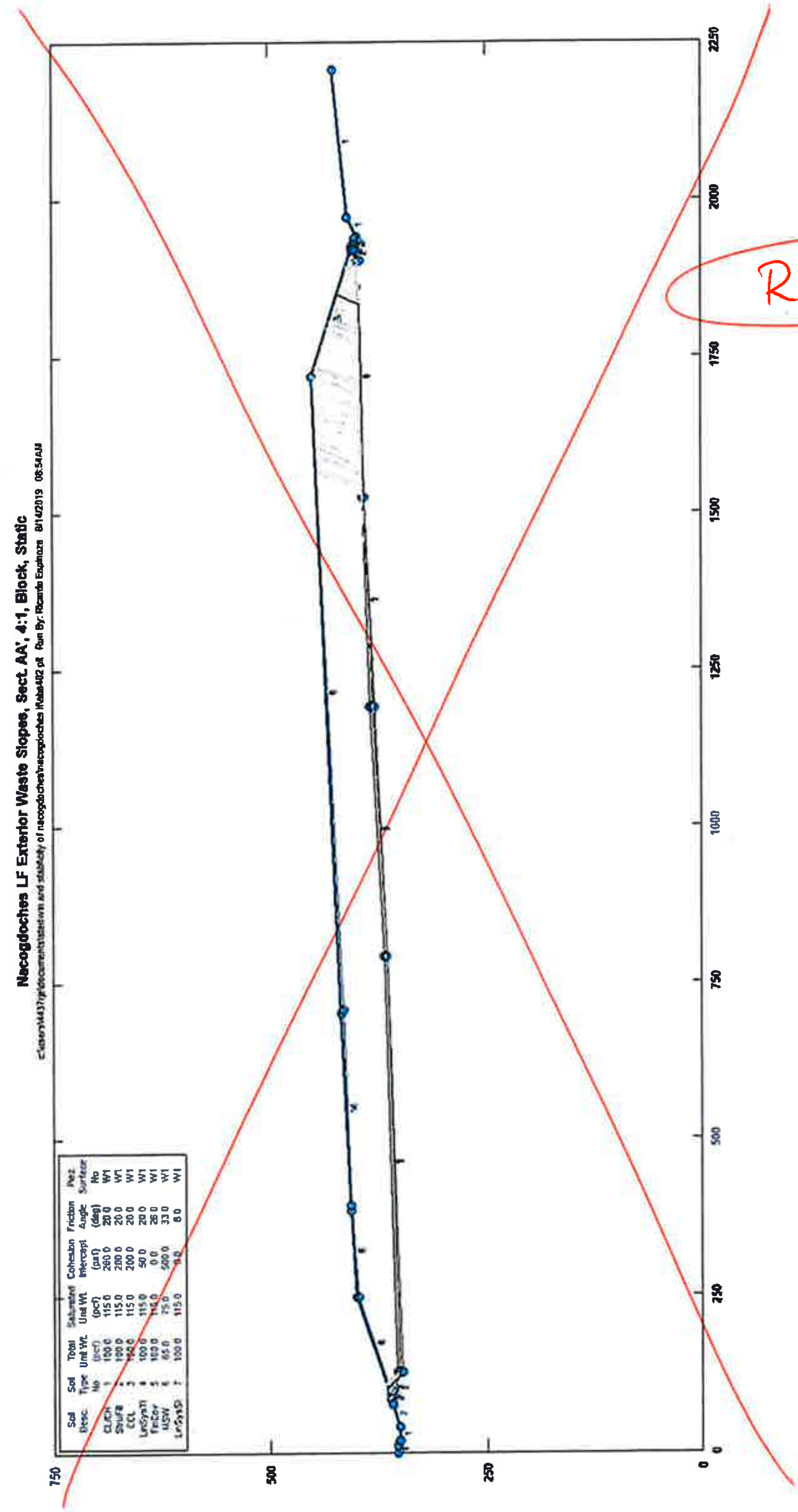
PCSTABL5M/si FSmin=2.94
Safety Factors Are Calculated By The Modified Janbu Method
0
250
500
750
1000
1250
1500
1750
2000
2250
REVISED


Nacogdoches LF Exterior Waste Slopes, Sect. AA', 4:1, Block, Static
0
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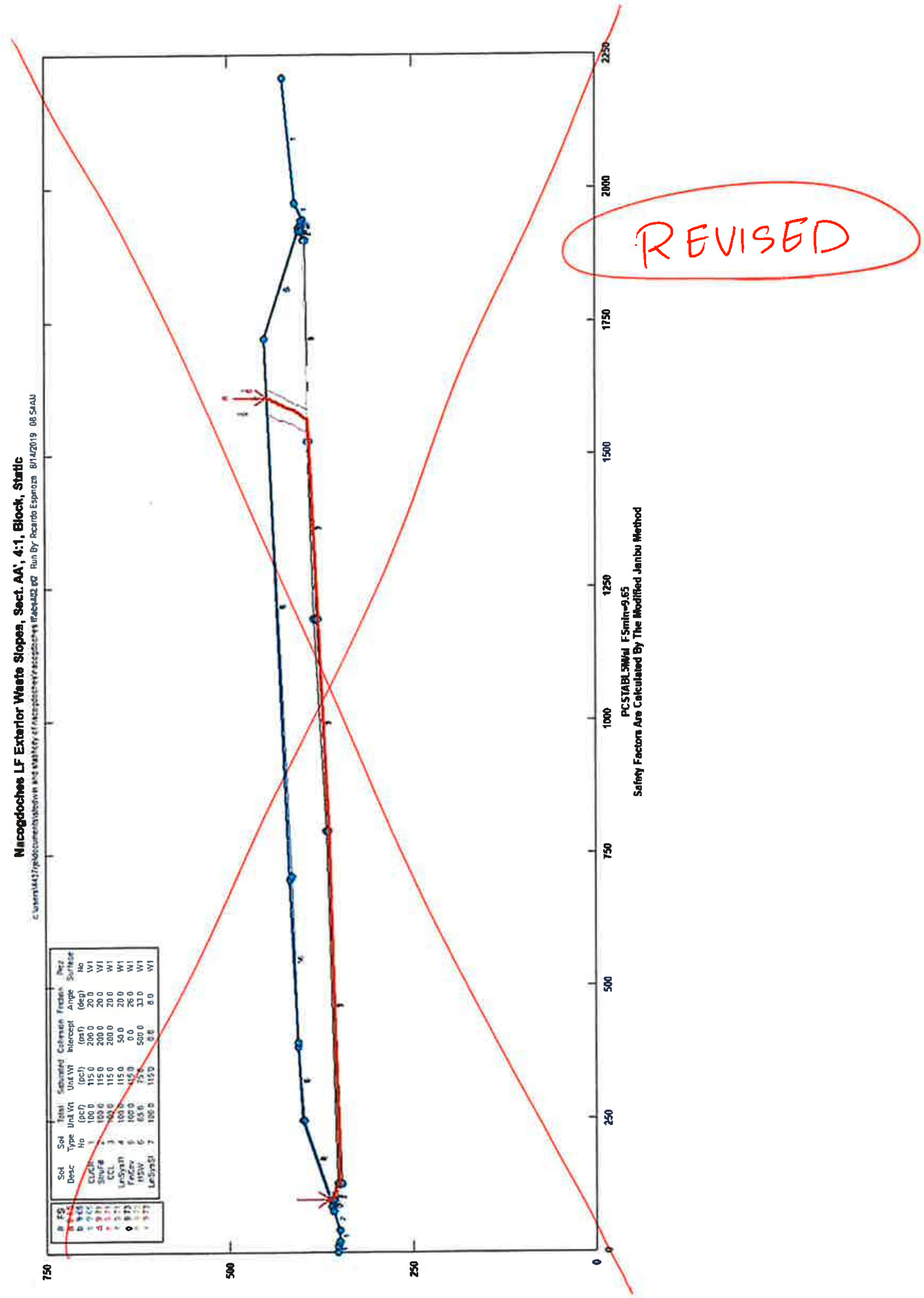
2000
2250
REVISED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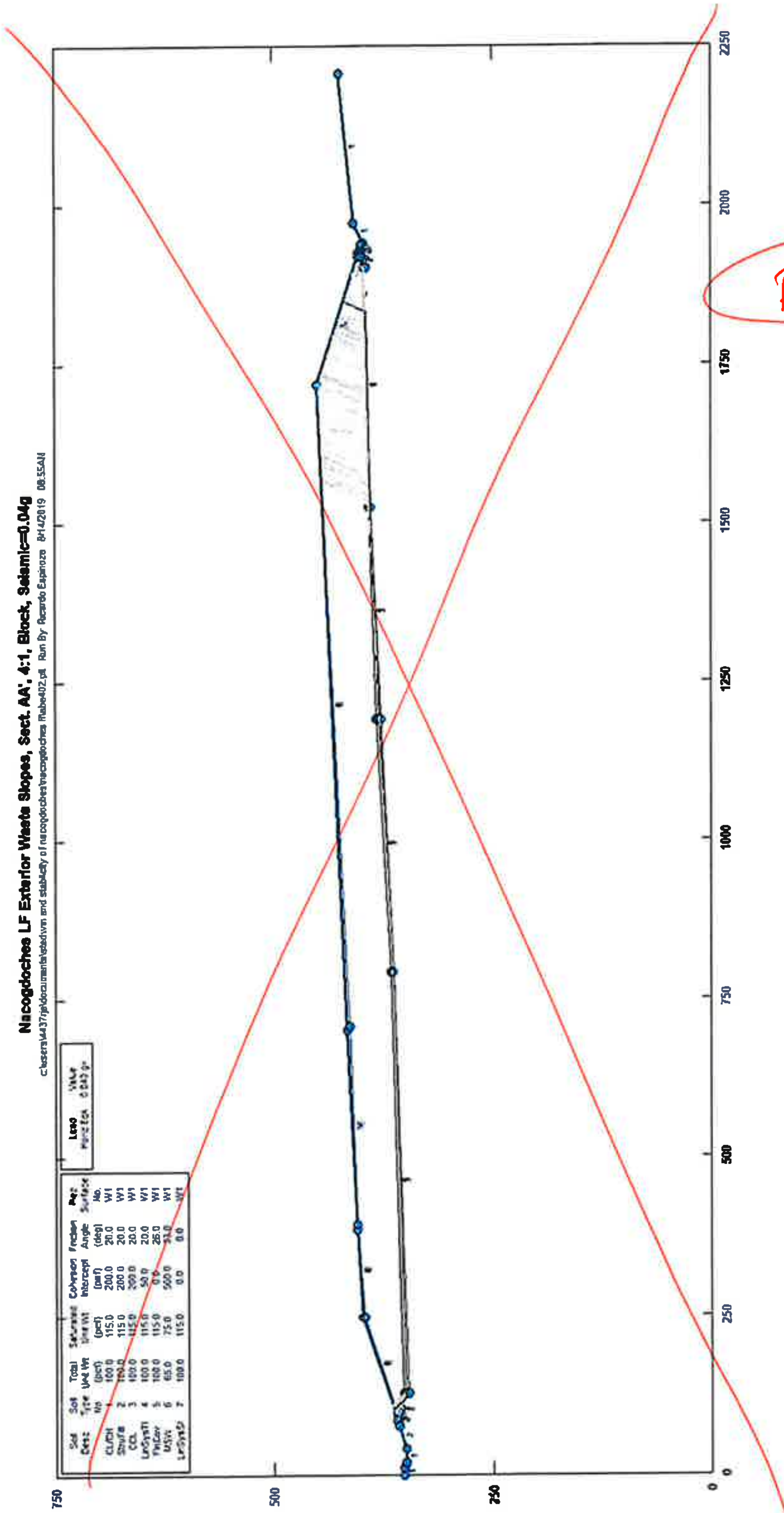
Safety Factors Are Calculated By The Modified Janbu Method
REVISED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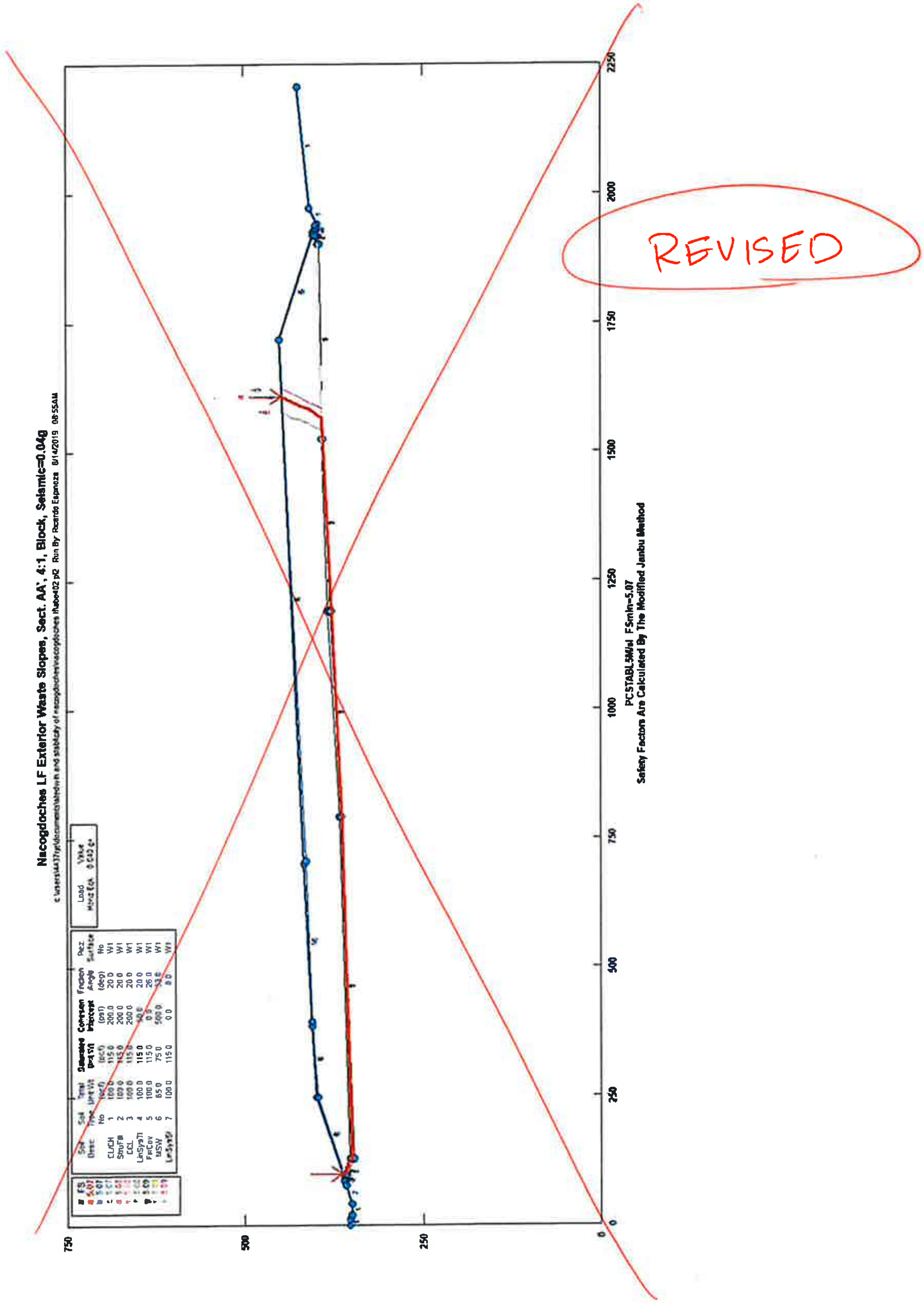
1000
1250
1500
1750
2000
2250

REVISED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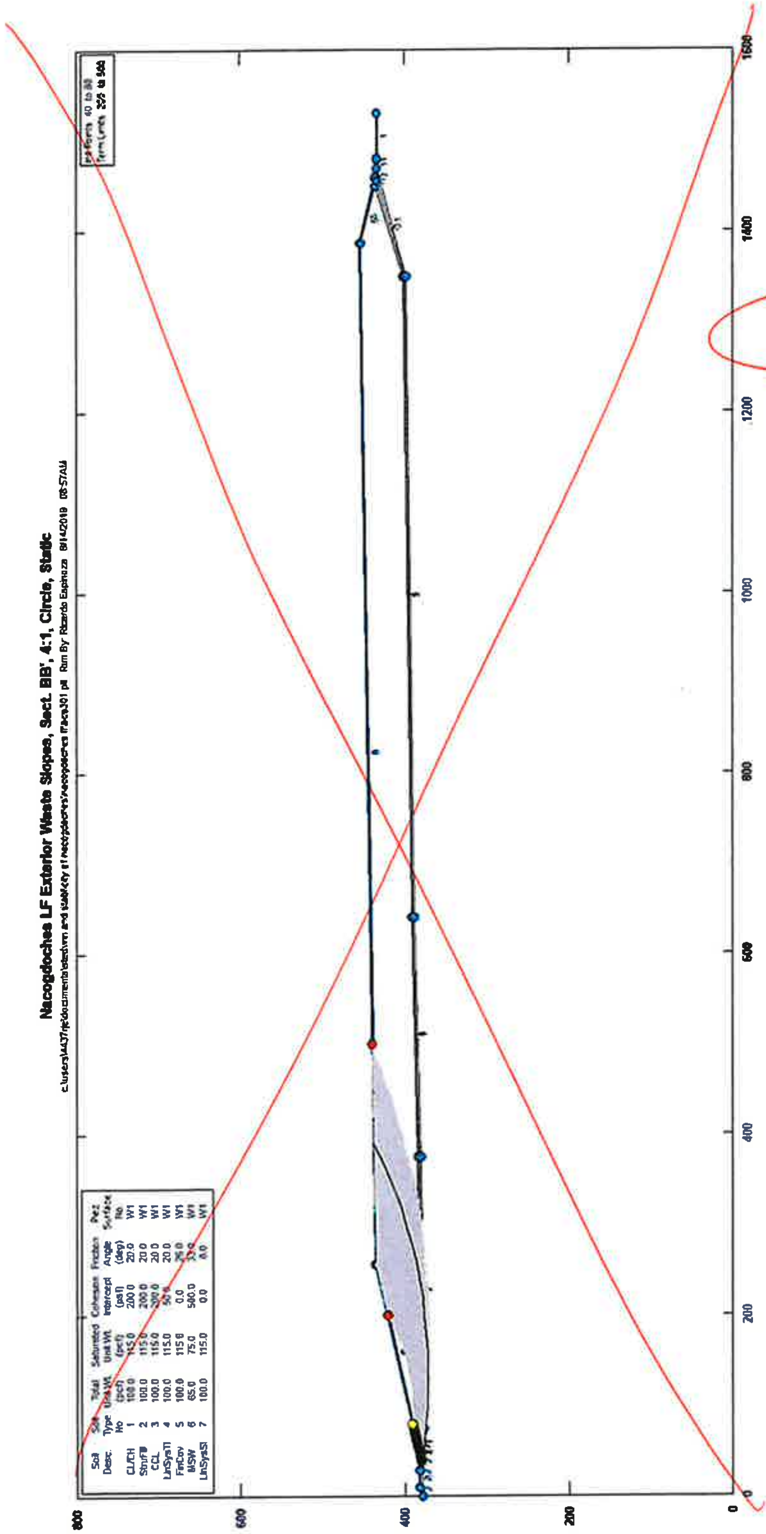
Safety Factors Are Calculated By The Modified Janbu Method
REVISED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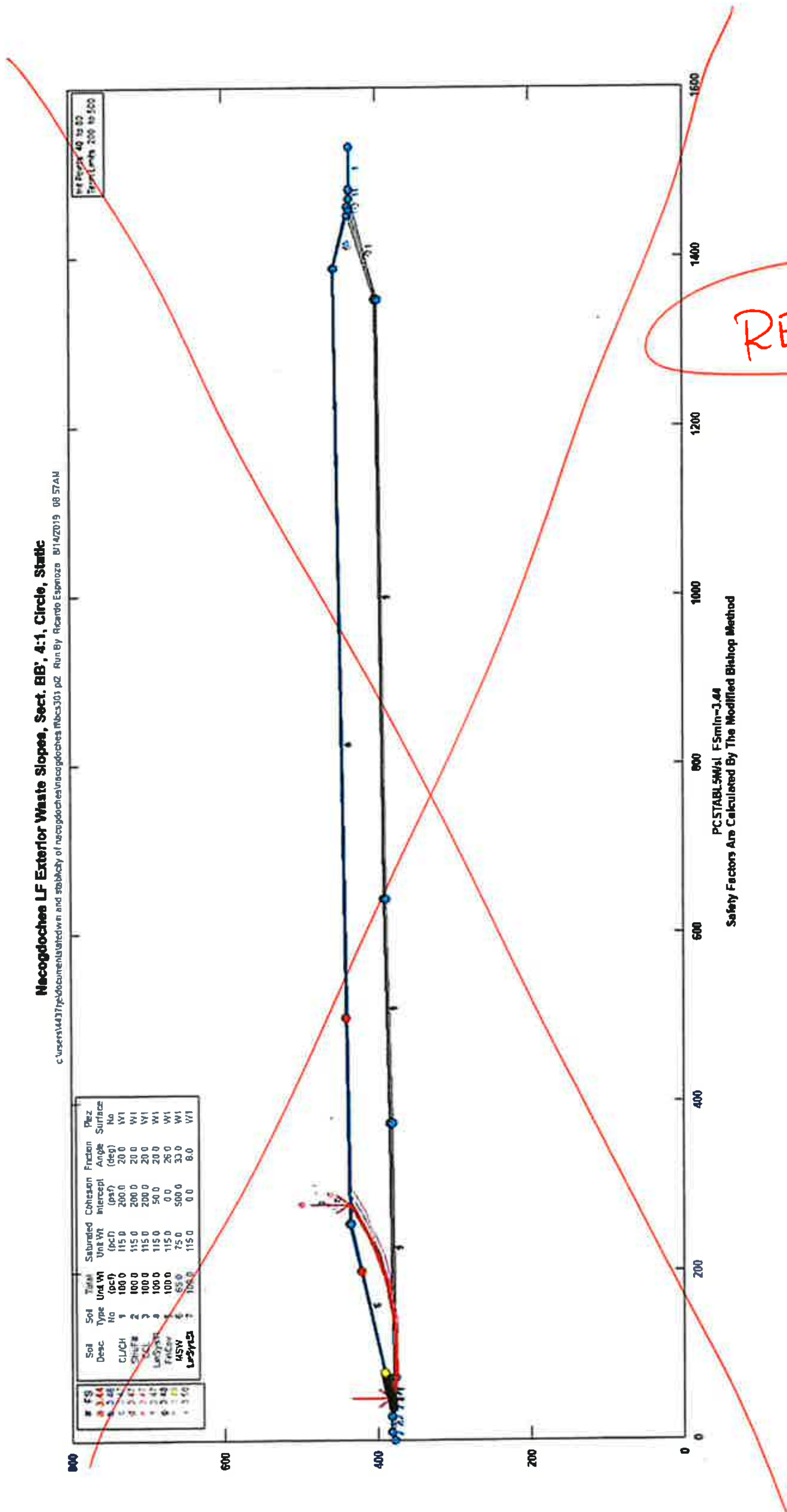
REVISED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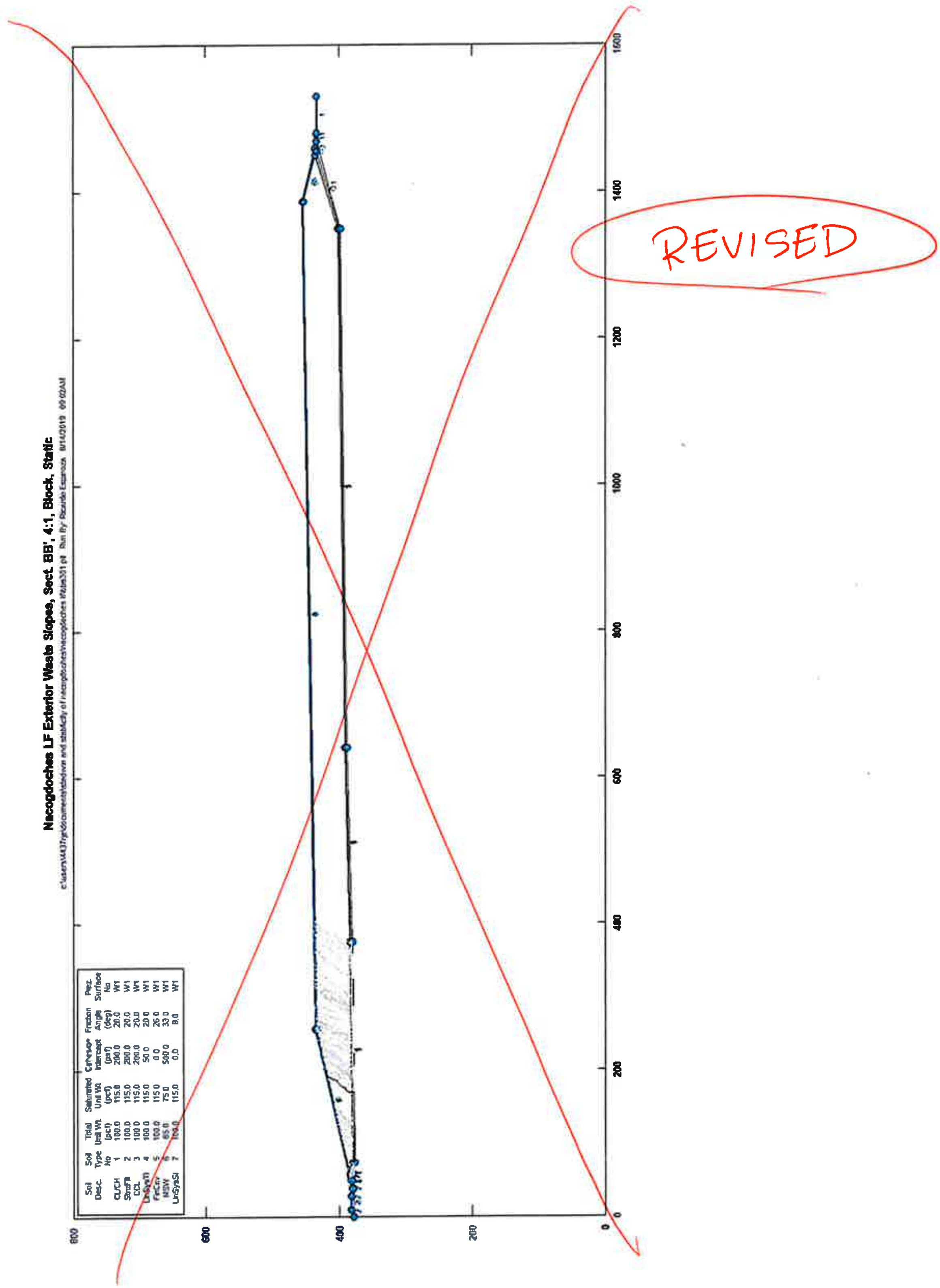
Safety Factors Are Calculated By The Modified Bishop Method
REVISED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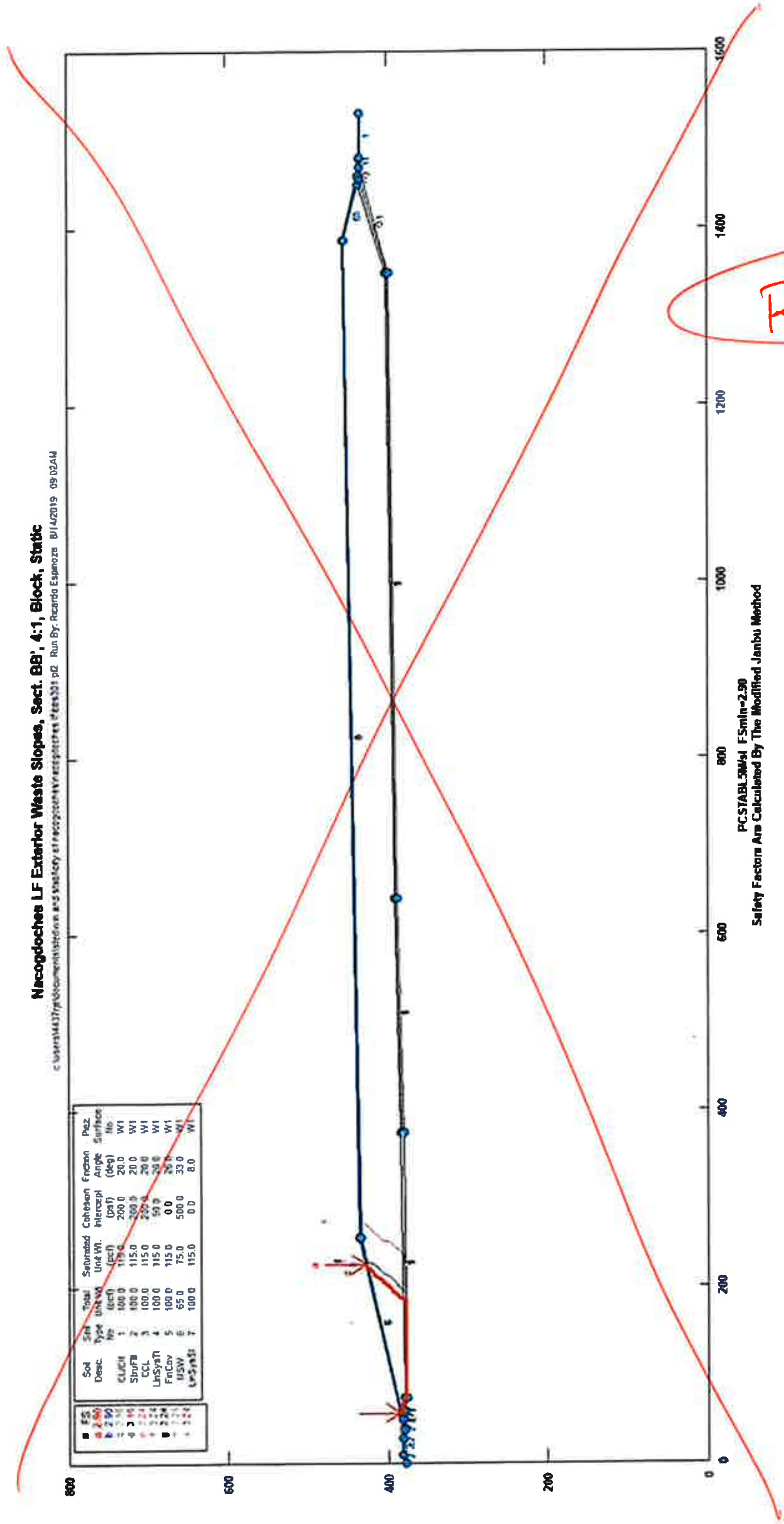
REVISED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PCSTABL5M/si FSmin=2.90
Safety Factors Are Calculated By The Modified Janbu Method
0
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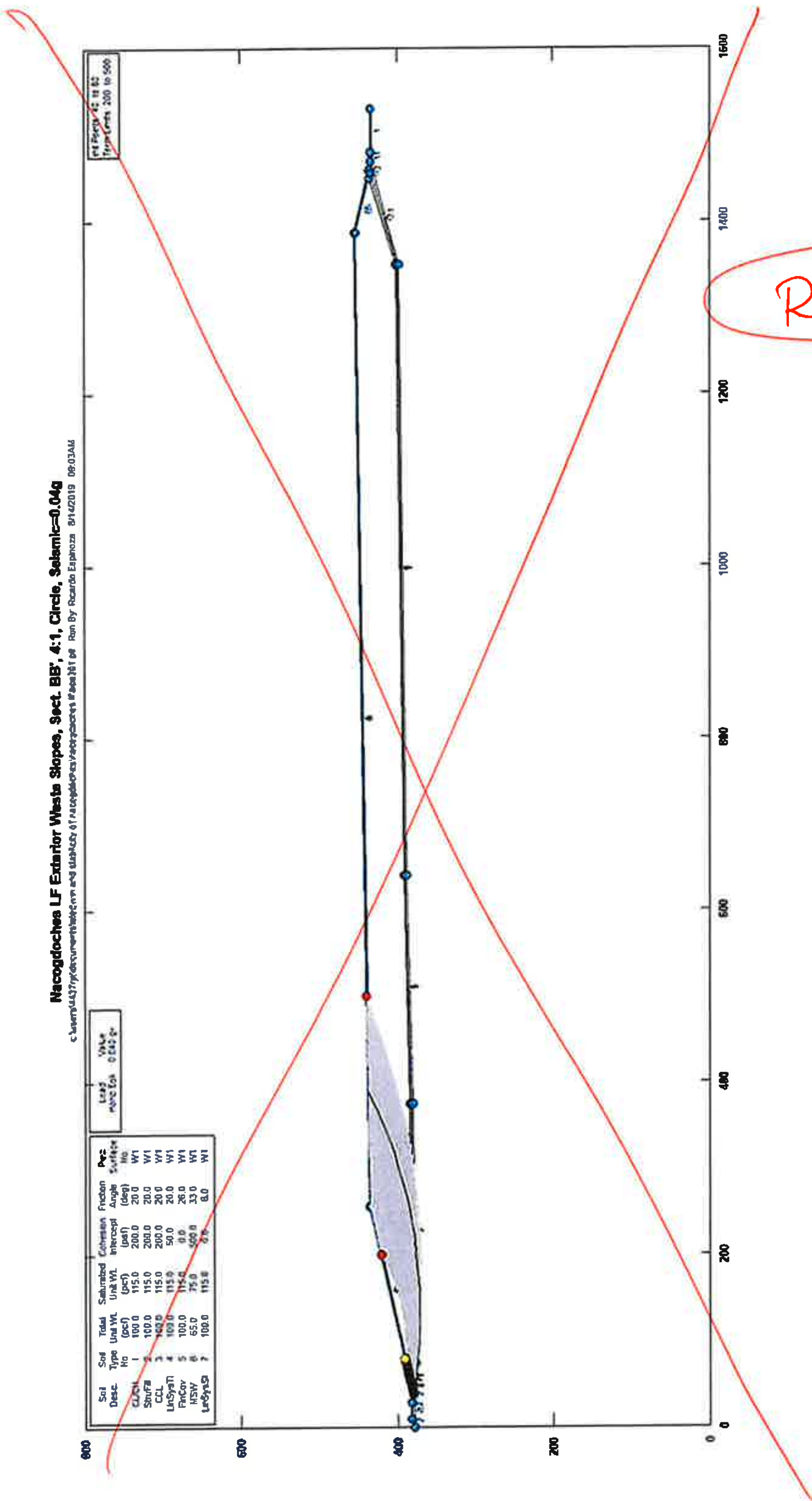
1200
1400
1600

REVISED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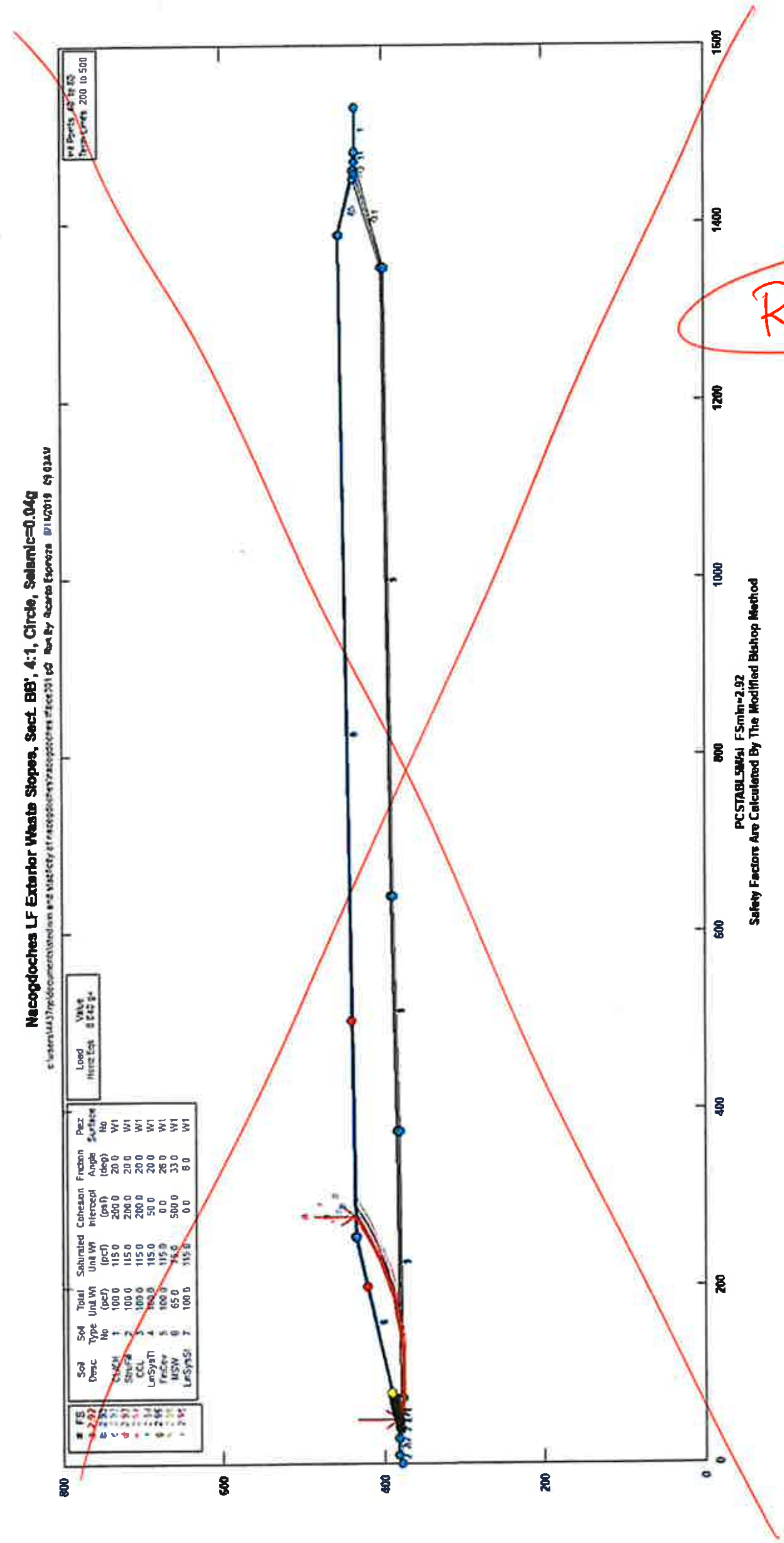
REVISED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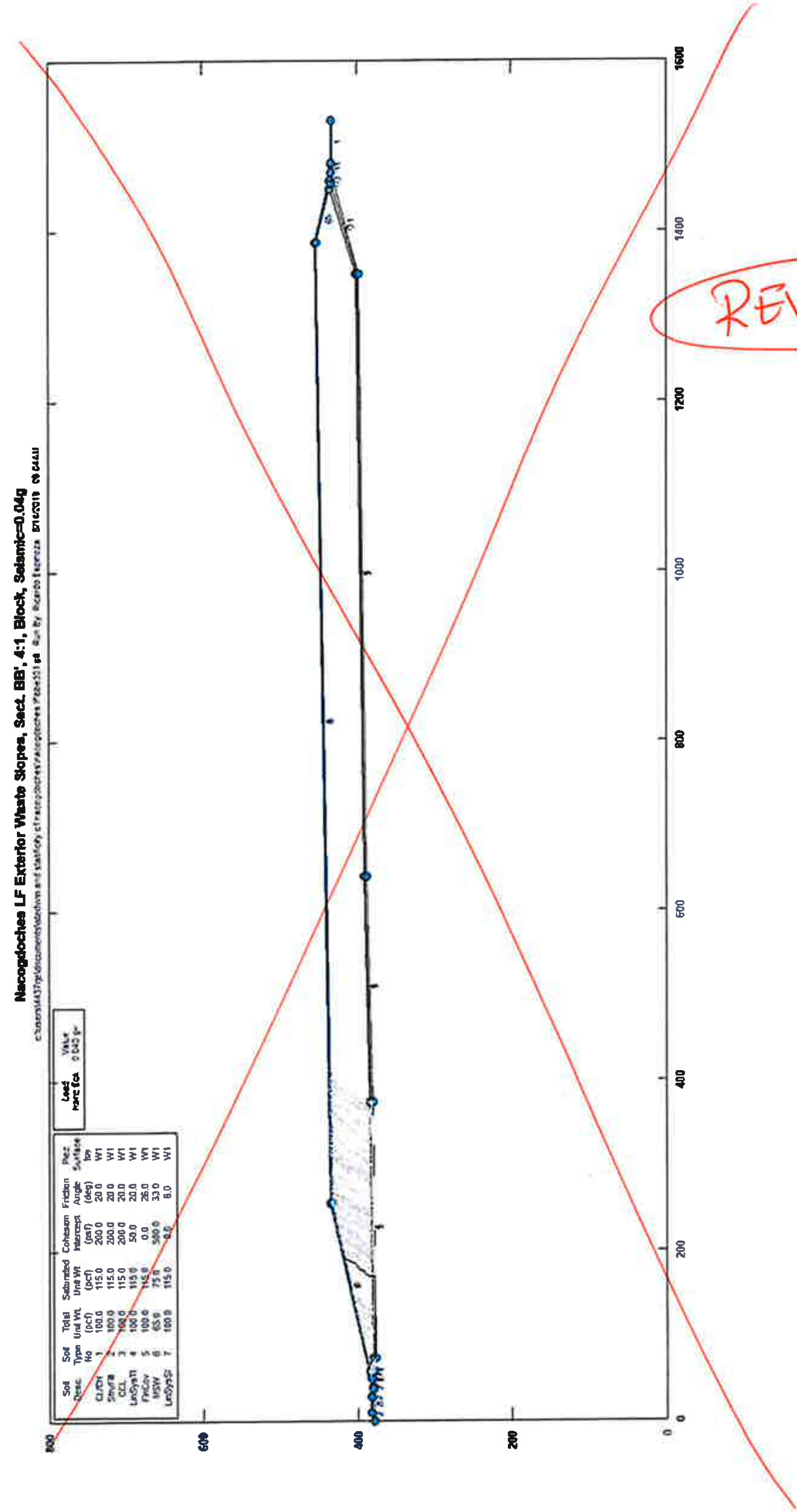
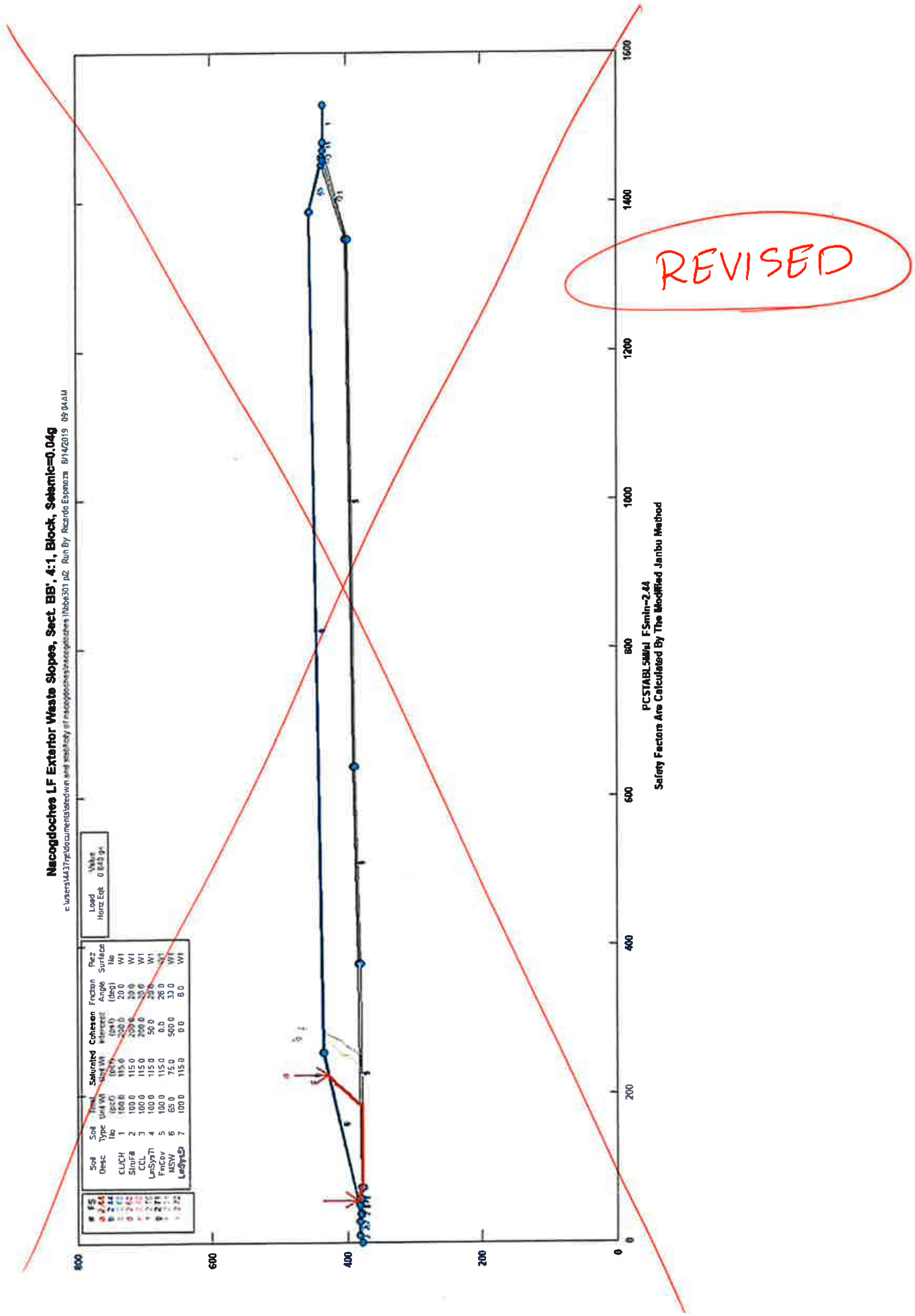
PCSTABL5M/si FSmin=2.92
Safety Factors Are Calculated By The Modified Bishop Method

REVISED


Nacogdoches LF Exterior Waste Slopes, Sect. BB', 4:1, Block, Seismic=0.04g
REVISED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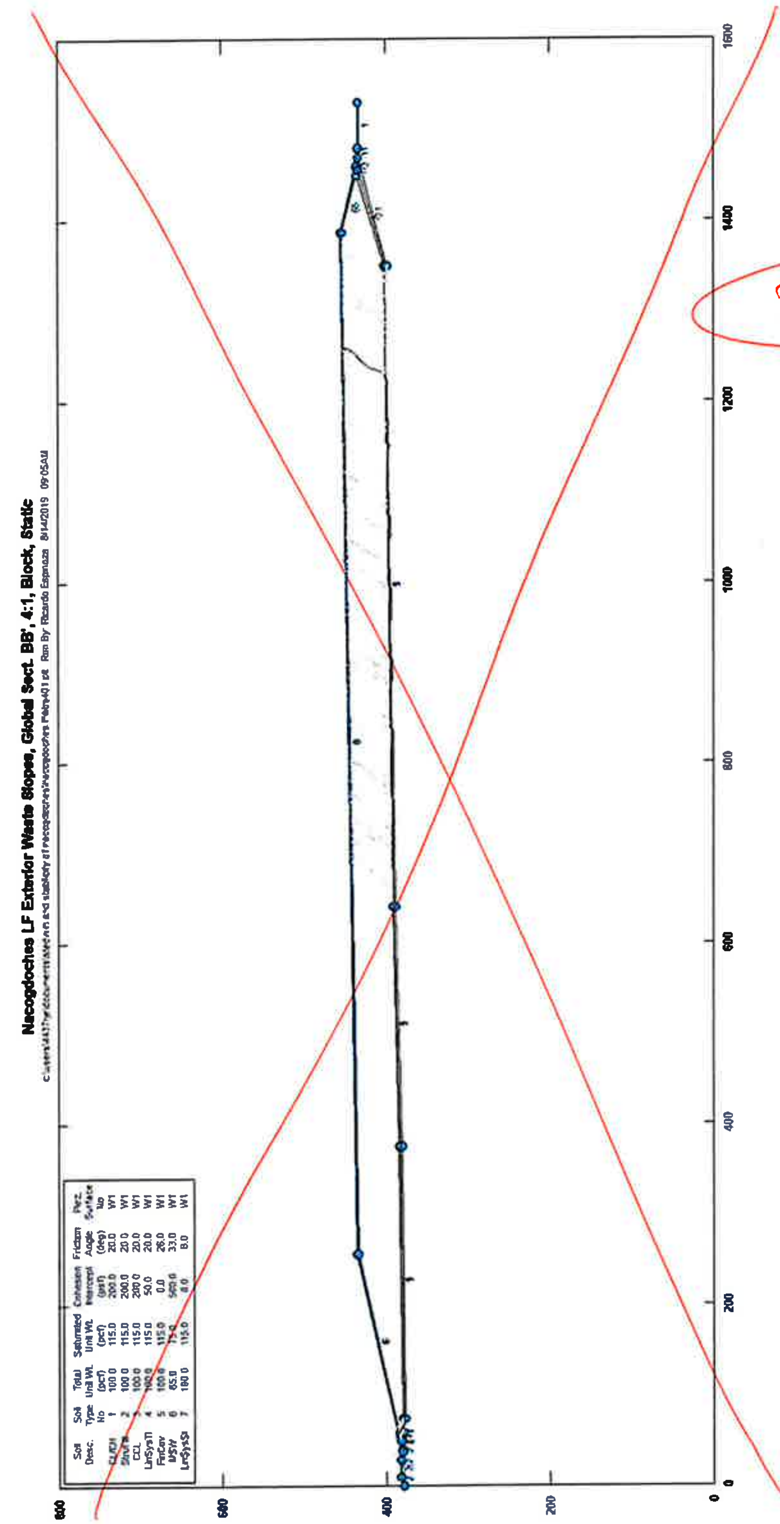
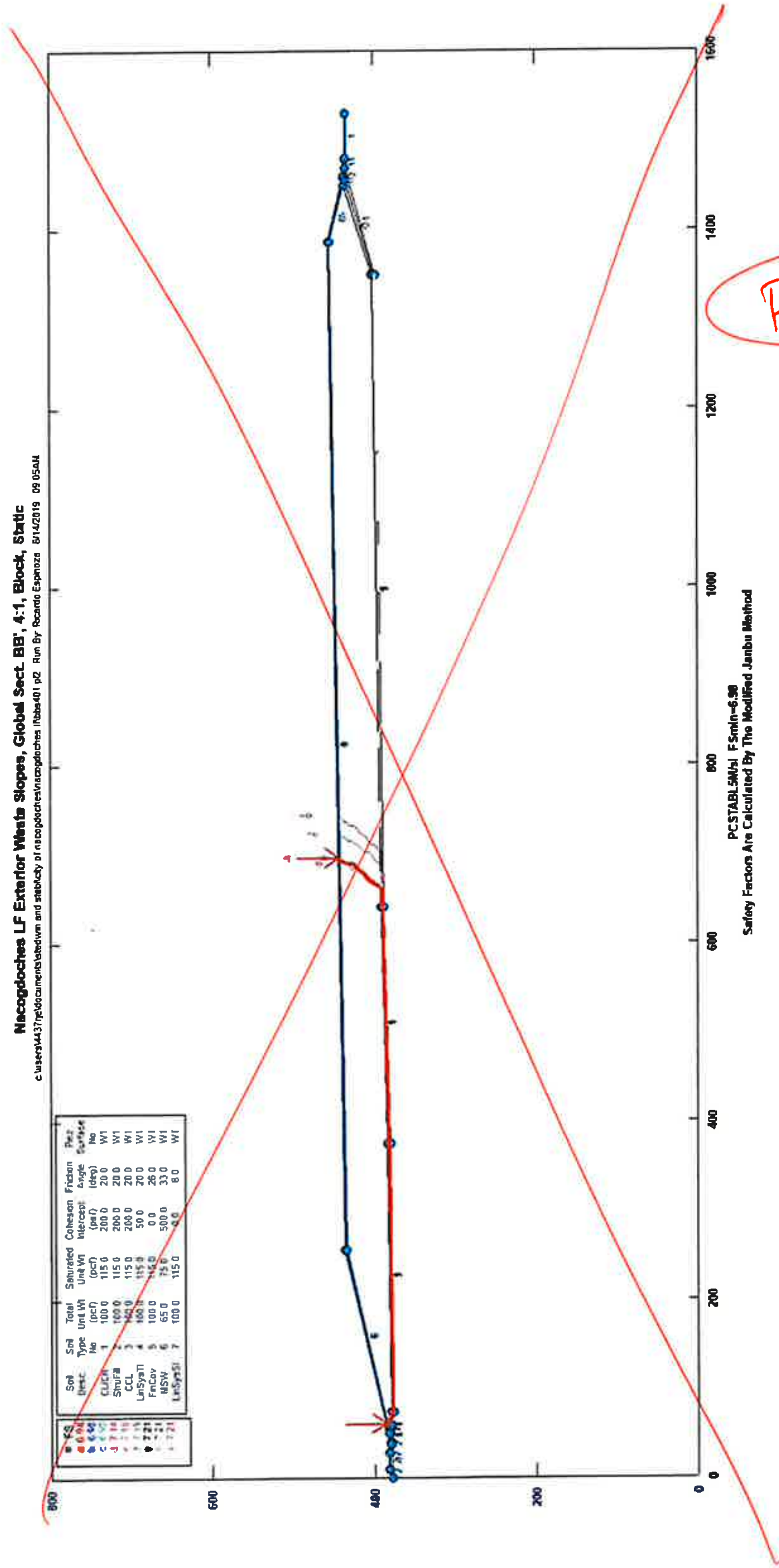
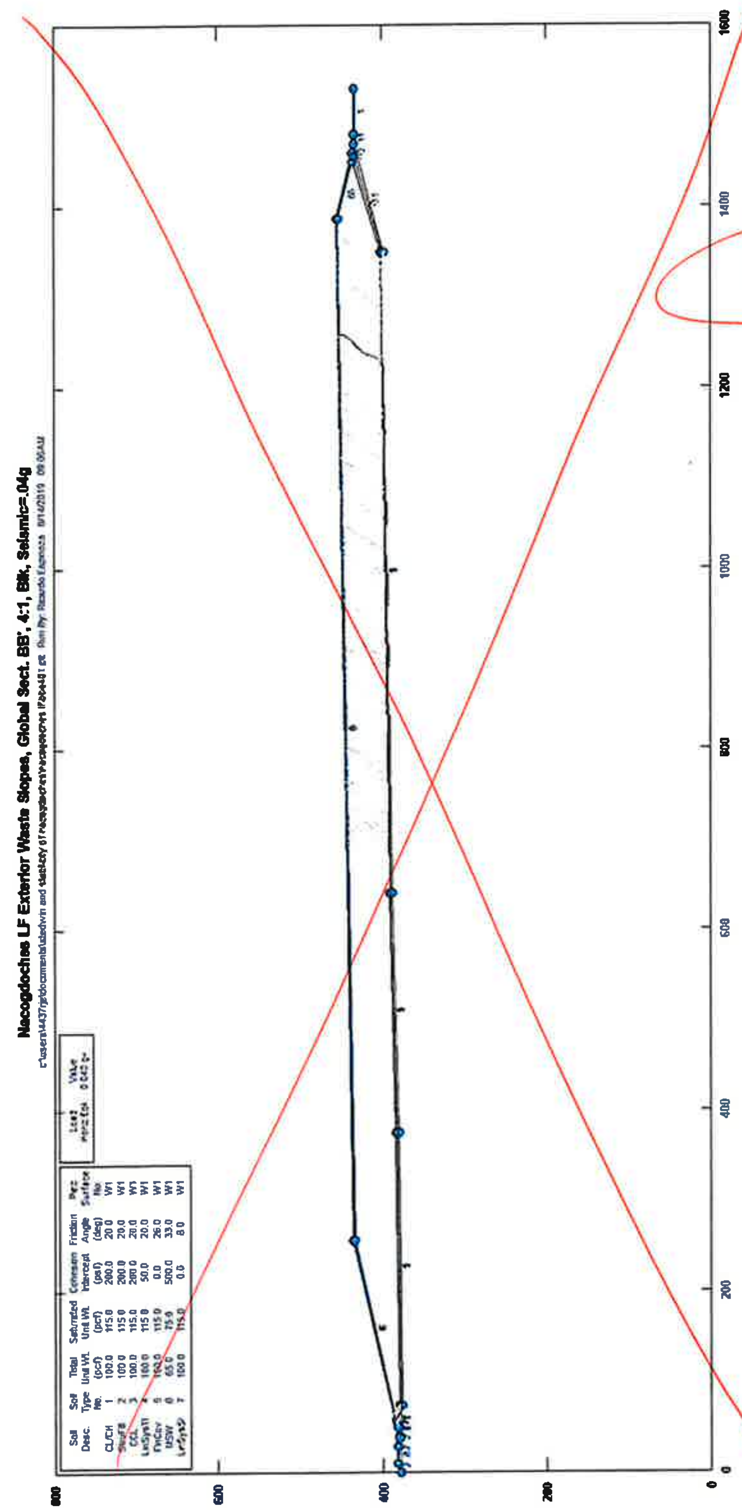
PCSTABL5M/si FSmin=2.44
Safety Factors Are Calculated By The Modified Janbu Method
REVISED

REVISED

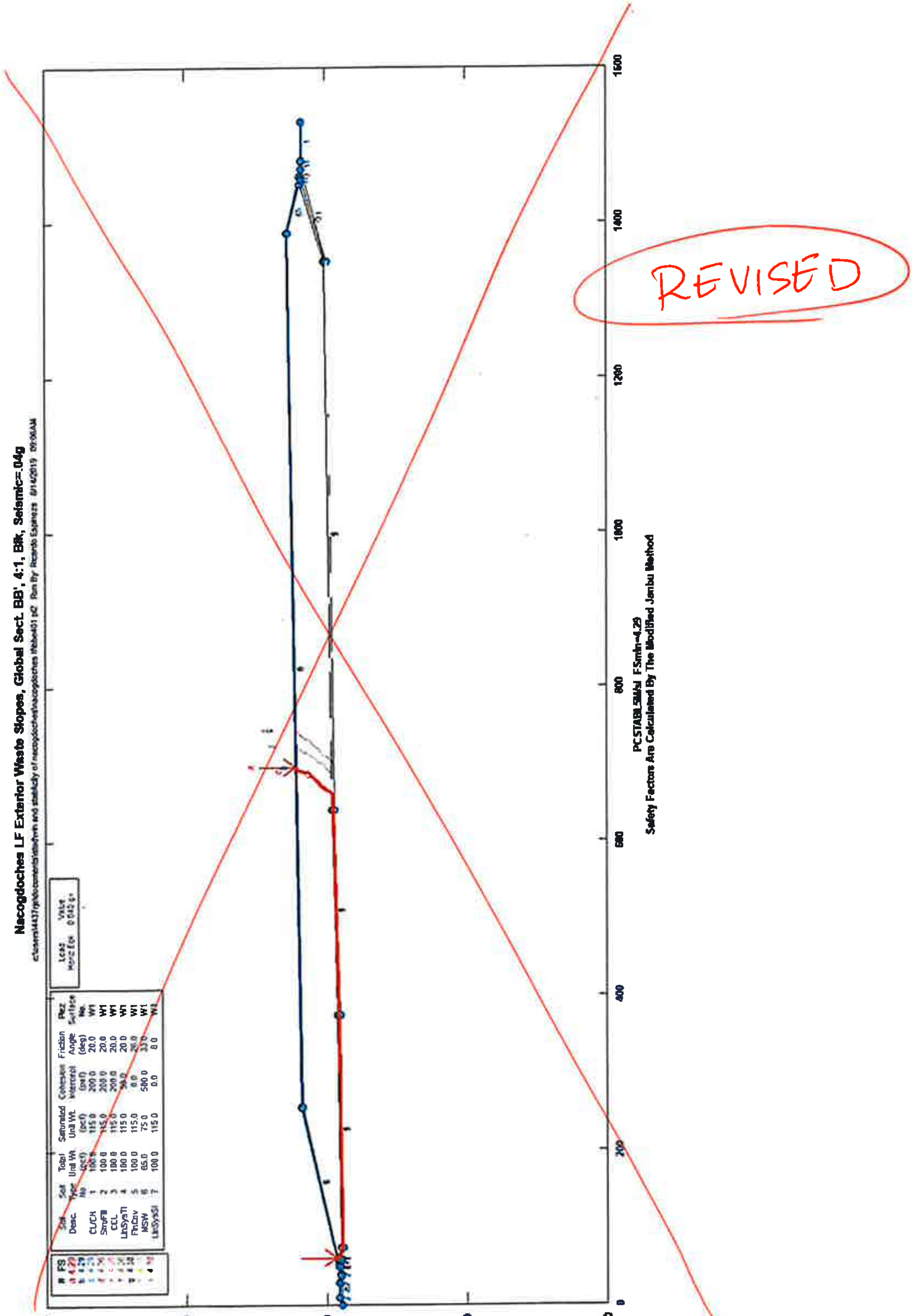

Nacogdoches LF Exterior Waste Slopes, Global Sect. BB', 4:1, Block, Static


Nacogdoches LF Exterior Waste Slopes, Global Sect. BB', 4:1, Block, Static
Safety Factors Are Calculated By The Modified Janbu Method

REVISED


Nacogdoches LF Exterior Waste Slopes, Global Sect. BB', 4:1, Blk, Seismic=.04g

REVISED


Nacogdoches LF Exterior Waste Slopes, Global Sect. BB', 4:1, Blk, Seismic=.04g
PCSTABL5M/si FSmin=4.29
Safety Factors Are Calculated By The Modified Janbu Method
REVISED

CITY OF NACOGDOCHES LANDFILL
NACOGDOCHES COUNTY, TEXAS
TCEQ PERMIT APPLICATION NO. MSW-720

PART III - SITE DEVELOPMENT PLAN
ATTACHMENT 15

UPDATE

Prepared for:

CITY OF NACOGDOCHES
4602 NW Stallings Drive
Nacogdoches, TX 75964

FOR PERMITTING PURPOSES ONLY

STATE OF TEXAS
JEFFREY K. REED
80103
LICENSED
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1/19/24

Prepared and Revision 1 by:

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281/293-8494

Revision 1 – July 1994
Revision 2 – September 2019/January 2020
Revision 3 – January 2024
Revision 4 – May 2024

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UPDATE

FOR PERMITTING PURPOSES ONLY

1/19/24

STATE OF TEXAS
JEFFREY K. REED
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LICENSED PROFESSIONAL ENGINEER

SCS Engineers
TBPE Reg. # F-3407

Appendices

CITY OF NACOGDOCHES LANDFILL
NACOGDOCHES COUNTY, TEXAS
TCEQ PERMIT APPLICATION NO. MSW-720

PART III - SITE DEVELOPMENT PLAN
ATTACHMENT 15, APPENDIX G
BLOCK O - LEACHATE GENERATION MODEL

UPDATE

FOR PERMITTING PURPOSES ONLY

STATE OF TEXAS
JEFFREY K. REED
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1/19/24

Prepared for:

CITY OF NACOGDOCHES
4602 NW Stallings Drive
Nacogdoches, TX 75964

Prepared by:

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Houston Office
12651 Briar Forest Drive
Houston, Texas 77077
281/293-8494

Revision 0 – June 2011
Revision 1 – July 2013
Revision 2 – January 2024
Revision 3 - May 2024
SCS Project No. 16209006.26

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UPDATE

FOR PERMITTING PURPOSES ONLY

STATE OF TEXAS
JEFFREY K. REED
80103
LICENSED PROFESSIONAL ENGINEER

1/19/24

SCS Engineers
TBPE Reg. # F-3407

APPENDIX G2

GEOCOMPOSITE DEMONSTRATION

UPDATE

SCS Engineers
TBPE Reg. # F-3407

1/19/24

STATE OF TEXAS
JEFFREY K. REED
80103
LICENSED
PROFESSIONAL ENGINEER

inclusive of pgs. G2-1 to G2-4

FOR PERMITTING PURPOSES ONLY

Prep'd By: ~~RRK~~ RJE
Chkd By: JKR
Date: 05/09/2024

Required:

Determine the hydraulic conductivity of the geocomposite drainage layer in the leachate collection system for use in the HELP model. This demonstration is based on the worst case conditions for leachate generation and geocomposite loading.

Method:

1. Determine the geocomposite thickness under the expected loading conditions.
2. Determine reduction factors for strength and environmental conditions based on expected duration in each stage of landfill development.
3. Compute the required minimum hydraulic conductivity of the geocomposite using the calculated reduction factors. The minimum hydraulic conductivity for the HELP modeling is designated as the minimum value that keeps the depth of leachate over the liner generally confined to the full thickness of the geocomposite drainage layer.
4. Using the hydraulic conductivity values from Method No. 3. (above), calculate minimum required transmissivity values for the geocomposite.
5. Obtain values for geocomposite transmissivity from manufacturer's data, and compare with the minimum required transmissivity values developed in Method Nos. 3. and 4. (above) to confirm that geocomposite properties used in the HELP model are representative of available geocomposites.

References:

1. Koerner, R.M., *Designing With Geosynthetics, Fifth Edition*, 2005.
2. Giroud, J.P., Zornberg, J.G., and Zhao, A., 2000, "Hydraulic Design of Geosynthetic and Granular Liquid Collection Layers", Geosynthetics International, Vol. 7, Nos. 4-6, pp. 285-380
3. GSE, FabriNet TRx Single-sided Geocomposite Transmissivity Data.

Attachment 15 Appendix G2 Rev2 May 2024

Solution:

1. Estimate geocomposite thickness for the worst case leachate generation and loading conditions, based on an initial thickness of 200 mils:

Assume the geocomposite will undergo linear compression due to weight of soil (i.e., daily, intermediate, or final cover and protective cover) and waste.

Unloaded Geocomposite Thickness =	0.20	in
Percent Thickness Retained When Subjected to 15,000 psf Surcharge =	80	%, as provided by manufacturer
Unit Weight of Waste =	65	pcf
Unit Weight of Soil Only =	120	pcf
Composite Unit Weight of Waste and Daily Cover = (80% Waste and 20% Daily Cover)	76	pcf

Table 1 - Geocomposite Thickness

Fill Condition	d_W[1] (ft)	d_S[2] (ft)	P[3] (psf)	t[4] (in)
Active	10	2.5	1,060	0.20
Interim	60	3.0	4,920	0.19
Final	60	4.5	5,100	0.19

[1] d_W is the depth of waste and daily cover soil above the geocomposite.
[2] d_S is the depth of soil (i.e., protective, daily, and intermediate) above the geocomposite.
[3] P is the pressure on the geocomposite due to the weight of the waste and soil.
[4] t is the thickness of the geocomposite after being subjected to linear compression.
t is calculated by equation (Initial Thickness) - (Max. Compression) x P/15,000.

2. Reduction Factors for Strength and Environmental Conditions

Table 2 - Reduction Factors

centered

Environmental Condition	Range	Fill Condition		
		Active[2] (10' Waste)	Interim (60' Waste)	Closed (60' Waste)
Geotextile Intrusion [1]	1.0 - 1.2	1.00	1.10	1.20
Creep Deformation [1]	1.4 - 2.0	1.00	1.60	1.80
Chemical Clogging [1,3]	1.5 - 2.0	1.00	1.50	2.00
Biological Clogging [3]	1.1 - 1.3	1.00	1.20	1.30
Composite Reduction Factor[4]	1.00 - 5.62	1.00	3.17	5.62

Notes:
[1] Range values for geotextile intrusion, creep deformation, and chemical clogging were obtained from Giroud, J.P., Zornberg, J.G., and Zhao, A., 2000, "Hydraulic Design of Geosynthetic and Granular Liquid Collection Layers", *Geosynthetics International*, Vol. 7, Nos. 4-6, pp. 285-380.
[2] Reduction factors were assumed to be negligible for the active condition due to the short duration of this landfill condition.
[3] Range values for biological clogging were obtained from GRI Standard GC8, Geosynthetic Institute, 2001, "Determination of the Allowable Flow Rate of a Drainage Geocomposite".
[4] The Composite Reduction Factor is the product of all of the factors for the respective fill condition.

3. Develop and confirm assumptions for hydraulic conductivity (k) of the geocomposite for HELP model.

Table 3 - Assumed Hydraulic Conductivity

Fill Condition	d_W[1] (ft)	P[2] (psf)	t[3] (in)	Reduction[4] Factor	k_{min}[5] (cm/s)	~~Peak~~ Calculated Leachate Head (in)[6]
Active	10	1,060	0.20	1.00	~~16.00~~ 9	~~0.10~~ 0.2
Interim	60	4,920	0.19	3.17	~~5.00~~ 4	~~0.16~~ 0.19
Closed	60	5,100	0.19	5.62	~~2.75~~ 2	~~0.0003~~ 0.001

[1] d_W is the depth of waste and daily cover above the geocomposite from Table 1.
[2] P is the pressure on the geocomposite due to the weight of the waste and soil from Table 1.
[3] t is the calculated geocomposite thickness from Table 1.
[4] Reduction Factors from Table 2.
[5] k is the assumed hydraulic conductivity value for HELP model. Reduction Factors will be applied to determine required minimum manufacturer transmissivity values, below. to achieve the calculated leachate head within the geocomposite thickness
[6] ~~Maximum~~ Calculated head on the liner, as calculated by HELP model, to achieve the calculated leachate head within the geocomposite thickness

4. Using the hydraulic conductivity values from Table 3 (above), calculate minimum transmissivity values for use during design and specifying geocomposites.

$$T_{min} = ((t * 2.54 \text{ cm/in}) * k_{min}) * \text{Reduction Factor}$$

Table 4 - Minimum Required Transmissivity for Geocomposite Design

Fill Condition	P (psf)	t (in)	k_{min} (cm/s)	Reduction Factor	T_{min} (cm^2/sec)	$T_{min\ Required}$ (m^3/sec/m)
Active	1,060	0.20	~~16.00~~ 9	1.00	4.57 ~~8.13E+00~~	~~8.13E-04~~ 4.57
Interim	4,920	0.19	~~5.00~~ 4	3.17	6.12 ~~7.64E+00~~	~~7.64E-04~~ 6.12
Closed	5,100	0.19	~~2.75~~ 2	5.62	5.42 ~~7.45E+00~~	~~7.45E-04~~ 5.42

5. Compare T_{min} values from Method No. 4 (above) with published manufacturer transmissivity values.

Table 5 - Comparison of Manufacturer's Reported Transmissivity to the Minimum Required Transmissivity

Fill Condition	P (psf)	T_{min} (m^2/sec) (see Table 4)	Manufacturer's Transmissivity Values P (psf)	T_{man}[1,3] (m^3/sec/m)	T_{min} ≤ T_{man} (Yes/No)
Active	1,060	4.57 ~~8.13~~E-04	1,000	1.00E-03	Yes
Interim	4,920	6.12 ~~7.64~~E-04	4,920	7.34E-04	Yes
Closed	5,100	5.42 ~~7.45~~E-04	5,100	7.21E-04	Yes

[1] Geocomposite Transmissivity values determined from tests with hydraulic gradient of 0.02. If higher gradient used by manufacturer to determine transmissivity, manufacturer will be required to certify that geocomposite will provide comparable drainage as described in Table 4, above.
[2] The product shown in the table is provided to demonstrate the availability of a product that will meet or exceed the required drainage characteristics. Other manufactured products, either bi-planar or tri-planar geocomposites are acceptable if confirmed to meet the minimum required transmissivity values indicated in Table 5 (above).
[3] The T_{man} value (i.e., as provided by geocomposite manufacturer), shown in the table above, is representative of the GSE 200-mil Fabrinet. The 1,000-psf surcharge (P) was taken directly from 100-hour Transmissivity Testing performed according to ASTM D 4716. The T_{man} values for the 4,920-psf and 5,100-psf surcharge conditions were interpolated from the 100-hr Transmissivity Test results.

Conclusion: As indicated in Table 5 and as shown on the HELP Model Summary Sheet, a geocomposite with drainage characteristics that meet or exceed the transmissivity values tested by the geocomposite manufacturer will be installed for the liner system, and such geocomposite will maintain less than 30 cm of leachate over the liner system.

HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE
HELP MODEL VERSION 4.0 BETA (2018)
DEVELOPED BY USEPA NATIONAL RISK MANAGEMENT RESEARCH LABORATORY

Title: Active, 10-foot Waste, 2.8% Slope... **Simulated On:** 5/2/2024 12:19

PAGES G2-5 TO G2-23 ADDED TO APPENDIX

Layer 1
Type 1 - Vertical Percolation Layer (Cover Soil)
CL - Clay Loam
Material Texture Number 11

Thickness	=	6 inches
Porosity	=	0.464 vol/vol
Field Capacity	=	0.31 vol/vol
Wilting Point	=	0.187 vol/vol
Initial Soil Water Content	=	0.3573 vol/vol
Effective Sat. Hyd. Conductivity	=	6.40E-05 cm/sec

Layer 2
Type 1 - Vertical Percolation Layer (Waste)
Municipal Solid Waste (MSW) (900 pcy)
Material Texture Number 18

Thickness	=	120 inches
Porosity	=	0.671 vol/vol
Field Capacity	=	0.292 vol/vol
Wilting Point	=	0.077 vol/vol
Initial Soil Water Content	=	0.3058 vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E-03 cm/sec

Layer 3
Type 1 - Vertical Percolation Layer
CL - Clay Loam
Material Texture Number 11

Thickness	=	24 inches
Porosity	=	0.464 vol/vol
Field Capacity	=	0.31 vol/vol
Wilting Point	=	0.187 vol/vol
Initial Soil Water Content	=	0.3479 vol/vol
Effective Sat. Hyd. Conductivity	=	6.40E-05 cm/sec

Layer 4
Type 2 - Lateral Drainage Layer
Custom Geonet 1

Material Texture Number 123

Thickness	=	0.2 inches
Porosity	=	0.85 vol/vol
Field Capacity	=	0.01 vol/vol
Wilting Point	=	0.005 vol/vol
Initial Soil Water Content	=	0.0346 vol/vol
Effective Sat. Hyd. Conductivity	=	9.00E+00 cm/sec
Slope	=	2.8 %
Drainage Length	=	325 ft

Layer 5

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	=	1 Holes/Acre
FML Installation Defects	=	4 Holes/Acre
FML Placement Quality	=	3 Good

Layer 6

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	=	85
Fraction of Area Allowing Runoff	=	0 %
Area projected on a horizontal plane	=	1 acres
Evaporative Zone Depth	=	6 inches
Initial Water in Evaporative Zone	=	2.144 inches
Upper Limit of Evaporative Storage	=	2.784 inches
Lower Limit of Evaporative Storage	=	1.122 inches
Initial Snow Water	=	0 inches

Initial Water in Layer Materials	=	57.439	inches
Total Initial Water	=	57.439	inches
Total Subsurface Inflow	=	0	inches/year

Note: SCS Runoff Curve Number was User-Specified.

Evapotranspiration and Weather Data

Station Latitude	=	31.37	Degrees
Maximum Leaf Area Index	=	0	
Start of Growing Season (Julian Date)	=	55	days
End of Growing Season (Julian Date)	=	336	days
Average Wind Speed	=	11.3	mph
Average 1st Quarter Relative Humidity	=	69	%
Average 2nd Quarter Relative Humidity	=	69	%
Average 3rd Quarter Relative Humidity	=	62	%
Average 4th Quarter Relative Humidity	=	69	%

Note: Evapotranspiration data was obtained for NACOGDOCHES, TEXAS

Normal Mean Monthly Precipitation (inches)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
4.45	3.17	3.53	3.13	5.29	4.18
2.6	3.08	4.08	4.13	4.54	4.44

Note: Precipitation was simulated using HELP v3.07 data files for the following location: HOUSTON, TEXAS

Normal Mean Monthly Temperature (Degrees Fahrenheit)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
51.4	54.5	61	68.7	74.9	80.6
83.1	82.6	78.4	69.7	60.1	54

Note: Temperature was simulated using HELP v3.07 data files for the following location: HOUSTON, TEXAS
Solar radiation was simulated using HELP v3.07 data files for the following location: HOUSTON, TEXAS (Latitude: 31.37)

Prep'd By: RJE
Chkd By:JKR
Date:05/09/2024

Average Annual Totals Summary

Title: Active, 10-foot Waste, 0.028 Slope, 325-foot drainage length
Simulated on: 5/2/2024 12:19

	Average Annual Totals for Years 1 - 30*			
	(inches)	[std dev]	(cubic feet)	(percent)
Precipitation	45.09	[6.73]	163,658.6	100.00
Runoff	0.000	[0]	0.0000	0.00
Evapotranspiration	25.498	[5.124]	92,557.4	56.56
Subprofile1				
Lateral drainage collected from Layer 4	19.6133	[5.0889]	71,196.1	43.50
Percolation/leakage through Layer 6	0.000020	[0.000004]	0.0714	0.00
Average Head on Top of Layer 5	0.0122	[0.0032]	---	---
Water storage				
Change in water storage	-0.0262	[1.8898]	-95.1	-0.06

* Note: Average inches are converted to volume based on the user-specified area.

Prep'd By: RJE
Chkd By:JKR
Date:05/09/2024

Peak Values Summary

Title: Active, 10-foot Waste, 0.028 Slope, 325-foot drainage length
Simulated on: 5/2/2024 12:20

	Peak Values for Years 1 - 30*		
	(inches)		(cubic feet)
Precipitation	4.62		16,770.6
Runoff	0.000		0.0000
Subprofile1			
Drainage collected from Layer 4	0.4208		1,527.6
Percolation/leakage through Layer 6	0.000000		0.0012
Average head on Layer 5	0.0958		---
Maximum head on Layer 5	0.1898		---
Location of maximum head in Layer 4	2.80	(feet from drain)	
Other Parameters			
Snow water	0.7003		2,542.1
Maximum vegetation soil water	0.4640	(vol/vol)	
Minimum vegetation soil water	0.1870	(vol/vol)	

Final Water Storage in Landfill Profile at End of Simulation Period

Title: Active, 10-foot Waste, 0.028 Slope, 325-foot drainage length
Simulated on: 5/2/2024 12:20
Simulation period: 30 years

	Final Water Storage	
Layer	(inches)	(vol/vol)
1	2.3610	0.3935
2	35.4100	0.2951
3	8.6187	0.3591
4	0.0158	0.0792
5	0.0000	0.0000
6	10.2480	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: Interim, 60' Waste, 2.8% Slope... **Simulated On:** 5/2/2024 12:05

Layer 1
Type 1 - Vertical Percolation Layer (Cover Soil)
CL - Clay Loam
Material Texture Number 11

Thickness	=	12	inches
Porosity	=	0.464	vol/vol
Field Capacity	=	0.31	vol/vol
Wilting Point	=	0.187	vol/vol
Initial Soil Water Content	=	0.3419	vol/vol
Effective Sat. Hyd. Conductivity	=	6.40E-05	cm/sec

Layer 2
Type 1 - Vertical Percolation Layer (Waste)
Municipal Solid Waste (MSW) (900 pcy)
Material Texture Number 18

Thickness	=	720	inches
Porosity	=	0.671	vol/vol
Field Capacity	=	0.292	vol/vol
Wilting Point	=	0.077	vol/vol
Initial Soil Water Content	=	0.2945	vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E-03	cm/sec

Layer 3
Type 1 - Vertical Percolation Layer
CL - Clay Loam
Material Texture Number 11

Thickness	=	24	inches
Porosity	=	0.464	vol/vol
Field Capacity	=	0.31	vol/vol
Wilting Point	=	0.187	vol/vol
Initial Soil Water Content	=	0.3431	vol/vol
Effective Sat. Hyd. Conductivity	=	6.40E-05	cm/sec

Layer 4
Type 2 - Lateral Drainage Layer
Custom Geonet 2

Material Texture Number 143

Thickness	=	0.19 inches
Porosity	=	0.85 vol/vol
Field Capacity	=	0.01 vol/vol
Wilting Point	=	0.005 vol/vol
Initial Soil Water Content	=	0.0693 vol/vol
Effective Sat. Hyd. Conductivity	=	4.00E+00 cm/sec
Slope	=	2.8 %
Drainage Length	=	325 ft

Layer 5

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	=	1 Holes/Acre
FML Installation Defects	=	4 Holes/Acre
FML Placement Quality	=	3 Good

Layer 6

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	=	85
Fraction of Area Allowing Runoff	=	100 %
Area projected on a horizontal plane	=	1 acres
Evaporative Zone Depth	=	12 inches
Initial Water in Evaporative Zone	=	4.103 inches
Upper Limit of Evaporative Storage	=	5.568 inches
Lower Limit of Evaporative Storage	=	2.244 inches
Initial Snow Water	=	0 inches

Initial Water in Layer Materials	=	234.629 inches
Total Initial Water	=	234.629 inches
Total Subsurface Inflow	=	0 inches/year

Note: SCS Runoff Curve Number was User-Specified.

Evapotranspiration and Weather Data

Station Latitude	=	31.37 Degrees
Maximum Leaf Area Index	=	2
Start of Growing Season (Julian Date)	=	55 days
End of Growing Season (Julian Date)	=	336 days
Average Wind Speed	=	11.3 mph
Average 1st Quarter Relative Humidity	=	69 %
Average 2nd Quarter Relative Humidity	=	69 %
Average 3rd Quarter Relative Humidity	=	62 %
Average 4th Quarter Relative Humidity	=	69 %

Note: Evapotranspiration data was obtained for NACOGDOCHES, TEXAS

Normal Mean Monthly Precipitation (inches)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
4.45	3.17	3.53	3.13	5.29	4.18
2.6	3.08	4.08	4.13	4.54	4.44

Note: Precipitation was simulated using HELP v3.07 data files for the following location: HOUSTON, TEXAS

Normal Mean Monthly Temperature (Degrees Fahrenheit)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
51.4	54.5	61	68.7	74.9	80.6
83.1	82.6	78.4	69.7	60.1	54

Note: Temperature was simulated using HELP v3.07 data files for the following location: HOUSTON, TEXAS
Solar radiation was simulated using HELP v3.07 data files for the following location: HOUSTON, TEXAS (Latitude: 31.37)

Average Annual Totals Summary

Title: Interim, 60' Waste, 2.8% Slope, 325' Length
Simulated on: 5/2/2024 12:06

	Average Annual Totals for Years 1 - 30*			
	(inches)	[std dev]	(cubic feet)	(percent)
Precipitation	45.09	[6.73]	163,658.6	100.00
Runoff	3.516	[1.61]	12,763.0	7.80
Evapotranspiration	31.213	[2.692]	113,304.1	69.23
Subprofile1				
Lateral drainage collected from Layer 4	10.2136	[3.9162]	37,075.4	22.65
Percolation/leakage through Layer 6	0.000022	[0.000007]	0.0787	0.00
Average Head on Top of Layer 5	0.0143	[0.0055]	---	---
Water storage				
Change in water storage	0.1422	[3.4521]	516.0	0.32

* Note: Average inches are converted to volume based on the user-specified area.

Peak Values Summary

Title: Interim, 60' Waste, 2.8% Slope, 325' Length
Simulated on: 5/2/2024 12:06

	Peak Values for Years 1 - 30*	
	(inches)	(cubic feet)
Precipitation	4.62	16,770.6
Runoff	2.340	8,495.8
Subprofile1		
Drainage collected from Layer 4	0.1910	693.2
Percolation/leakage through Layer 6	0.000000	0.0012
Average head on Layer 5	0.0978	---
Maximum head on Layer 5	0.1938	---
Location of maximum head in Layer 4	2.85 (feet from drain)	
Other Parameters		
Snow water	0.7003	2,542.1
Maximum vegetation soil water	0.4516 (vol/vol)	
Minimum vegetation soil water	0.1870 (vol/vol)	

Prep'd By: RJE
Chkd By:JKR
Date:05/09/2024

Final Water Storage in Landfill Profile at End of Simulation Period

Title: Interim, 60' Waste, 2.8% Slope, 325' Length
Simulated on: 5/2/2024 12:06
Simulation period: 30 years

	Final Water Storage	
Layer	(inches)	(vol/vol)
1	3.7279	0.3107
2	215.5460	0.2994
3	9.3178	0.3882
4	0.0541	0.2849
5	0.0000	0.0000
6	10.2480	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: Closed, 2% Slope, 200' Length **Simulated On:** 5/2/2024 12:09

Layer 1
Type 1 - Vertical Percolation Layer (Cover Soil)
CL - Clay Loam
Material Texture Number 11

Thickness	=	6	inches
Porosity	=	0.464	vol/vol
Field Capacity	=	0.31	vol/vol
Wilting Point	=	0.187	vol/vol
Initial Soil Water Content	=	0.4536	vol/vol
Effective Sat. Hyd. Conductivity	=	6.40E-05	cm/sec

Layer 2
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	=	1	Holes/Acre
FML Installation Defects	=	4	Holes/Acre
FML Placement Quality	=	3	Good

Layer 3
Type 1 - Vertical Percolation Layer
Custom Soil 1
Material Texture Number 43

Thickness	=	18	inches
Porosity	=	0.427	vol/vol
Field Capacity	=	0.418	vol/vol
Wilting Point	=	0.367	vol/vol
Initial Soil Water Content	=	0.4094	vol/vol
Effective Sat. Hyd. Conductivity	=	1.00E-05	cm/sec

Layer 4
Type 1 - Vertical Percolation Layer
CL - Clay Loam
Material Texture Number 11

Thickness	=	6 inches
Porosity	=	0.464 vol/vol
Field Capacity	=	0.31 vol/vol
Wilting Point	=	0.187 vol/vol
Initial Soil Water Content	=	0.31 vol/vol
Effective Sat. Hyd. Conductivity	=	6.40E-05 cm/sec

Layer 5

Type 1 - Vertical Percolation Layer (Waste)
Municipal Solid Waste (MSW) (900 pcy)
Material Texture Number 18

Thickness	=	720 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 6

Type 1 - Vertical Percolation Layer
CL - Clay Loam
Material Texture Number 11

Thickness	=	24 inches
Porosity	=	0.464 vol/vol
Field Capacity	=	0.31 vol/vol
Wilting Point	=	0.187 vol/vol
Initial Soil Water Content	=	0.31 vol/vol
Effective Sat. Hyd. Conductivity	=	6.40E-05 cm/sec

Layer 7

Type 2 - Lateral Drainage Layer
Custom Geonet 1
Material Texture Number 123

Thickness	=	0.19 inches
Porosity	=	0.85 vol/vol
Field Capacity	=	0.01 vol/vol
Wilting Point	=	0.005 vol/vol
Initial Soil Water Content	=	0.0116 vol/vol
Effective Sat. Hyd. Conductivity	=	2.00E+00 cm/sec
Slope	=	2 %
Drainage Length	=	200 ft

Layer 8

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	=	1	Holes/Acre
FML Installation Defects	=	4	Holes/Acre
FML Placement Quality	=	3	Good

Layer 9
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	=	85	
Fraction of Area Allowing Runoff	=	100	%
Area projected on a horizontal plane	=	1	acres
Evaporative Zone Depth	=	6	inches
Initial Water in Evaporative Zone	=	2.721	inches
Upper Limit of Evaporative Storage	=	2.784	inches
Lower Limit of Evaporative Storage	=	1.122	inches
Initial Snow Water	=	0	inches
Initial Water in Layer Materials	=	239.88	inches
Total Initial Water	=	239.88	inches
Total Subsurface Inflow	=	0	inches/year

Note: SCS Runoff Curve Number was User-Specified.

Evapotranspiration and Weather Data

Station Latitude	=	31.37	Degrees
Maximum Leaf Area Index	=	3.5	
Start of Growing Season (Julian Date)	=	55	days
End of Growing Season (Julian Date)	=	336	days

Average Wind Speed	=	11.3 mph
Average 1st Quarter Relative Humidity	=	69 %
Average 2nd Quarter Relative Humidity	=	69 %
Average 3rd Quarter Relative Humidity	=	62 %
Average 4th Quarter Relative Humidity	=	69 %

Note: Evapotranspiration data was obtained for NACOGDOCHES, TEXAS

Normal Mean Monthly Precipitation (inches)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
4.45	3.17	3.53	3.13	5.29	4.18
2.6	3.08	4.08	4.13	4.54	4.44

Note: Precipitation was simulated using HELP v3.07 data files for the following location: HOUSTON, TEXAS

Normal Mean Monthly Temperature (Degrees Fahrenheit)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
51.4	54.5	61	68.7	74.9	80.6
83.1	82.6	78.4	69.7	60.1	54

Note: Temperature was simulated using HELP v3.07 data files for the following location: HOUSTON, TEXAS
Solar radiation was simulated using HELP v3.07 data files for the following location: HOUSTON, TEXAS (Latitude: 31.37)

Average Annual Totals Summary

Title: Closed, 2% Slope, 200' Length
Simulated on: 5/2/2024 12:11

	Average Annual Totals for Years 1 - 30*			
	(inches)	[std dev]	(cubic feet)	(percent)
Precipitation	45.09	[6.73]	163,658.6	100.00
Runoff	13.984	[5.121]	50,761.5	31.02
Evapotranspiration	31.053	[2.761]	112,722.7	68.88
Subprofile1				
Percolation/leakage through Layer 2	0.045954	[0.006734]	166.8	0.10
Average Head on Top of Layer 2	1.7634	[0.2677]	---	---
Subprofile2				
Lateral drainage collected from Layer 7	0.0460	[0.0067]	166.8	0.10
Percolation/leakage through Layer 9	0.000002	[0]	0.0065	0.00
Average Head on Top of Layer 8	0.0001	[0]	---	---
Water storage				
Change in water storage	0.0021	[0.568]	7.5660	0.00

* Note: Average inches are converted to volume based on the user-specified area.

Peak Values Summary

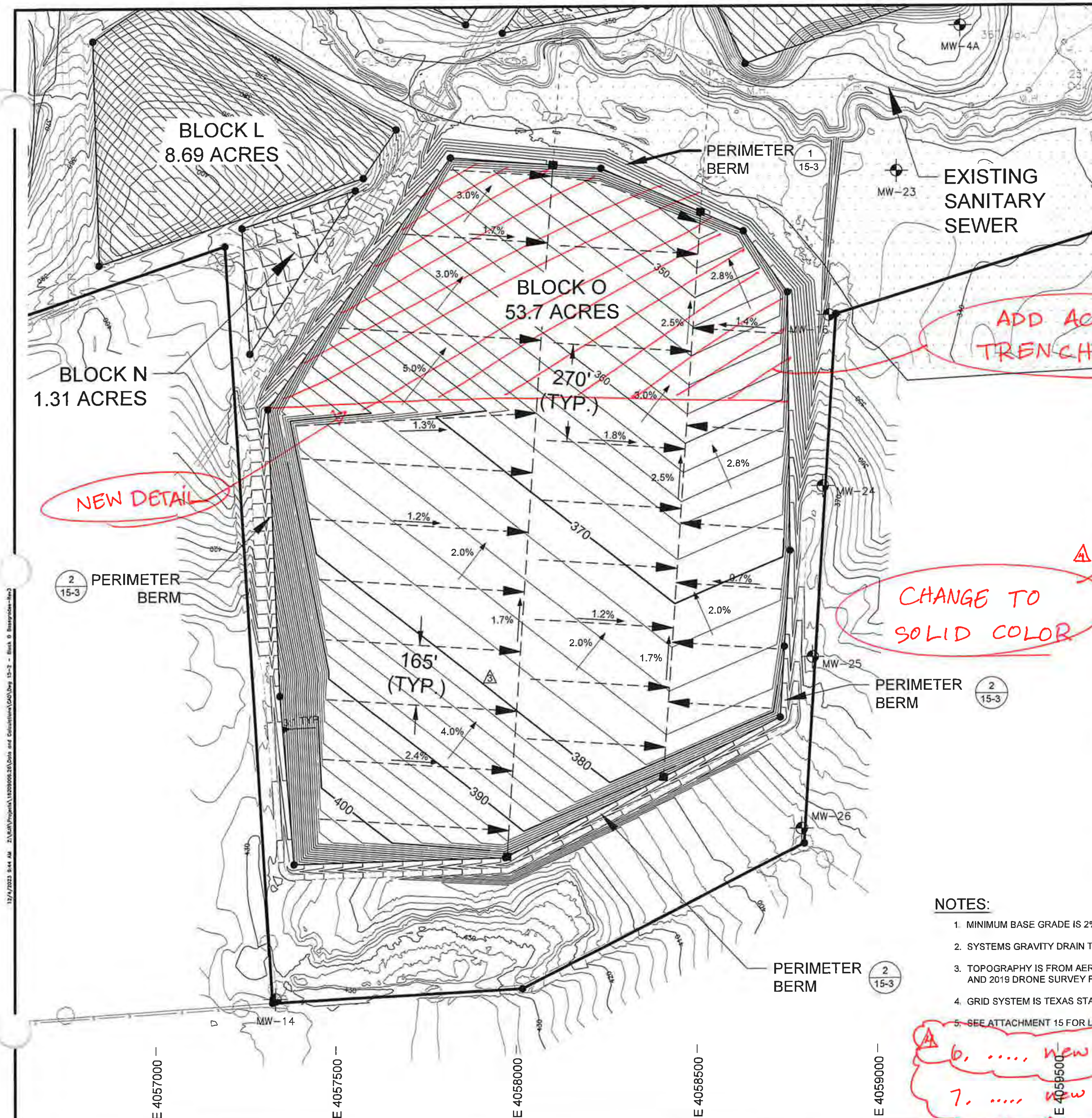
Title: Closed, 2% Slope, 200' Length
Simulated on: 5/2/2024 12:11

	Peak Values for Years 1 - 30*		
	(inches)		(cubic feet)
Precipitation	4.62		16,770.6
Runoff	4.085		14,827.1
Subprofile1			
Percolation/leakage through Layer 2	0.000415		1.5059
Average head on Layer 2	6.0000		
Subprofile2			
Drainage collected from Layer 7	0.0004		1.4913
Percolation/leakage through Layer 9	0.000000		0.0000
Average head on Layer 8	0.0004		---
Maximum head on Layer 8	0.0007		---
Location of maximum head in Layer 7	0.00	(feet from drain)	
Other Parameters			
Snow water	0.7003		2,542.1
Maximum vegetation soil water	0.4640	(vol/vol)	
Minimum vegetation soil water	0.1870	(vol/vol)	

Final Water Storage in Landfill Profile at End of Simulation Period

Title: Closed, 2% Slope, 200' Length
Simulated on: 5/2/2024 12:11
Simulation period: 30 years

	Final Water Storage	
Layer	(inches)	(vol/vol)
1	2.7840	0.4640
2	0.0000	0.0000
3	7.3688	0.4094
4	1.8600	0.3100
5	210.2400	0.2920
6	7.4400	0.3100
7	0.0021	0.0108
8	0.0000	0.0000
9	10.2480	0.4270
Snow water	0.0000	---



N 10607000

N 10606500

SCALE

0 300 600 FEET

N 10606000

N 10605500

N 10605000

N 10604500

LEGEND:

PROPERTY BOUNDARY	
FUTURE TRENCHES	⚠4 (SEE NOTE 6)
CLOSED TRENCHES	⚠4 (SEE NOTE 6)
UNUSEABLE TRENCHES	⚠4 (REMOVED FROM PLAN)
ACTIVE TRENCHES	⚠4 (SEE NOTE 6)
100 YEAR FLOODPLAIN	
MONITOR WELL LOCATION (MW-25)	
LEACHATE COLLECTION PIPE TRENCH HEADERS	
LEACHATE COLLECTION PIPE TRENCH LATERALS	
LEACHATE GRAVITY DRAIN TO EXISTING SEWER	
TOP OF LINER GRADE (380) ⚠1	
LEACHATE COLLECTION PIPE CLEANOUT RISER ⚠2	
N 10604500 STATE PLANE COORDINATE	
PROPOSED ROADWAY	

NOTES:

1. MINIMUM BASE GRADE IS 2%. MINIMUM LEACHATE PIPE SLOPE IS 0.5%.
2. SYSTEMS GRAVITY DRAIN TO EXISTING 12" Ø SANITARY SEWER SYSTEM AS SHOWN
3. TOPOGRAPHY IS FROM AERIAL SURVEY FLOWN ON JANUARY 7, 2011 BY BASE MAPPING CO., LTD AND 2019 DRONE SURVEY FLOWN BY HYDREX DRONE DIVISION DATED 1-19-2019.
4. GRID SYSTEM IS TEXAS STATE PLANE COORDINATES, NAD 83.
5. ~~SEE ATTACHMENT 15 FOR LEACHATE COLLECTION SYSTEM DESIGN AND DETAILS.~~

⚠4 6. ..... new note .....

7. ..... new note .....

FOR PERMITTING PURPOSES ONLY

REV	DATE	DESCRIPTION	BY
⚠4	05/2024	.....	SCS
⚠3	12/2023	REVISE BLOCK O BASE GRADES AND LCS	SCS
⚠2	8/2019	REVISE BLOCK O, LCS	SCS
⚠1	8/2013	REVISED LEGEND	UKR

TEXAS BOARD OF PROFESSIONAL ENGINEERS REG. NO. F-3407

DRAWING TITLE: BASE GRADES - BLOCK O

PROJECT TITLE: LANDFILL RECONFIGURATION PERMIT MODIFICATION

CLIENT: CITY OF NACOGDOCHES LANDFILL
PERMIT NO. MSW-720
NACOGDOCHES, NACOGDOCHES COUNTY, TEXAS

UPDATE

STATE OF TEXAS
JEFFREY K. REED
80103
LICENSED
PROFESSIONAL ENGINEER
1/9/24

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT CONSULTING ENGINEERS
12651 BRIAR FOREST, SUITE 205, HOUSTON, TX 77077
PH (281) 397-6747 FAX NO. (281) 293-7878

PROJ. NO. 16209006.02 | DSN. BY: RLD | DWN. BY: RLD | CHK. BY: JKR | Q/A RVW BY: JRM | APP. BY: JKR

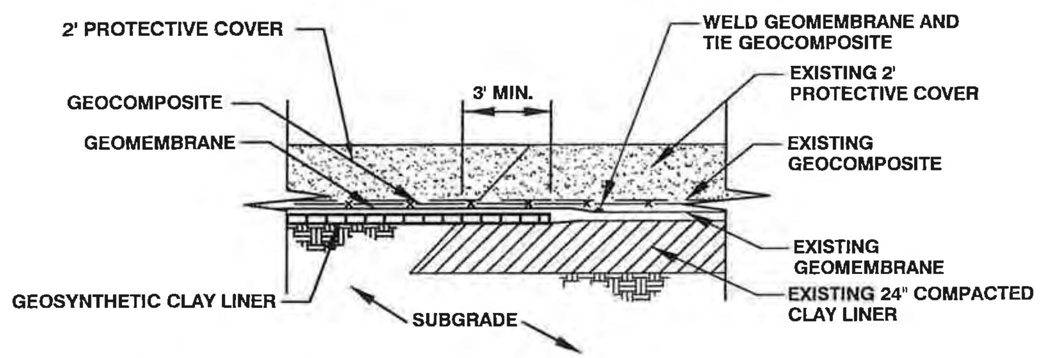
CADD FILE: DWG 15-2 - BLOCK O BASEGRADES-REV3

DATE: 6-2011

SCALE: AS SHOWN

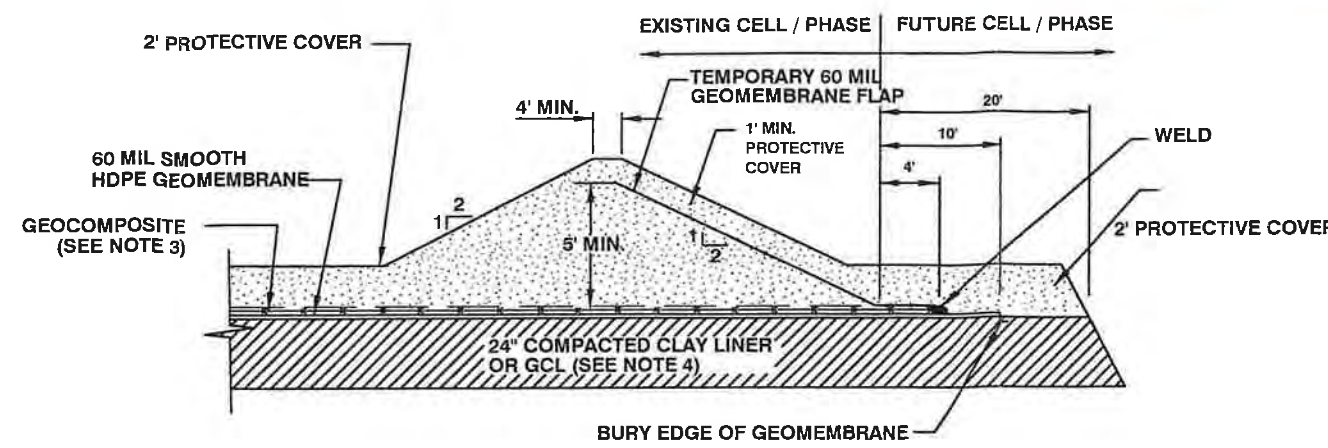
DRAWING NO. 15-2

△2 05/2024 ..... SCS



3 / 15-5 LINER TIE-IN TO ADJACENT CELL (GCL/CCL) △1

NOT TO SCALE



2 / 15-5 TEMPORARY RAINFLAP △1

NOT TO SCALE

NOTE:

THIS DETAIL MAY BE USED IN THE EVENT A PARTIAL CELL IS CONSTRUCTED OR THE CELL/PHASE IS DIVIDED FOR STORMWATER CONTROL PURPOSES.

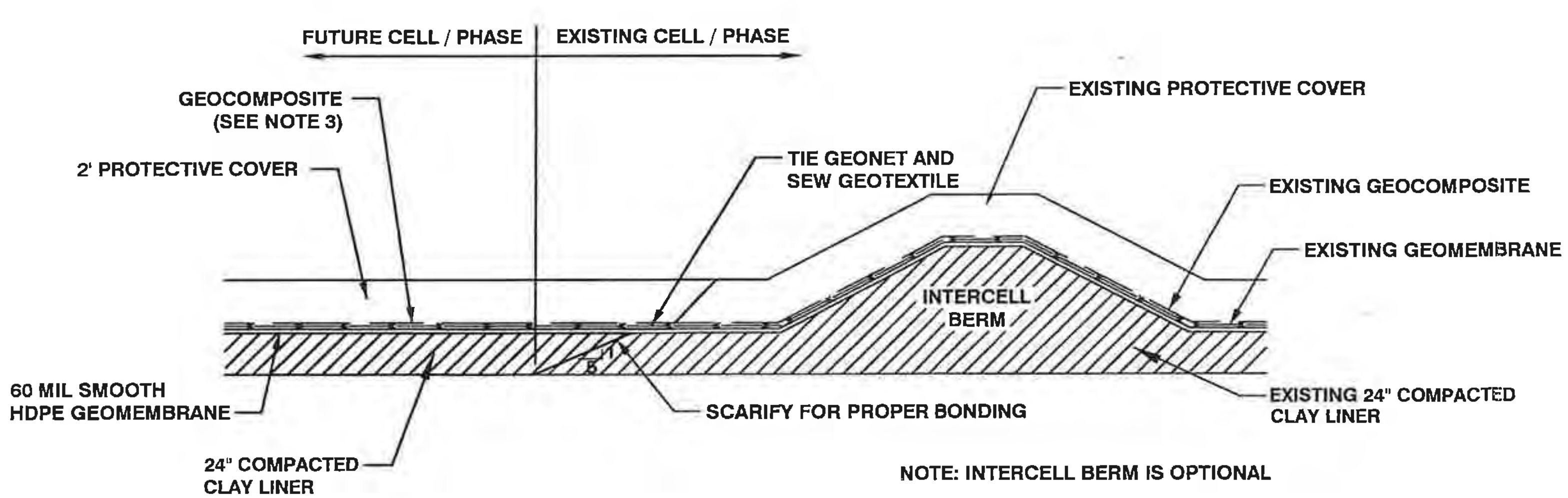
REORGANIZE

UPDATE

ADD NEW DETAIL 4

FOR PERMITTING PURPOSES ONLY

STATE OF TEXAS
JEFFREY K. REED
80103
PROFESSIONAL ENGINEER
8/15/13



1 / 15-5 LINER TIE-IN TO ADJACENT CELL AT INTERCELL BERM △1

NOT TO SCALE

NOTES:

1. ALL DIMENSIONS INDICATE MINIMUM VALUES UNLESS OTHERWISE NOTED.
2. GEOCOMPOSITE DRAINAGE LAYER SHALL HAVE A MINIMUM TRANSMISSIVITY OF $1E^{-4}$ M^2/SEC AT A GRADIENT OF 0.1 UNDER A LOAD OF 10,000 P.S.F. DOUBLE SIDED GEOCOMPOSITE SHALL BE HEAT-BONDED BOTH SIDES.
3. THE DRAINAGE LAYER ON THE CELL FLOOR SHALL CONSIST OF A SINGLE-SIDED GEOCOMPOSITE ON SMOOTH GEOMEMBRANE. TEXTURED GEOMEMBRANE MAY BE USED ON FLOOR WITH DOUBLE-SIDED GEOCOMPOSITE.
4. FOR BLOCK O, A REINFORCED GEOSYNTHETIC CLAY LINER MAY BE USED IN LEIU OF A 2' COMPACTED CLAY LINER. △1

REV	DATE	DESCRIPTION	BY
1	8/2013	ADDED GCL/CCL LINER TIE-IN	JKR

TEXAS BOARD OF PROFESSIONAL ENGINEERS REG. NO. F-3407

DRAWING TITLE: LINER SYSTEM DETAILS

PROJECT TITLE: LANDFILL RECONFIGURATION PERMIT MODIFICATION

CLIENT: CITY OF NACOGDOCHES LANDFILL, PERMIT NO. MSW-720, NACOGDOCHES, NACOGDOCHES COUNTY, TEXAS

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT CONSULTING ENGINEERS
12651 BRIAR FOREST, SUITE 205, HOUSTON, TX 77077

PROJ. NO. 16209006.02 | DWN. BY: JMG | CHK. BY: RLD

CADD FILE: DWG 15-5 LINER SYSTEM DET

DATE: 6/2011

SCALE: AS SHOWN

DRAWING NO. 15-5