Landfill 33, Ltd. - Table of Contents

SECTION 1

R1

ANDREWS ENGINEERING

3300 Ginger Creek Drive | 217.787.2334
Springfield, IL 62711

April 5, 2019

IEPA - DIVISION OF RECORDS MANAGEMENT
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REVIEWER: MED

Kenn Smith, P.E.
Permit Section
Bureau of Land
Illinois Environmental Protection Agency
1021 North Grand Avenue East
Springfield, Illinois 62794-9276

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APR 05 2019
IEPA-BOL
PERMIT SECTION

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IEPA/BOL

Re: 0498100007 – Effingham County
Landfill 33, Ltd.
Illinois EPA Permit No. 1995-231-LFM
Final Cover Modification of Permitted Area

Dear Mr. Smith:

On behalf of our client, Landfill 33, Ltd., enclosed herewith are the original and three copies of an Application for a Significant Modification to modify the final cover of the Landfill 33 Disposal Facility (Landfill 33). Completed Illinois EPA application forms (LPC-PA1, LPC-PA16, LPC-PA8, and 39i certification) are provided in Attachment 1.

Currently, Landfill 33 has developed the entire facility and completed closure activities for +/- 9.1 acres out of the permitted +/- 40.6 acres based on the current design. Landfill 33 is anticipated to reach capacity in late 2023 or 2024 depending upon tonnage received at the gate and compaction rates achieved at the facility. In addition, as part of the development and permitting of the existing facility, approximately +/- 62,350 cubic yards of in-place waste capacity have been lost due to design modifications or as-built construction, further reducing the capacity of the landfill.

The facility is in the early stages of planning a new lateral waste unit/new landfill (new pollution control facility as defined by Section 39.2 of the Illinois Environmental Protection Act [Act]) that will require approximately 4 to 5 years with siting, permitting and initial site development. Since the current facility is anticipated to close about the same time the new landfill could open, there is no buffer in the schedule to account for unforeseen changes. Given that the schedule is very tight for permitting and development of a new landfill prior to the current landfill closing, options for extending the existing life of the current facility have been evaluated.

Landfill 33 is requesting a final cover modification to revise the final cover contours and stay below the permitted defined maximum elevation of 644 MSL. The proposed final cover modification will enhance the facility design, gain back the airspace lost due to previous permitting and construction activities and extend the life of the facility to allow a smooth transition to the new landfill.

This proposed final cover modification will not increase the waste footprint or final height of the existing landfill and all slopes will remain at a 4H:1V as permitted. This application only modifies the top final cover contours and will adjust the maximum elevation of the facility closer to the center of the current waste unit to create a more natural final landform. A copy of the revised waste capacity calculation is included in Attachment 2. In addition, cross sections were generated to illustrate the proposed modifications (Attachment 6).

The change in the airspace/waste disposal capacity from this modification is approximately +/- 420,650 cubic yards. This is based on the additional 483,000 cubic yards from this modification less the 62,350 cubic yards previously lost due to design modifications and construction. This application has been provided to and discussed with the Effingham County Board. In the opinion of the Effingham County Board, the proposed final cover modification is consistent with the previous Siting Approval, so long as the final maximum elevation of 644 MSL is not exceeded. Attachment 3 contains information submitted to the Effingham County Board.

A slope stability analysis has been completed for the proposed final cover modification (Attachment 4). The results demonstrate safety factors that meet all of the requirements of 35 Ill. Adm. Code 811.304. Attachment 4 also contains the revised analyses, computerized printouts and summary report for the proposed final cover modifications.

The stormwater design for the facility has been revised to account for the proposed final cover modification. The final cover modification will modify the existing and future slopes and perimeter ditches associated with the facility footprint. In addition, perimeter ditches, terraces, letdowns and culverts have been reviewed and redesigned as necessary to accommodate the final cover modification. Outfall locations have been reviewed to verify that the existing design meets the needs for the proposed final cover modification. The results demonstrate that the proposed final cover modification meets all the requirements of 35 Ill. Adm. Code 811.103. Attachment 5 contains the revised stormwater analyses and a summary report.

The revised set of plan sheets (reduced copy) is located in Attachment 6. A full-size set has been included to accompany this application. The only location that has been revised with the proposed final cover modification is the final cover system and stormwater management. For ease of review, a full revised plan set has been included with this application for the facility.

A revised Groundwater Impact Assessment (GIA) has been completed to evaluate the existing and lateral expansion areas with respect to the final cover modification. The complexity of the site geology required the assessment of three distinct modeling scenarios. These scenarios are identified as the Existing Landfill Unit, the South Unit and the Northwest Unit. Sensitivity analyses were performed on the hydrogeologic data used in the models. Baseline model scenarios were then developed from the sensitivity analysis to provide a conservative model framework for the impact assessment. Surrogates were developed from the baseline models to express all leachate constituents within the conceptual models framework. Maximum allowable predicted concentrations were also calculated for the leachate constituents utilizing the contaminant transport models. On the basis of this study, this facility does not produce a statistically significant increase over background concentrations over the life, post-closure care, and 100 year assessment periods, pursuant to 35 IAC 811.317 and 811.320.

Should you have any further questions concerning this matter, do not hesitate to contact me at (217) 787-2334.

Sincerely,

Douglas W. Mauntel, P.E.
Director of Engineering Services

STE:dwm:ndd

Attachment(s)

cc: Chris Sartain – IEPA (email)
Brian Hayes – Landfill 33, Ltd. (hard copy and email)
Ron Edwards – Landfill 33, Ltd. (email)

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Attachments

R4

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Attachment 1

Permit Application Forms
(LPC-PA1, PA-8, 39i Certification and PA-16)

Illinois Environmental Protection Agency

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General Application for Permit (LPC - PA1)

This form must be used for any application for permit from the Bureau of Land, except for landscape waste composting or hazardous waste management facilities regulated in accordance with RCRA, Subtitle C. One original, and two copies, or three if applicable, of all permit application forms must be submitted. Attach the original and appropriate number of copies of any necessary plans, specifications, reports, etc. to fully support and describe the activities and modifications being proposed. Attach sufficient information to demonstrate the compliance with all regulatory requirements. Incomplete applications will be rejected. Please refer to the instructions for further guidance. **Note: Applicants must provide a physical address; the post office will not deliver a certified letter (final action letter) to a P.O. Box only. Please provide an extended ZIP+4 code for the site identification and owner/operator information.**

You may complete this form online, save a copy locally, print, sign and submit it to the Bureau of Land at the address below. Note: Hand-delivered permit applications must be delivered between 8:30 am and 5:00 pm, Monday through Friday (excluding State holidays) to:

Bureau of Land, Permit Section, Mail Code #33
1021 North Grand Avenue East, P.O. Box 19276
Springfield, IL 62794-9276

Instructions

I. Site Identification

Site Name: Landfill 33, LTD — IEPA BOL No.: 0498100007

Street Address: 1713 South Willow Street — P.O. Box: 703

City: Effingham — State: IL — Zip + 4: *62401 — County: Effingham

*Notification letters will not be sent without a 9-digit zip code.

Existing DE/OP Permit Numbers (if applicable): 1995-231-LFM

II. Applicant Identification

	Owner	Operator (if Different)
Name	Wendt Family Trust;R.Deibel;Landfill 33,LT	Landfill 33, LTD
Street Address	715 S. First	
PO Box		703
City	Effingham	Effingham
State	IL	IL
Zip + 4	62401	62401
Phone	217-821-1877	217-342-3747
Contact	Lori Martin	Brian Hayes
Email Address	seve55@me.com	lf33bhayes@consolidated.net
FEIN ID No.	37-6341850	37-1093457

Agency correspondence mailed to:

☑ Owner ☑ Operator ☐ Other - Explain:

TYPE OF SUBMISSION/REVIEW PERIOD:	TYPE OF FACILITY:	TYPE OF WASTE:
☐ New Landfill/180 days (35 IAC Part 813)	☑ Landfill	☑ General Municipal Refuse
☐ Landfill Expansion/180 days (35 IAC Part 813)	☐ Land Treatment	☐ Hazardous
☑ Sig. Mod. to Operate/90 days (35 IAC Part 813)	☐ Transfer Station	☑ Special (Non-Hazardous)
☐ Other Sig. Mod./90 days (35 IAC Part 813)	☐ Treatment Facility	☐ Chemical Only (exec. putrescible)
☐ Renewal of Landfill/90 days (35 IAC Part 813)	☐ Storage	☐ Inert Only (exec. chem. & putrescible)
☐ Development/90 days (35 IAC Part 807)	☐ Incinerator	☐ Used Oil
☐ Operating/45 days (35 IAC Part 807)	☐ Composting	☐ Potentially Infectious Medical Waste
☐ Operating/90 days (35 IAC Part 848)	☐ Recycling/Reclamation	☐ Landscape/Yard Waste
☐ Supplemental/90 days (35 IAC Part 807)	☐ Used Tire Storage/Processing Facility	☐ Used Tires
☐ Permit Transfer/90 days (35 IAC Part 807)	☐ Other (Specify)	☒ Other (Specify)
☐ Renewal of Experimental Permit (35 IAC Part 807)		

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This Agency is authorized to require this information under Section 4 and Title X of the Environmental Protection Act (415 ILCS 5/4, 5/39). Failure to disclose this information may result in: a civil penalty of not to exceed $50,000 for the violation and an additional civil penalty of not to exceed $10,000 for each day during which the violation continues (415 ILCS 5/42).

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III. Description of this Permit Request: (Note: The box below will expand as needed)

Application for a Significant Modification to modify the final cover of the Landfill 33 Disposal Facility (Landfill 33).

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IV. Completeness Requirements

1. Have all required public notice letters been mailed in accordance with the LPC-PA16 instructions? Yes ✓ No ○ N/A ○

(If so, provide a list of those recipients of the required public notice letters for Illinois EPA retention. Such retention shall not imply any Illinois EPA review and/or confirmation of the list.)

Public Notice Recipients

Name	Title	Street Address	P.O. Box	City	State	Zip Code
Kyle McCarter	Senator - District 54	310 Gallatin		Vandalia	IL	62471
Charles Meier	Representative - District 108	121 Broadway, Suite 1		Highland	IL	62249
Bryan Kibler	State's Attorney	120 West Jefferson, Suite 201		Effingham	IL	62401
James Niemann	County Chairman	101 North 4th Street, Suite 301		Effingham	IL	62401
Kerry Hirtzel	County Clerk	101 North 4th Street, Suite 201		Effingham	IL	62401
Effingham City Clerk	City Clerk	201 East Jefferson - First Floor		Effingham	IL	62401

	Yes	No	N/A
2. a. Is the Siting Certification Form (LPC-PA8) completed and enclosed?	○	✓	○
b. Is siting approval currently under litigation?	○	✓	○
3. a. Is a closure, and if necessary a post-closure plan covering these activities being submitted, or	○	✓	○
b. has one already been approved?	✓	○	○
If yes, provide the permit number: 1995-231-LFM			
4. a. For operating waste disposal sites, only: Has any employee, owner, operator, officer or director of the owner or operator had a prior conduct certification denied, canceled or revoked?	○	✓	○
b. Have you included a demonstration of how you comply or intend to comply with 35 Ill. Adm. Code 745?	○	✓	○
5. a. For waste disposal sites, only: Is the property for the facility held in a beneficial trust?	○	✓	○
b. If yes, is a beneficial trust certification form (LPC-PA9) completed and enclosed?	○	○	✓
6. a. Does the application contain information or proposals regarding the hydrogeology; groundwater monitoring, modeling or classification; a groundwater impact assessment; or vadosezone monitoring for which you are requesting approval?	✓	○	○
b. If yes, have you submitted a third copy of the application (4 total) and supporting documents?	✓	○	○

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7. Has the required 39(i) certification been attached? A 39(i) certification must be submitted with information concerning the following persons or entities:

a. the owner of the business entity applying for the permit;	✓	○	○
b. the operator of the business entity applying for the permit;	✓	○	○
c. each employee or officer of the owner or operator who signed the permit application or has managerial authority at the site; and	✓	○	○
d. any additional owner, operator, or officer or employee of the owner or operator from whom a certification is requested by the Illinois EPA, including any officer or employee who will be responsible for overseeing or implementing regulated activities governed by the permit.	✓	○	○

If no, then complete this certification as indicated.

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V. Signatures:

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Original signatures are required. Signature stamps or applications transmitted electronically or by FAX are not acceptable.

All applications shall be signed by the person designated below as a duly authorized representative of the owner an/or operator. A printed name for each signature should also be provided.

Corporation - By a principal executive officer of the level of vice-president or above.
Partnership or Sole Proprietorship - By a general partner or the proprietor, respectively.
Government - By either a principal executive officer or a ranking elected official.

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A person is a duly authorized representative of the owner and operator only if:

1. They meet the criteria above or the authorization has been granted in writing by a person described above; and
2. Is submitted with this application (a copy of a previously submitted authorization can be used).

I hereby affirm that all information contained in this application is true and accurate to the best of my knowledge and belief. I further swear that I am a duly authorized representative of the owner/operator and I am authorized to sign this permit application form.

Any person who knowingly makes a false, fictitious, or fraudulent material statement, orally or in writing, to the Illinois EPA commits a Class 4 felony. A second or subsequent offense after conviction is a Class 3 felony. (415 ILCS 5/44(h))

Lori L. Martin
Owner Signature

3-1-19
Date

LORI L. MARTIN
Printed Name

executor
Title

Notary: Subscribed and Sworn before me

this 1st day of March 2019.

OFFICIAL SEAL
LISA M BOHNHOFF
NOTARY PUBLIC - STATE OF ILLINOIS
MY COMMISSION EXPIRES:06/14/22

My commission expires on: 6-14-22

Lisa M Bohnhoff
Signature & Stamp/Seal of Notary Public

Operator Signature

3/1/19
Date

BRIAN D HAYES
Printed Name

Pres
Title

Notary: Subscribed and Sworn before me

this 1st day of March 2019.

OFFICIAL SEAL
LISA M BOHNHOFF
NOTARY PUBLIC - STATE OF ILLINOIS
MY COMMISSION EXPIRES:06/14/22

My commission expires on: 6-14-22

Lisa M Bohnhoff
Signature & Stamp/Seal of Notary Public

Engineer's Name: Douglas W. Mauntel
Engineer's Ttle: Project Engineer

Company: Andrews Engineering, Inc.
Registration Number: 062-054530

Street Address: 3300 Ginger Creek Drive
PO Box:

City: Springfield
State: IL
Zip Code: 62711
Phone: 217-787-2334

Email Address: dwmauntel@andrews-eng.com

License Expiration Date: 11/30/19

Signature:

Date: 4/4/19

DOUGLAS W. MAUNTEL
062-054530
REGISTERED
PROFESSIONAL
ENGINEER
OF
ILLINOIS

Professional Engineer's Seal

Illinois Environmental Protection Agency

Bureau of Land • 1021 North Grand Avenue East • P.O. Box 19276 • Springfield • Illinois • 62794-9276

Notice of Application for Permit to Manage Waste (LPC-PA16)

Kyle McCarter
Senate District 54
310 W Gallatin
Vandalia, IL 62471

Date: April 5, 2019

To Elected Officials and Concerned Citizens:

The purpose of this notice is to inform you that a permit application has been submitted to the Illinois EPA, Bureau of Land, for a solid waste project described below. You are not obligated to respond to this notice, however, if you have any comments, please submit them in writing to the Bureau of Land, Attn: Permit Section, at the above address, or contact the Permit Section at 217/524-3300 within 21 days.

The permit application, which is identified below, is for a project described at the bottom of this page.

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Site Identification:

Site Name: Landfill 33 IEPA ID Number: 0498100007

Street Address: 1713 South Willow P.O. Box: 703

City: Effingham State: IL Zip Code: 62401-4065 County: Effingham

TYPE OF PERMIT SUBMISSIONS:	TYPE OF FACILITY:	TYPE OF WASTE:
☐ New Landfill	☑ Landfill	☑ General Municipal Refuse
☐ Landfill Expansion	☐ Land Treatment	☐ Hazardous
☐ First Significant Modification	☐ Transfer Station	☑ Special (Non-Hazardous)
☐ Significant Modification to Operate	☐ Treatment Facility	☐ Chemical Only (exec. putrescible)
☑ Other Significant Modification	☐ Storage	☐ Inert Only (exec. chem. & putrescible)
☐ Renewal of Landfill	☐ Incinerator	☐ Used Oil
☐ Development	☐ Composting	☐ Solvents
☐ Operating	☐ Recycling/Reclamation	☐ Landscape/Yard Waste
☐ Supplemental	☐ Other (Specify)	☐ Other (Specify)
☐ Transfer		
☐ Name Change		
☐ Generic		

Description of Project:

Application requesting final cover modification.

IL 532-0334
LPC 040 Rev.3/2013

This Agency is authorized to require this information under Section 4 and Title X of the Environmental Protection Act (415 ILCS 5/4, 5/39). Failure to disclose this information may result in: a civil penalty of not to exceed $50,000 for the violation and an additional civil penalty of not to exceed $10,000 for each day during which the violation continues (415 ILCS 5/42). This form has been approved by the Forms Management Center.

Illinois Environmental Protection Agency

R11

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39(i) Certification for Operating a Waste Management Facility

Pursuant to 415 ILCS 5/39(i), prior to issuing any RCRA permit, or any permit for a waste storage site, sanitary landfill, waste disposal site, waste transfer station, waste treatment facility, waste incinerator, clean construction or demolition debris fill operation, or used tire storage site, the Illinois EPA must conduct an evaluation of the prospective owner's or operator's prior experience in waste management operations, clean construction or demolition debris fill operations, and tire storage site management. As part of that evaluation please complete and submit this form with your permit application.

This form may be completed online and saved locally before printing, signing and submitting it to the Illinois EPA at the address below. If the form is completed manually, please type or print clearly.

Illinois Environmental Protection Agency
Division of Land Pollution Control - #33
39(i) Certification
1021 North Grand Avenue East
P.O. Box 19276
Springfield, IL 62794-9276

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PERMIT SECTION

I. Applicant Information

Site Name: Landfill 33, LTD   IEPA BOL No.: 0498100007

Site Address: 1713 South Willow Street

City: Effingham   State: IL   Zip Code: 62401

Permit Numbers (if applicable): 1995-231-LFM

Owner

Owner Name: Wendt Family Trust;R.Deibel, Landfill33LTD

Street Address: 715 S. First

City: Effingham   State: IL   Zip: 62401

Operator

Operator Name: Landfill 33, LTD

Street Address: PO Box 703

City: Effingham   State: IL   Zip: 62401

II. Officers and Employees with Site Responsibility

A. Officers: List the name and title of all officers of the owner or operator that will have personal involvement or active participation in the operation or management of the site or facility for which the application is submitted.

Name	Title
Lori Wendt	Executer of Wendt Family Trust
Brian Hayes	President

B. Employees: List the name and title of each employee of the owner or operator that will have personal involvement or active participation in the overall operation or management of the site or facility for which the application is submitted (e.g. site managers, site engineers, and other persons who direct or control the overall day-to-day management of the operation, but not persons whose duties are exclusively limited to equipment operation, labor, or similar non-managerial functions).

Name	Title
Brian Hayes	Operator

III. Owner, Operator, Officer, and Employee Information

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A. Prior Conduct Identification

The applicant must answer each of the following questions for every owner or operator, and for any officer or employee identified under Section II. If the answer to any of the following questions is affirmative, the applicant must complete an Attachment A for each person for whom the answer is affirmative and include a copy of each final administrative or judicial determination that required an affirmative response. If the information for each owner, operator, officer, and employee has not changed since the applicant's last submission of a 39(i) certification, the applicant can skip to Section III(C), below.

1) Has there been a finding that any person named in Section II violated federal, State, or local laws, regulations, standards, or ordinances in the operation of one or more waste management facilities or sites, clean construction or demolition debris fill operation facilities or sites, or tire storage sites? ○ Yes ✓ No

2) Has any person named in Section II ever been convicted in this or another State of any crime which is a felony under the laws of this State, or convicted of a felony in a federal court; or convicted in this or another state or federal court of any of the following crimes: forgery, official misconduct, bribery, perjury, or knowingly submitting false information under any environmental law, regulation, or permit term or condition? ○ Yes ✓ No

3) Has there been a finding against any person named in Section II of gross carelessness or incompetence in handling, storing, processing, transporting or disposing of waste, clean construction or demolition debris, or used or waste tires, or a finding of gross carelessness or incompetence in using clean construction or demolition debris as fill? ○ Yes ✓ No

B. Pending Proceedings

The applicant must answer each of the following questions for every owner or operator, and for any officer or employee identified in Section II. If the answer to any of the following questions is affirmative, the applicant must complete an Attachment A for each person for whom the answer is affirmative and provide information identified in Attachment A regarding the pending proceeding.

1. Is there any proceeding currently pending against any person named in Section II that could result in a conviction or finding described in subsection A, above? ○ Yes ✓ No

2. Is there any proceeding currently pending against any person named in Section II that could result in the reversal of a conviction or finding described in subsection A, above? ○ Yes ✓ No

C. Prior Application Information

If (i) the applicant has previously submitted the Attachments required pursuant to subsections A and B above and (ii) the Attachments previously submitted are still complete, true, and correct, then the applicant does not need to include Attachments with this submission if fhe following box is checked:

☐ By checking this box, I affirm that the Attachments previously submitted are still complete, true, and correct and wish to incorporate them into this Certification.

If the above box is checked, identify the application that contains the previously submitted Attachments that are complete, true, and correct.

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Authorization for Release of Information

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This Certification must be signed by an officer of the applicant.

The undersigned authorizes any representative of the Illinois Environmental Protection Agency bearing this release to obtain any information from the Illinois State Police pertaining to the criminal records of the applicant and hereby directs the Illinois State Police to release such information upon request of the bearer. The undersigned authorizes a review of and full disclosure of all records, or any part thereof, concerning the applicant's criminal records by and to a duly authorized agent of the Illinois Environmental Protection Agency, whether the records are of public, private, or confidential nature. The intent of this authorization is to give consent for full and complete disclosure of the applicant's criminal records.

The undersigned fully understands that any information which is developed directly or indirectly, in whole or in part, as a result of this authorization will be considered in determining whether a permit shall be issued by the Illinois Environmental Protection Agency under the Environmental Protection Act [415 ILCS 5]. The undersigned further agrees to release the Illinois State Police and the Illinois Environmental Protection Agency, its agents and designees under this release, from any and all liability which may be incurred as a result of compliance with this authorization for release of information.

Certification Statements

I certify under penalty of law that the information submitted, including information on any Attachments submitted as part of or incorporated into this Certification, is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Any person who knowingly makes a false, fictitious, or fraudulent material statement, orally or in writing, to the Illinois EPA commits a Class 4 felony. A second or subsequent offense after conviction is a Class 3 felony. (415 ILCS 5/44(h))

[signature]	3/6/19
Signature of Applicant Officer	Date
BRIAN D. HAYES	PRESIDENT
Printed Name	Title

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Attachment A (1 of 1)

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This Attachment must be completed for each owner or operator, and for each officer or employee identified in Section II, for whom one or more affirmative responses were included in Section III.

Name: ______________________ Title: ______________________

Status: ☐ Owner ☐ Operator ☐ Officer ☐ Employee (check all that apply)

A. Prior Findings or Convictions

1. Has there been a finding that the person named above violated federal, State, or local laws, regulations, standards, or ordinances in the operation of one or more waste management facilities or sites, clean construction or demolition debris fill operation facilities or sites, or tire storage sites? ○ Yes ○ No
2. Has the person named above ever been convicted in this or another State of any crime which is a felony under the laws of this State, or convicted of a felony in a federal court; or convicted in this or another state or federal court of any of the following crimes: forgery, official misconduct, bribery, perjury, or knowingly submitting false information under any environmental law, regulation, or permit term or condition? ○ Yes ○ No
3. Has there been a finding against the person named above of gross carelessness or incompetence in handling, storing, processing, transporting or disposing of waste, clean construction or demolition debris, or used or waste tires, or a finding of gross carelessness or incompetence in using clean construction or demolition debris as fill? ○ Yes ○ No

If the answer to any of the above questions is Yes, attach a copy of each final administrative or judicial determination that required an affirmative response.

B. Pending Proceedings

Is there any proceeding currently pending that could result in one of the following:

1. A conviction or finding described in subsection A, above? ○ Yes ○ No
2. The reversal of a conviction or finding described in subsection A, above? ○ Yes ○ No

If the answer to any of the above questions is Yes, please provide information about the pending proceeding, including the parties involved, the adjudicating body, the docket number, the nature of the proceeding, and the status. The box below will expand as needed. Attach additional sheets if necessary.

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Illinois Environmental Protection Agency

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39(i) Certification for Operating a Waste Management Facility

Pursuant to 415 ILCS 5/39(i), prior to issuing any RCRA permit, or any permit for a waste storage site, sanitary landfill, waste disposal site, waste transfer station, waste treatment facility, waste incinerator, clean construction or demolition debris fill operation, or used tire storage site, the Illinois EPA must conduct an evaluation of the prospective owner's or operator's prior experience in waste management operations, clean construction or demolition debris fill operations, and tire storage site management. As part of that evaluation please complete and submit this form with your permit application.

This form may be completed online and saved locally before printing, signing and submitting it to the Illinois EPA at the address below. If the form is completed manually, please type or print clearly.

Illinois Environmental Protection Agency
Division of Land Pollution Control - #33
39(i) Certification
1021 North Grand Avenue East
P.O. Box 19276
Springfield, IL 62794-9276

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I. Applicant Information

Site Name: Landfill 33, LTD IEPA BOL No.: 0498100007

Site Address: 1713 South Willow Street

City: Effingham State: IL Zip Code: 62401

Permit Numbers (if applicable): 1995-231-LFM

Owner

Owner Name: Wendt Family Trust;Landfill 33,LTD

Street Address: 715 S. First

City: Effingham State: IL Zip: 62401

Operator

Operator Name: Landfill 33, LTD

Street Address: 703

City: Effingham State: IL Zip: 62401

II. Officers and Employees with Site Responsibility

A. Officers: List the name and title of all officers of the owner or operator that will have personal involvement or active participation in the operation or management of the site or facility for which the application is submitted.

Name	Title
Lori Martin	Executer of Wendt Family Trust

B. Employees: List the name and title of each employee of the owner or operator that will have personal involvement or active participation in the overall operation or management of the site or facility for which the application is submitted (e.g. site managers, site engineers, and other persons who direct or control the overall day-to-day management of the operation, but not persons whose duties are exclusively limited to equipment operation, labor, or similar non-managerial functions).

Name	Title
Brian Hayes	President

III. Owner, Operator, Officer, and Employee Information

R16

A. Prior Conduct Identification

The applicant must answer each of the following questions for every owner or operator, and for any officer or employee identified under Section II. If the answer to any of the following questions is affirmative, the applicant must complete an Attachment A for each person for whom the answer is affirmative and include a copy of each final administrative or judicial determination that required an affirmative response. If the information for each owner, operator, officer, and employee has not changed since the applicant's last submission of a 39(i) certification, the applicant can skip to Section III(C), below.

1) Has there been a finding that any person named in Section II violated federal, State, or local laws, regulations, standards, or ordinances in the operation of one or more waste management facilities or sites, clean construction or demolition debris fill operation facilities or sites, or tire storage sites? ○ Yes ✓ No

2) Has any person named in Section II ever been convicted in this or another State of any crime which is a felony under the laws of this State, or convicted of a felony in a federal court; or convicted in this or another state or federal court of any of the following crimes: forgery, official misconduct, bribery, perjury, or knowingly submitting false information under any environmental law, regulation, or permit term or condition? ○ Yes ✓ No

3) Has there been a finding against any person named in Section II of gross carelessness or incompetence in handling, storing, processing, transporting or disposing of waste, clean construction or demolition debris, or used or waste tires, or a finding of gross carelessness or incompetence in using clean construction or demolition debris as fill? ○ Yes ✓ No

B. Pending Proceedings

The applicant must answer each of the following questions for every owner or operator, and for any officer or employee identified in Section II. If the answer to any of the following questions is affirmative, the applicant must complete an Attachment A for each person for whom the answer is affirmative and provide information identified in Attachment A regarding the pending proceeding.

1. Is there any proceeding currently pending against any person named in Section II that could result in a conviction or finding described in subsection A, above? ○ Yes ✓ No

2. Is there any proceeding currently pending against any person named in Section II that could result in the reversal of a conviction or finding described in subsection A, above? ○ Yes ✓ No

C. Prior Application Information

If (i) the applicant has previously submitted the Attachments required pursuant to subsections A and B above and (ii) the Attachments previously submitted are still complete, true, and correct, then the applicant does not need to include Attachments with this submission if fhe following box is checked:

☐ By checking this box, I affirm that the Attachments previously submitted are still complete, true, and correct and wish to incorporate them into this Certification.

If the above box is checked, identify the application that contains the previously submitted Attachments that are complete, true, and correct.

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Authorization for Release of Information

R17

This Certification must be signed by an officer of the applicant.

The undersigned authorizes any representative of the Illinois Environmental Protection Agency bearing this release to obtain any information from the Illinois State Police pertaining to the criminal records of the applicant and hereby directs the Illinois State Police to release such information upon request of the bearer. The undersigned authorizes a review of and full disclosure of all records, or any part thereof, concerning the applicant's criminal records by and to a duly authorized agent of the Illinois Environmental Protection Agency, whether the records are of public, private, or confidential nature. The intent of this authorization is to give consent for full and complete disclosure of the applicant's criminal records.

The undersigned fully understands that any information which is developed directly or indirectly, in whole or in part, as a result of this authorization will be considered in determining whether a permit shall be issued by the Illinois Environmental Protection Agency under the Environmental Protection Act [415 ILCS 5]. The undersigned further agrees to release the Illinois State Police and the Illinois Environmental Protection Agency, its agents and designees under this release, from any and all liability which may be incurred as a result of compliance with this authorization for release of information.

Certification Statements

I certify under penalty of law that the information submitted, including information on any Attachments submitted as part of or incorporated into this Certification, is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Any person who knowingly makes a false, fictitious, or fraudulent material statement, orally or in writing, to the Illinois EPA commits a Class 4 felony. A second or subsequent offense after conviction is a Class 3 felony. (415 ILCS 5/44(h))

Lori Martin	3/7/19
Signature of Applicant Officer	Date
Lori Martin	Executer of Wendt Family Trust
Printed Name	Title

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Attachment A (1 of 1)

R18

This Attachment must be completed for each owner or operator, and for each officer or employee identified in Section II, for whom one or more affirmative responses were included in Section III.

Name: ______________________ Title: ______________________

Status: ☐ Owner ☐ Operator ☐ Officer ☐ Employee (check all that apply)

A. Prior Findings or Convictions

1. Has there been a finding that the person named above violated federal, State, or local laws, regulations, standards, or ordinances in the operation of one or more waste management facilities or sites, clean construction or demolition debris fill operation facilities or sites, or tire storage sites? ○ Yes ○ No
2. Has the person named above ever been convicted in this or another State of any crime which is a felony under the laws of this State, or convicted of a felony in a federal court; or convicted in this or another state or federal court of any of the following crimes: forgery, official misconduct, bribery, perjury, or knowingly submitting false information under any environmental law, regulation, or permit term or condition? ○ Yes ○ No
3. Has there been a finding against the person named above of gross carelessness or incompetence in handling, storing, processing, transporting or disposing of waste, clean construction or demolition debris, or used or waste tires, or a finding of gross carelessness or incompetence in using clean construction or demolition debris as fill? ○ Yes ○ No

If the answer to any of the above questions is Yes, attach a copy of each final administrative or judicial determination that required an affirmative response.

B. Pending Proceedings

Is there any proceeding currently pending that could result in one of the following:

1. A conviction or finding described in subsection A, above? ○ Yes ○ No
2. The reversal of a conviction or finding described in subsection A, above? ○ Yes ○ No

If the answer to any of the above questions is Yes, please provide information about the pending proceeding, including the parties involved, the adjudicating body, the docket number, the nature of the proceeding, and the status. The box below will expand as needed. Attach additional sheets if necessary.

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A

IT SECTION

2

Attachment 2

Revised Waste Capacity Calculations

R21

ANDREWS ENGINEERING

3300 GINGER CREEK DRIVE, SPRINGFIELD, IL 62711-7233

AUTOCAD CIVIL 3D 2018

VOLUME CALCULATION WORKSHEET

Surface 1: **Permit Waste**

File Location:

Surface 2: **Proposed Waste**

File Location:

AEI Project Name:	Calculated by:	Date:
Landfill 33, LTD	MPN	2/15/2019

AEI Project Number:	Drawing Path:
180130/0006	..\..\..\2018\Final Cover Modification\EXHIBIT A.dwg

Reason for calculation:

Airspace Loss

	Cut: (cu.yd.)	Fill: (cu.yd.)	Net: (cu.yd.)
Composite Method:	22,356	0	22,356

Notes:

40,000 CY lost in permitting (1.20 million CY sited vs. 1.16 million permitted)

22,350 CY lost in construction

Total lost equates to 62,350 CY

LEGEND

- PROPERTY BOUNDARY (FACILITY BOUNDARY)
- WASTE BOUNDARY
- CELL BOUNDARY
- AIRSPACE LOSS AND SETTLEMENT AREAS

VOLUME CALCULATIONS	
AREA 1 - CLOSURE SETTLEMENT	18,185 CY
AREA 2 - CELL 7	4,171 CY

NOTES

1. SITE FEATURES WERE BASED ON THE FLYOVER TAKEN ON MARCH 30, 2016 BY SIDWELL COMPANY.
2. FOR CLARITY, NOT ALL SITE FEATURES ARE SHOWN.

N

0 150 300 600
SCALE: IN FEET

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APPROVED BY: STE | DESIGNED BY: STE | DRAWN BY: MPN

NO.	DATE	REVISION DESCRIPTION	BY

AIRSPACE LOSS

PREPARED FOR
LANDFILL 33, LTD.
EFFINGHAM COUNTY, ILLINOIS

DATE: FEBRUARY 2019
PROJECT ID: 180130/0006
SHEET NUMBER:
EXHIBIT A

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R23

ANDREWS ENGINEERING

3300 GINGER CREEK DRIVE, SPRINGFIELD, IL 62711-7233

AUTOCAD CIVIL 3D 2018

VOLUME CALCULATION WORKSHEET

Surface 1: **Permit Waste**

File Location:

Surface 2: **Proposed Waste**

File Location:

AEI Project Name:	**Calculated by:**	**Date:**
Landfill 33, LTD	MPN	2/15/2019

AEI Project Number:	**Drawing Path:**
180130/0006	..\..\..\Volume Calculations\2018\Top Expansion\S5.dwg

Reason for calculation:

Vertical Expansion

	Cut: (cu.yd.)	**Fill: (cu.yd.)**	**Net: (cu.yd.)**
Composite Method:	0	483,164	483,164

Notes:

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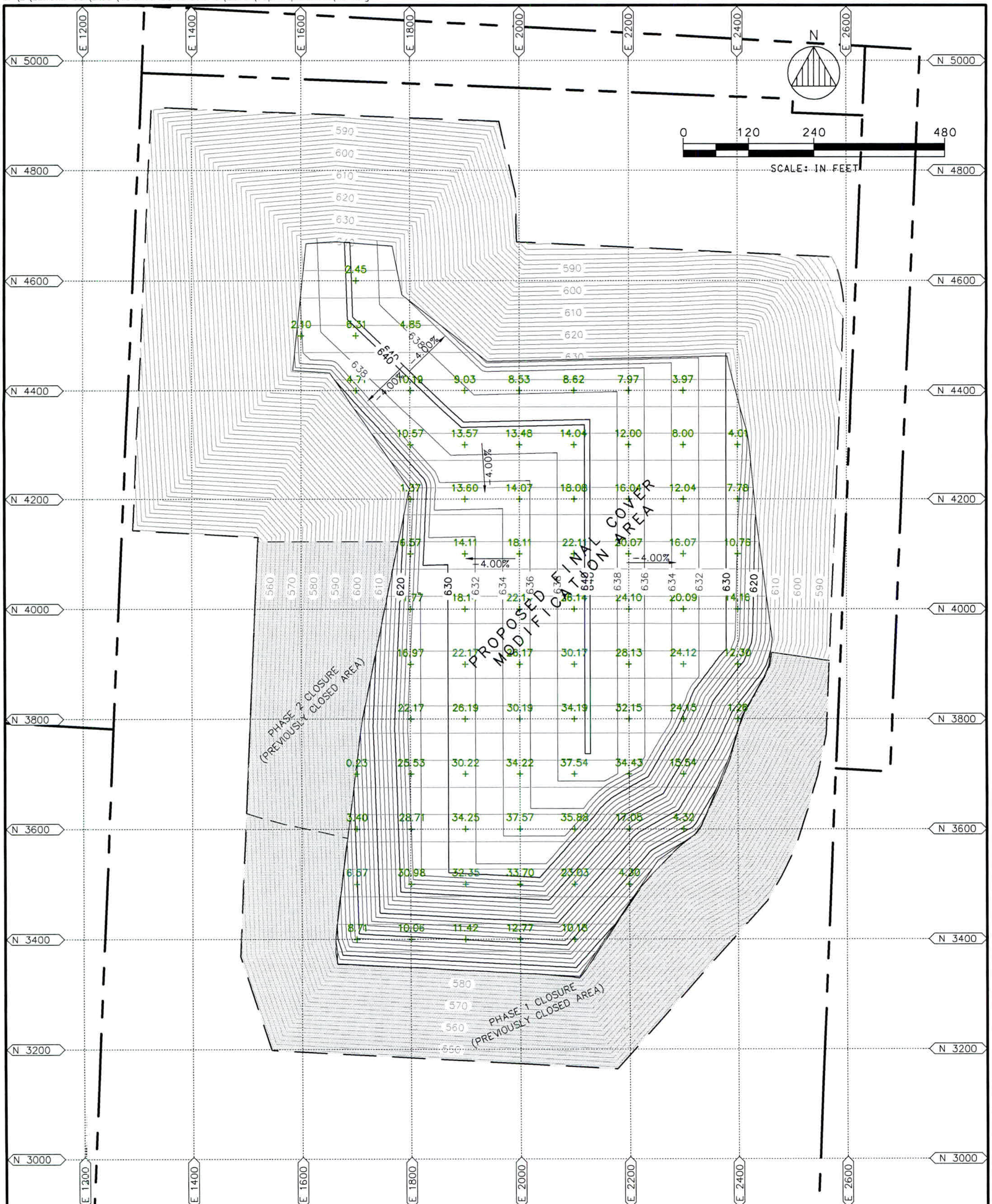
R24



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APPROVED BY: DWM | DESIGNED BY: DWM | DRAWN BY: MPN

PROPOSED FINAL COVER GRADES

PLANS PREPARED FOR
LANDFILL 33, LTD.
EFFINGHAM COUNTY, ILLINOIS

DATE: FEBRUARY 2019
PROJECT ID: 180130/0006
SHEET NUMBER: VOL-2

3

R26

Illinois
Environmental
Protection Agency

Bureau of Land
1021 North Grand Avenue East
Box 19276
Springfield, IL 62794-9276

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CERTIFICATION OF SITING APPROVAL (LPC-PA8)

Name of Applicant for Siting: Landfill 33, Ltd.

Address of Siting Applicant: 1713 South Willow Street, Effingham, Illinois 62401

Name of Site: Landfill 33 Site Number (if assigned): 0498100007

Site Information: Nearest Municipality: Effingham County: Effingham

Unit of local government from which siting approval was obtained: Effingham County

1. On November 19 (Date), 2018, the Effingham County Board (Governing body of county or municipality) of Effingham County (County or municipality) approved the site location suitability of Final Cover Modification of Landfill 33 (Name of site) as a new pollution control facility in accordance with Section 39.2 of the Illinois Environmental Protection Act, Ill. Rev. Stat., ch 111 ½, Section 1039.2.

2. The Illinois EPA may need to verify the information on this form, please indicate a person from the unit of local government ("siting authority") whom a representative from the Illinois EPA may contact regarding this approval:

   Bryan Kibler, Effingham County States Attorney, (217) 347-7741
   (Name, title, and telephone number)

3. Identify the type of activity(ies) for which local siting approval was obtained: waste storage (☐), sanitary landfill (☒), waste disposal (☒), waste transfer (☐), waste treatment (☐), waste incinerator (☐).

4. Did the local siting authority approve the acceptance of special waste? ☒ Yes ☐ No
   Did the local siting authority approve the acceptance of hazardous waste? ☐ Yes ☒ No

5. Attached to this certification is a true and correct statement of the legal descriptions of the site as it was approved by the aforementioned local siting authority. ☒ Yes ☐ No
   (Note: A legal description must be attached to this document, by the local siting authority, to make the application complete)

IL 532 1429
LPC 218 Rev. March 2003

This Agency is authorized to require this information under Illinois Revised Statutes, 1979, Chapter 111 1/2, Section 1039. Disclosure of this information is required under that Section. Failure to do so may prevent this form from being processed and could result in your application being denied. This form has been approved by the Forms Management Center.

6. Did the local siting authority impose any specific condition(s)? ☐ Yes ☒ No
If yes, is a copy of the conditions attached to this form? ☐ Yes ☒ No
(Note: These conditions are provided for information only to the Illinois EPA. The Illinois EPA is not obligated to monitor nor enforce local conditions.)

7. **This item is applicable only to landfills or disposal sites.**
Was a legal description of horizontal and vertical waste boundaries approved? (i.e., the waste envelop). ☐ Yes ☐ No ☒ N/A
See legal description of the new pollution control facility attached per #5.
If no, is there a maximum disposal capacity approved? (i.e., the waste envelop). ☐ Yes ☐ No ☒ N/A

If either of the questions under #7 above was answered yes, the legal description or maximum capacity must be attached to this form by the local siting authority to make the application complete.

8. The undersigned has been authorized by the Effingham County Board of
(siting authority of county or municipality)
Effingham County to execute this certification on their behalf.
(county or municipality)

Name: Bryan M. Kibler

Signature: Bryan M Kibler

Title: Effingham County States Attorney

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SUBSCRIBED AND SWORN TO BEFORE ME SEAL:

this 28th day of March, 2019

Julie R Reedy
Notary Public

ste\Effingham County - PA8

"Official Seal"
JULIE R REEDY
Notary Public, State of Illinois
My Commission Expires 7/7/19

RESOLUTION TO APPROVE LANDFILL EXPANSION

WHEREAS, Landfill 33, LTD has filed with the Effingham County Board a request for approval of a vertical expansion of an existing landfill facility; and

WHEREAS, a public hearing was held on January 20, 2000, at which hearing testimony and exhibits were presented concerning the said request; and

WHEREAS, the Effingham County Board has studied the proposal of Landfill 33 LTD and the testimony and exhibits received at the public hearing and further has made certain findings of fact relative thereto, which findings are attached hereto and incorporated herein by reference.

NOW, THEREFORE, BE IT RESOLVED by the members of the Effingham County Board in session on this 21 day of February, 2000, that the findings of fact are hereby adopted and that the request of the applicant Landfill 33 LTD for a vertical expansion of an existing landfill facility is hereby GRANTED.

PASSED AND APPROVED this 21ST day of FEBRUARY 2000.

AYES: 9

NAYES: 0

Leon Gobczynski, Chairman

ATTEST: Robert L. Behrman
Robert L. Behrman
Clerk and Recorder

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JUN 2 9 2000
IEPA-DLPC

CERTIFICATION

I, Robert L. Behrman the Clerk and Recorder of the County of Effingham, State of Illinois, do certify that I am the keeper of the books and records of Effingham County and that the foregoing is a true and correct copy of a resolution duly adopted by the Effingham County Board at a regular meeting duly convened and held on the 21ST day of FEBRUARY 2000.

Robert L. Behrman
Robert L. Behrman

EFFINGHAM COUNTY BOARD
FINDING OF FACT REGARDING REQUEST FOR EXPANSION OF EXISTING LANDFILL FACILITY SUBMITTED BY LANDFILL 33, LTD

The Effingham County Board, having heard and considered the testimony and exhibits received as evidence at a public hearing held January 20, 2000, makes the following findings of fact in relation to the request by Landfill 33 LTD for approval for a vertical expansion of an existing landfill facility, located in Effingham County, Illinois:

1. The facility's expansion, as proposed by Landfill 33 LTD, is necessary to accommodate the waste needs of Effingham County.

2. The proposed expansion of the existing facility's design, location and proposed operation are such that the public health, safety and welfare will be protected.

3. The proposed location of the expansion of the existing facility is not incompatible with the character of the surrounding area and the location is such that the effect on the value of surrounding property will be minimized.

4. The subject facility, including the proposed expansion, is located outside the boundary of the 100 year flood plain.

5. The plan of operations for the facility, including it's proposed expansion is designed to minimize the danger to the surrounding area from fire, spills or other operational accidents.

6. The traffic patterns to and from the existing facility are so designed as to minimize the impact on existing traffic flow.

7. The following criteria, appearing in Section 39.2 of the Environmental Protection Act, do not apply to the request of Landfill 33 LTD in this case:

a.) If the facility will be treating, staring or disposing of hazardous waste, an emergency response plan exists for the facility which includes notification, containment and evacuation procedures to be followed in case of accidental release; and

b.) If the facility will be located within a regulated recharge area, any applicable requirements specified by the Board for such areas have been met.

8. The planned expansion of the existing facility is consistent with county board solid waste management plan.

Effingham County Board

Attachment 3

Effingham County Resolution

ANDREWS ENGINEERING, INC.

March 7, 2018

Mr. Brian Hayes
Landfill 33, Ltd.
1713 South Willow
Effingham, Illinois 62401

Re: 0498100007 - Effingham County
Landfill 33 Ltd.
Siting Review

Dear Mr. Hayes:

As requested, Andrews Engineering, Inc. (AEI) has reviewed the documents related to the Vertical Expansion (Log No. 2001-248) at Landfill 33, LTD. in regards to options for additional airspace to allow time for siting a new landfill to the east of the existing facility.

The landfill, as currently permitted, is anticipated to reach capacity in late 2022 or 2023 depending upon tonnage received at the gate and compaction rates achieved at the facility. Initiation of operations at a new lateral waste unit/new landfill (new pollution control facility as defined by Section 39.2 of the Illinois Environmental Protection Act [Act]) will require approximately 4 to 5 years with siting, permitting and initial site development. Since the current facility is anticipated to close about the same time the new landfill could open, there is no buffer in the schedule to account for unforeseen changes. New landfills typically begin the siting process 7 to 8 years in advance of existing facility closure to provide time to transfer operations from one facility to another. Given that the schedule is very tight for permitting and development of a new landfill prior to the current landfill closing, options for extending the existing life of the current facility are being evaluated.

Based upon our review of the Siting Application (submitted to the Effingham County Board on September 27, 1999), the Effingham County Board Resolution to Approve the Landfill Expansion (approved February 21, 2000) and the Application for Vertical Expansion and Permit Renewal (Log No. 2001-248, submitted on June 29, 2001 and approved on June 28, 2002), it is the opinion of Andrews that the existing permitted contours of the landfill may be modified to allow for additional airspace, provided the maximum elevation of 644 mean sea level (MSL) is not exceeded.

Summary of findings:

1) The Effingham County Board Resolution to Approve the Landfill Expansion (approved February 21, 2000) is vague and not detailed. In 1999, Andrews requested a vertical expansion for an approximate 1.2 million additional cubic yards of waste and included a map with final contours. The Effingham County Board approved the request without any additional conditions related to waste volume, final contours or a maximum elevation.

2) In the permitting process with the Illinois Environmental Protection Agency (EPA), final cover contours were approved with a defined maximum elevation of 644 MSL and a waste volume of 1.16 million cubic yards of in-place waste capacity.

Mr. Brian Hayes
Landfill 33, Ltd.

March 7, 2018

Since the original Effingham County Board approval was vague and does not specify any additional conditions in regards to waste volume, final cover contours or a maximum elevation, and the Illinois EPA only gave a final absolute elevation as part of the permitting process, an argument could be made to the Effingham County Board that the final contours can be reconfigured where the peak elevation is closer to the center of the waste unit. Additional capacity may be achieved by flattening out the top of the landfill to stay below the maximum elevation of 644 MSL, and that no siting is necessary by the County. Approval of this additional capacity would require the Effingham County Board to complete a LPC-PA8 form (Siting Certification Form) and provide a letter to Landfill 33, LTD. stating that the airspace gained as part of the revisions to the final contours is within the originally approved conditions. Approximately 1.2 million cubic yards of airspace was approved during the siting process and was not meant to be absolute.

Once the letter and LPC-PA8 Form have been obtained from the Effingham County Board, an application will be filed with the IEPA to revise the final cover contours of the existing facility. This will allow Landfill 33, LTD. to provide sufficient landfill capacity at the existing facility until the new landfill is sited, permitted, and developed.

Please let us know if you have any questions or require further information. Thank you.

Sincerely,

Douglas W. Mauntel, PE
Director of Engineering Services

DWM:sjb

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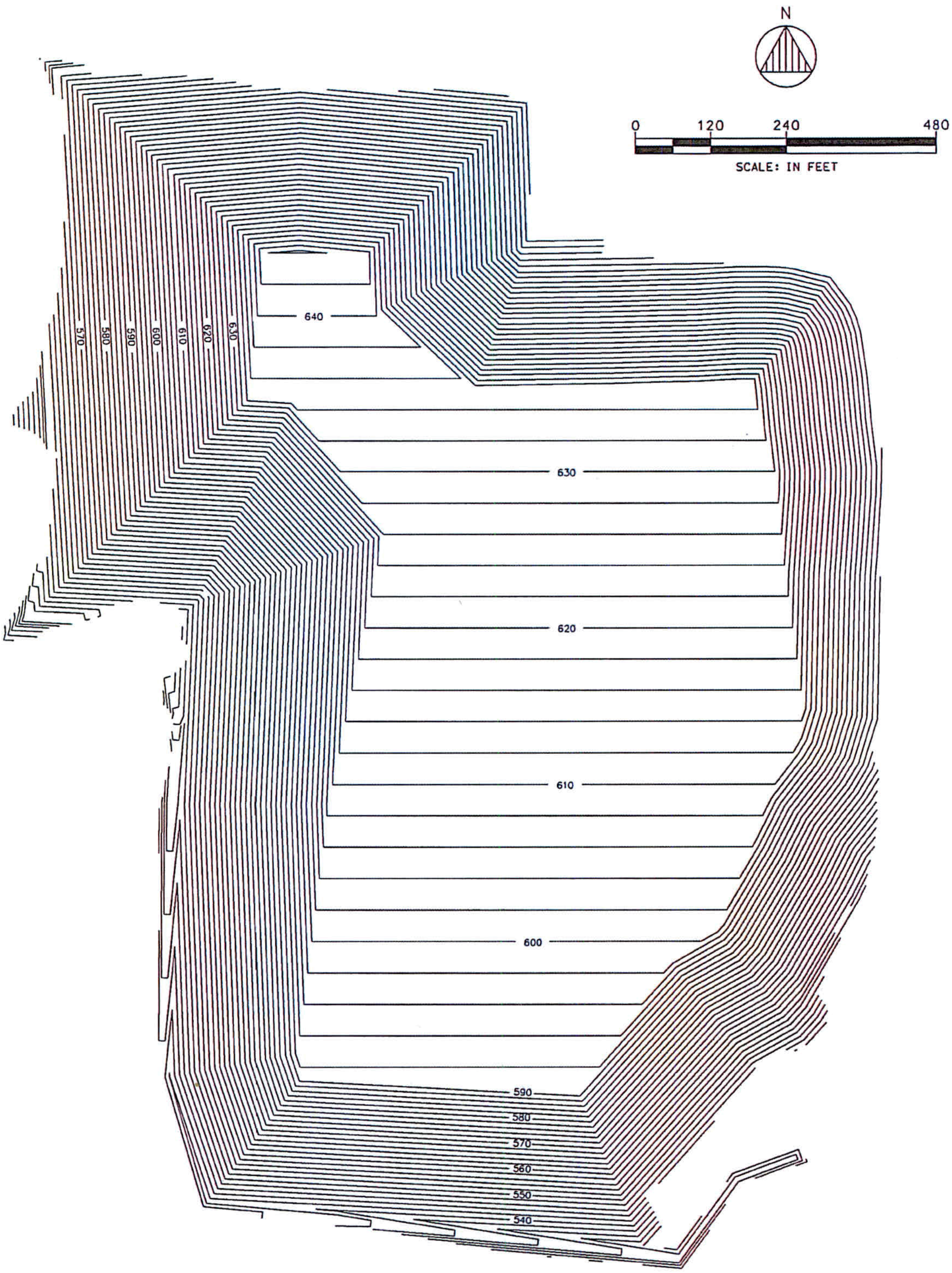

ANDREWS ENGINEERING, INC.
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PH (217) 787-2334 FAX (217) 787-9495
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PROFESSIONAL DESIGN ENGINEERING AND LAND SURVEYING FIRM #184-001541

APPROVED BY: DWM | DESIGNED BY: DWM | DRAWN BY: MPN

EXISTING PERMITTED FINAL COVER GRADES

PLANS PREPARED FOR

LANDFILL 33, LTD.

EFFINGHAM COUNTY, ILLINOIS

DATE: FEBRUARY 2018

PROJECT ID: 180130/0006

SHEET NUMBER: EX-1

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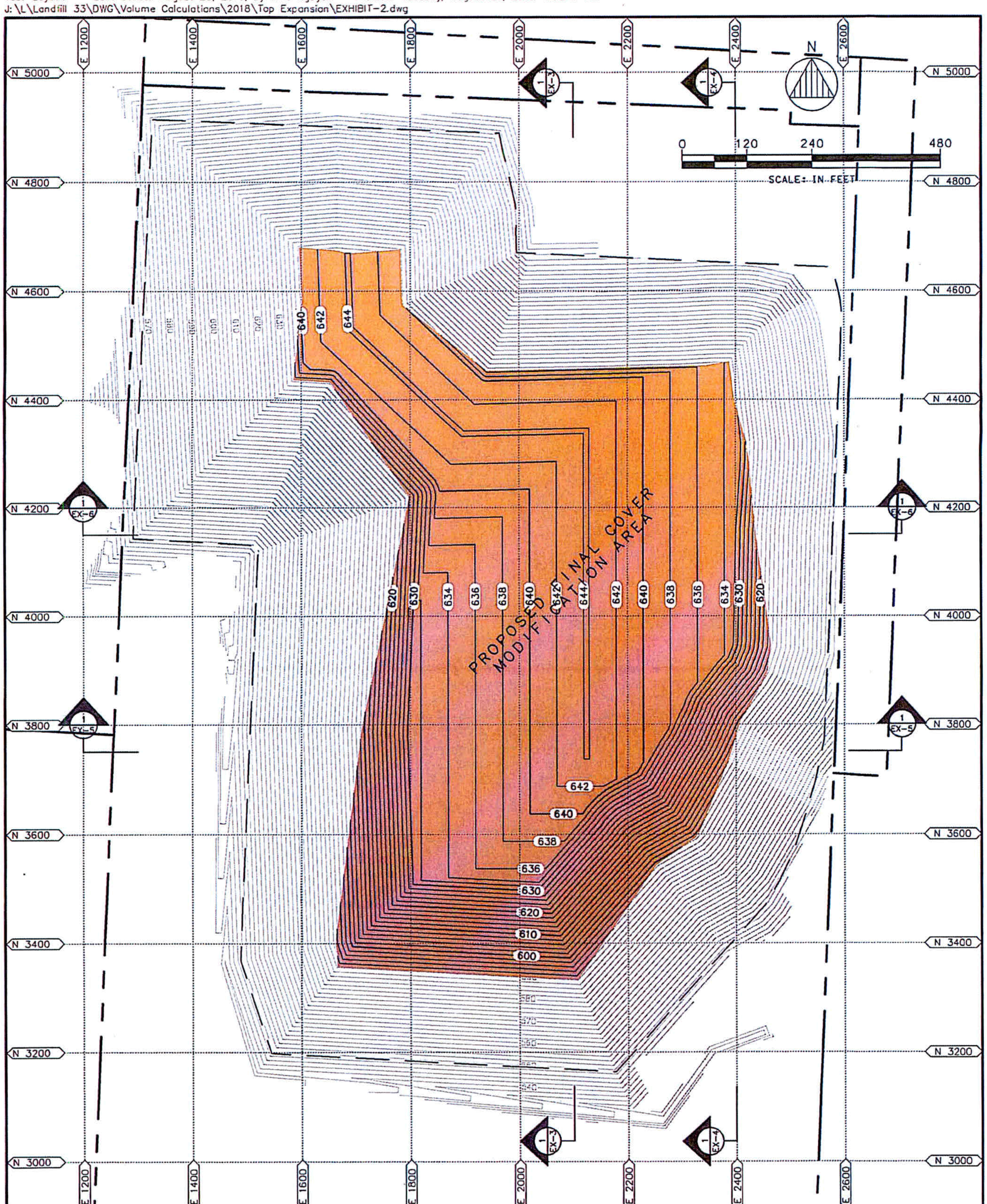

ANDREWS ENGINEERING, INC. 3300 GINGER CREEK DRIVE SPRINGFIELD, ILLINOIS 62711-7233 PH (217) 787-2334 FAX (217) 787-9495 PONTIAC, IL • LOMBARD, IL • INDIANAPOLIS, IN • WARRENTON, MO PROFESSIONAL DESIGN ENGINEERING AND LAND SURVEYING FIRM #184-001541	PROPOSED FINAL COVER GRADES	*DATE:* FEBRUARY 2018
	PLANS PREPARED FOR LANDFILL 33, LTD. EFFINGHAM COUNTY, ILLINOIS	*PROJECT ID:* 180130/0006
APPROVED BY: DWM | *DESIGNED BY:* DWM | *DRAWN BY:* MPN		*SHEET NUMBER:* EX-2

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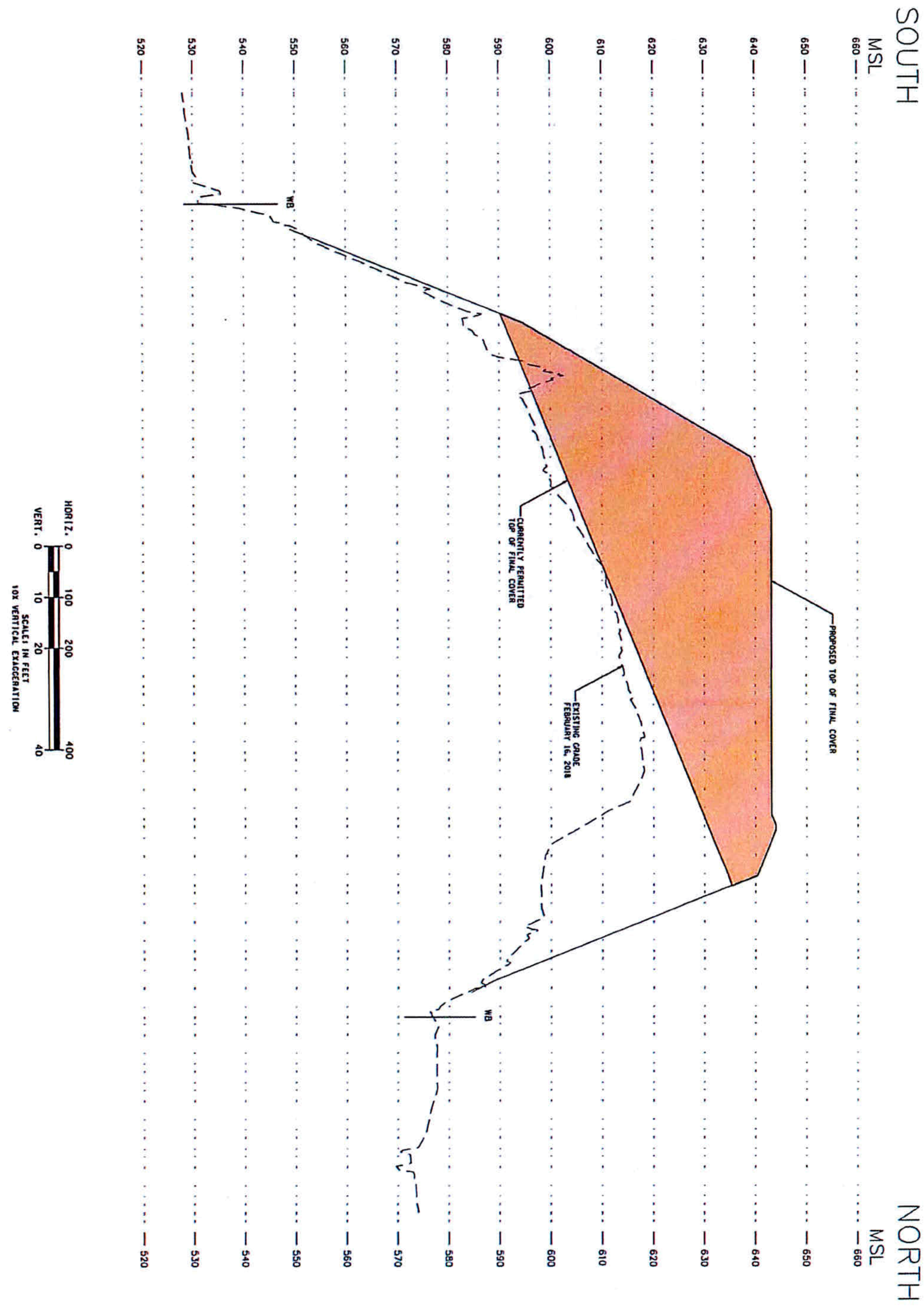

NO.	DATE	REVISION DESCRIPTION	BY

ANDREWS ENGINEERING, INC.
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PROFESSIONAL DESIGN ENGINEERING AND LAND SURVEYING FIRM #184-001541

APPROVED BY: DWM | DESIGNED BY: DWM | DRAWN BY: MPH

CROSS SECTION AT E 2,100

SIGNIFICANT MODIFICATION TO PERMIT FOR
LANDFILL 33, LTD.
EFFINGHAM COUNTY, ILLINOIS

DATE: AUGUST 2018
PROJECT ID: 180130/0006
SHEET NUMBER:
EX-3

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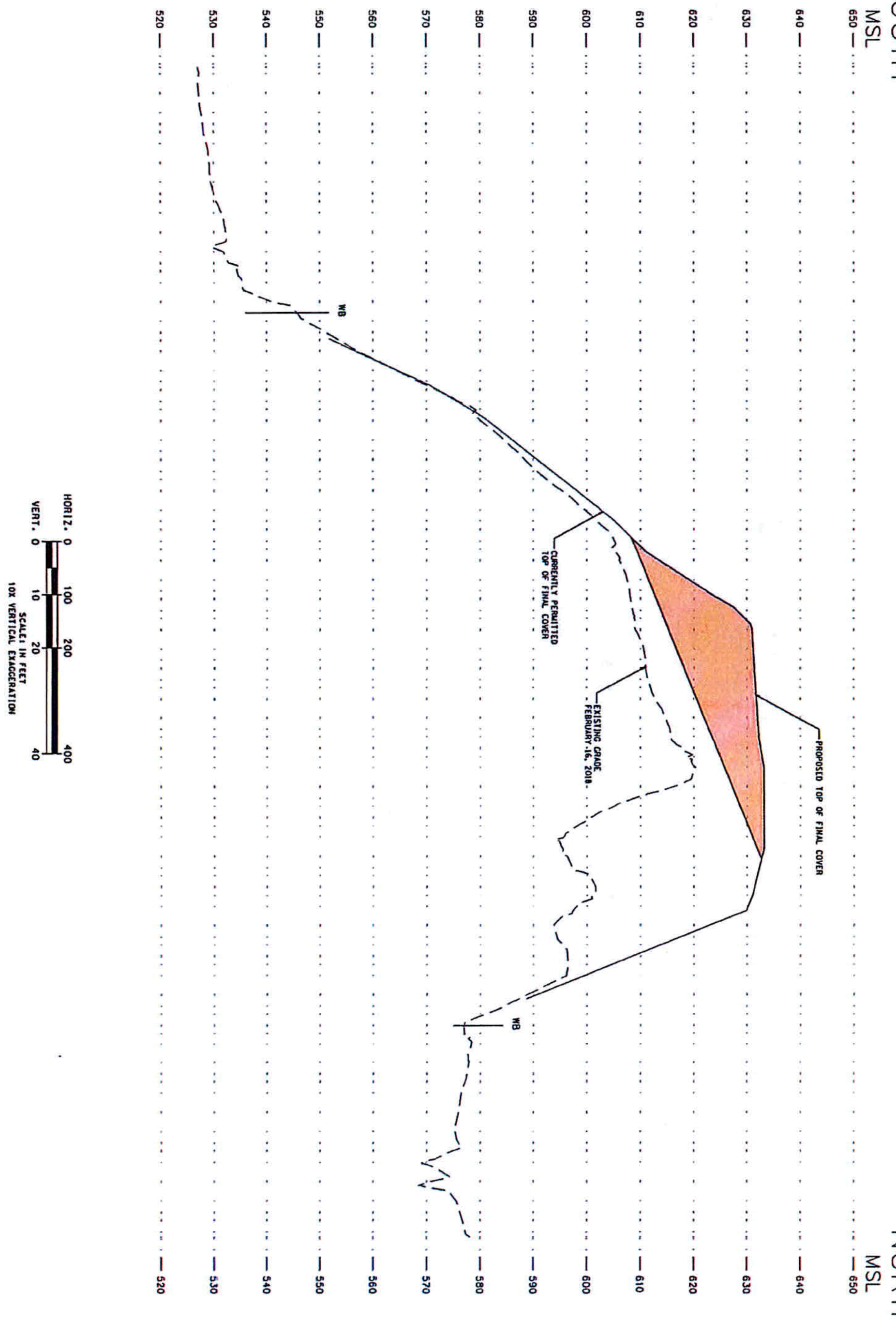

NO.	DATE	REVISION DESCRIPTION	BY

CROSS SECTION AT E 2,400

SIGNIFICANT MODIFICATION TO PERMIT FOR

LANDFILL 33, LTD.

EFFINGHAM COUNTY, ILLINOIS

ANDREWS ENGINEERING, INC.
3300 GINGER CREEK DRIVE
SPRINGFIELD, ILLINOIS 62711-7233
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APPROVED BY: DWM | DESIGNED BY: DWM | DRAWN BY: MPN

DATE: AUGUST 2018
PROJECT ID: 180130/0006
SHEET NUMBER: EX-4

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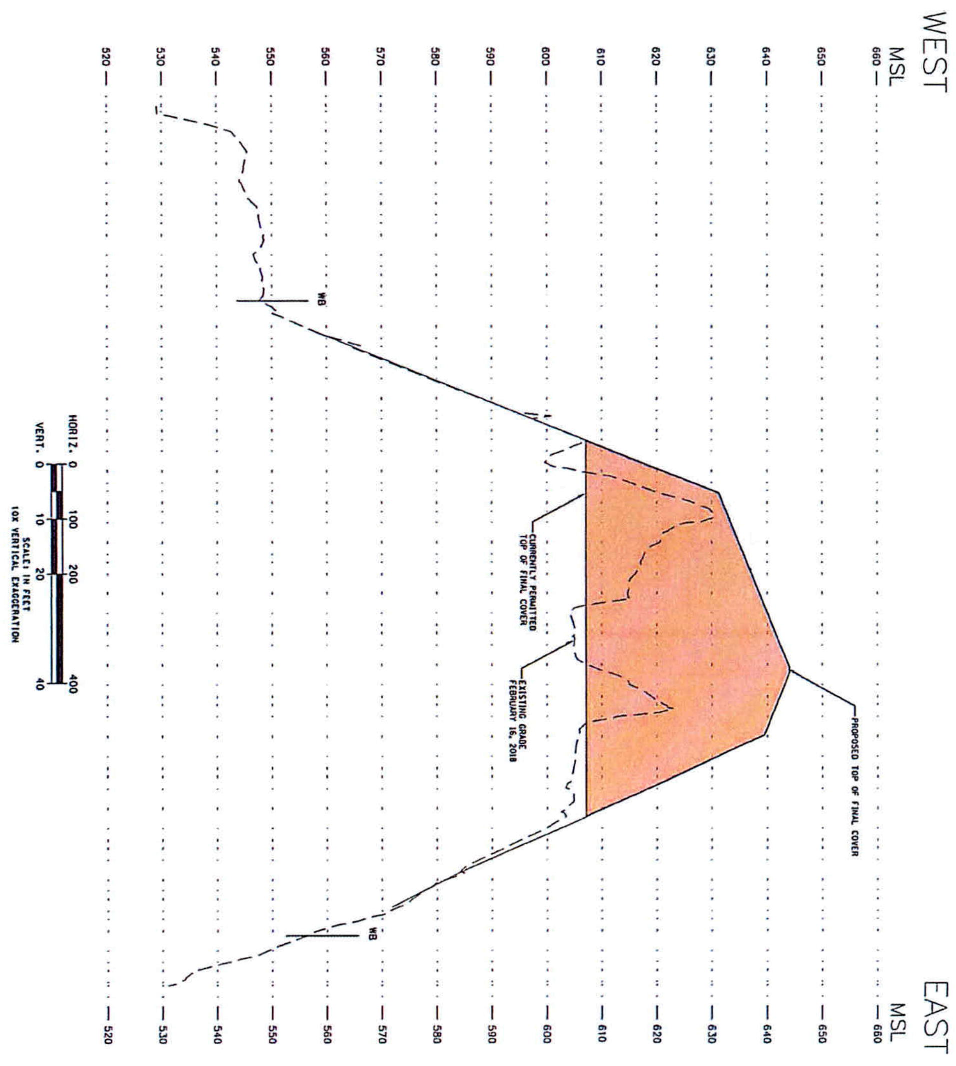

NO.	DATE	REVISION DESCRIPTION	BY	

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3300 GINGER CREEK DRIVE
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PROFESSIONAL DESIGN ENGINEERING AND LAND SURVEYING FIRM #184-001541

APPROVED BY: DWM | DESIGNED BY: DWM | DRAWN BY: MPN

CROSS SECTION AT N 3,750

SIGNIFICANT MODIFICATION TO PERMIT FOR
LANDFILL 33, LTD.
EFFINGHAM COUNTY, ILLINOIS

DATE: AUGUST 2018
PROJECT ID: 180130/0006
SHEET NUMBER: EX-5

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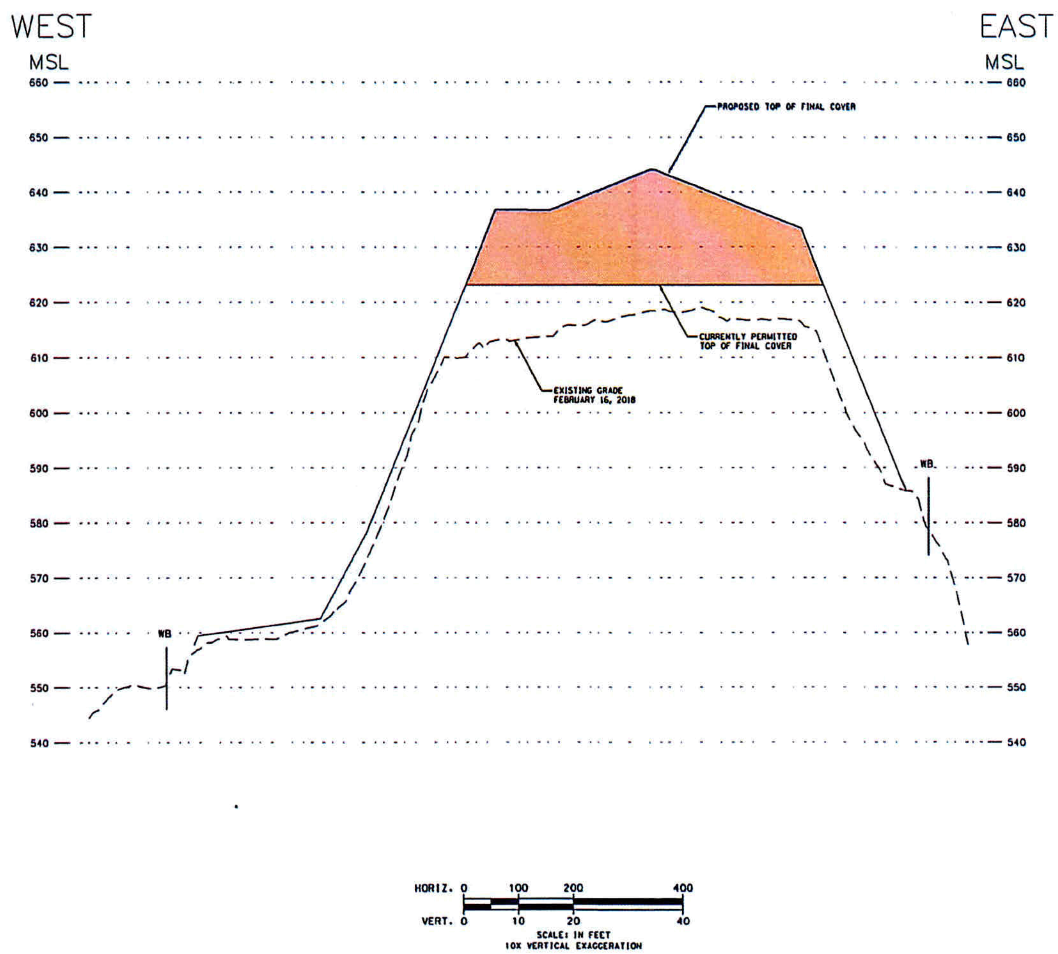

NO.	DATE	REVISION DESCRIPTION	BY

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3300 GINGER CREEK DRIVE
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PROFESSIONAL DESIGN ENGINEERING AND LAND SURVEYING FIRM #184-001541

APPROVED BY: DWM | DESIGNED BY: DWM | DRAWN BY: MPN

CROSS SECTION AT N 4,150

SIGNIFICANT MODIFICATION TO PERMIT FOR
LANDFILL 33, LTD.
EFFINGHAM COUNTY, ILLINOIS

DATE: AUGUST 2018
PROJECT ID: 180130/0006
SHEET NUMBER:
EX-6

4

Attachment 4

Slope Stability Analysis

1. FOUNDATION AND MASS STABILITY ANALYSIS

The foundation and mass stability analysis contained herein relies upon the data provided in the Foundation and Mass Stability Analysis dated August 2001 performed by Andrews Environmental Engineering Inc. (AEEI) as required by 35 IAC 811.304. The analysis contained herein is required for the slope modification.

1.1 Bearing Capacity Analysis

The bearing capacity analysis has been evaluated and is included in Attachment A of the Foundation and Mass Stability Analysis Section. Due to the landfill nearing capacity, the short-term condition no longer exists thus only the long-term bearing capacity analysis was performed. Once the site has a significant amount of waste placed such as the existing condition, the pore pressures within the foundation gray silty clay would dissipate prior to having a significant loading differential. The long-term bearing capacity is far in excess of the statutory factor of safety required.

1.2 Slope Stability Analysis

Slope stability analysis was conducted using the geotechnical strength parameters from the previous report with updated strengths for the municipal solid waste based upon the technical paper titled "Shear Strength of Municipal Solid Waste for Stability Analyses" by Timothy D. Stark, Nejan Huvaj-Sharihan, and Guocheng Lit published in July 2008. The final cover strengths were also updated to reflect updated data from newer geosynthetic cover products. Below is Table 1 containing all soil, rock, sand and waste's unit weights and short- and long-term strengths.

TABLE 1

Layer	Unit Weight	Short Term		Long Term	
		Cohesion (psf)	Friction Angle	Cohesion (psf)	Friction Angle
Brown Silty Clay Cover	120	750	0	100	27
Cover Geosynthetic	62	39	25	39	25
Low Permeable Cover	130	1,000	0	100	28
MSW	70	125	35	125	35
Sand	130	0	32	0	32
Brown Silty Clay Liner	130	0	23.4	0	23.4
Brown Silty Clay	140	250	28	250	28
Gray Silty Clay	135	1,100	17.2	150	23
Gray Shale	130	5,000	0	33.5	0

1.3 Site Specific Seismic Coefficient

The site specific seismic coefficient provided by the USGS Earthquake Hazards Program using the Unified Hazard Tool was obtained and is contained in Attachment B. The site specific seismic coefficient is 0.1837 peak ground acceleration which is a percentage of gravitation acceleration. The seismic conditions contained herein were only analyzed using the short-term strength parameters since seismic events occur over a short duration only lasting minutes, not weeks or months.

1.4 Slope Stability Analysis Software

Andrews conducted slope stability analysis on the critical cross section using Slope/W, a software program developed by Geo-Slope International. Morgenstern-Price method was used as the limit equilibrium slope stability method. The Morgenstern-Price method satisfies all conditions of equilibrium, including both moment and force equilibrium, and accounts for the interslice normal and shear forces at variable inclinations. The Morgenstern-Price method has been described as an accurate procedure applicable to nearly all slope geometries and soil profiles as stated in the MSHA Design Manual. The soil profiles and slope geometry were entered into Slope/W along with the soil strengths and densities that are provided in Table 1.

1.5 Critical Cross Section

The apparent most critical cross section was selected as Cross Section D-D' as shown in Drawing B2-2. This cross section has a majority of the base grades located within the Subtitle D lined area and capturing a large area of the area impacted by the slope modification.

1.6 Global Stability Analysis

Global slope stability analysis was conducted using a circular search method for both the short-term, long-term and seismic conditions. The global circular search method limits imposed in the modeling were based upon the initiation and termination points of the failure surface. The initiation and termination points were allowed to occur over a large portion of the final surface with the critical failure surfaces not being limited by the initiation or termination interval, except for the long-term which produced a shallow failure surface only in the protective cover soil. This search method was to allow for the most critical surface within the landfill only and the entire site including the foundation soils and bedrock.

The results of the global slope stability analysis are tabulated below in Table 2 with the Slope/W stability analysis included in Attachment C.1.

TABLE 2

Condition	Calculated Factor of Safety	IEPA Min. Factor of Safety
Short-Term Stability	3.092	1.5
Long-Term Stability	2.790	1.5
Seismic Stability	1.538	1.3

1.7 Landfill Liner Interface Stability Analysis

The landfill liner interface slope stability analysis was conducted along the clay liner and geomembrane interface in the base grades of the landfill using a grid search method for both the short-term, long-term and seismic conditions. The specified grid search method limits imposed in the modeling were based upon the locations of the points of the failure surface within the landfill liner. The strength parameters for the three feet of clay liner was selected as the interface shear strength of the clay liner to geomembrane interface to be conservative to account for slightly varying base grade slopes within the landfill at other orientations. The grid search points were allowed to occur over a more targeted portion of the clay liner with the critical failure surfaces not being the limiting factor other in the southernmost location which is limited by the actual geometry of the landfill base grades.

The results of the interface surface stability analysis are tabulated below in Table 3 with the Slope/W stability analysis included in Attachment C.2.

TABLE 3

Condition	Calculated Factor of Safety	IEPA Min. Factor of Safety
Short-Term Stability	2.951	1.5
Long-Term Stability	2.910	1.5
Seismic Stability	1.540	1.3

1.8 Final Cover Interface Stability Analysis

The landfill final cover interface slope stability analysis was conducted along the low permeable cover, cover geosynthetic and protective cover soil interfaces in the landfill cover using a grid search method for both the short-term, long-term and seismic conditions. The specified grid search method limits imposed in the modeling were based upon the locations of the points of the failure surface within the landfill cover at the interface. The strength parameters for each of the cover materials are presented in Table 1 with the strength parameter for the cover geosynthetic equivalent to an interface shear strength to soil as the critical shear strength. The grid search points were allowed to occur within the critical interface and was the limiting factor in the southernmost location at the toe of the final cover system.

The results of the final cover interface stability analysis are tabulated below in Table 4 with the Slope/W stability analysis included in Attachment C.3. Cover stability analysis is included in Attachment C.4.

TABLE 4

Condition	Calculated Factor of Safety	IEPA Min. Factor of Safety
Short-Term Stability	2.337	1.5
Long-Term Stability	1.598	1.5
Seismic Stability	1.336	1.3

ATTACHMENT A

BEARING CAPACITY ANALYSIS

Bearing Capacity Analysis

The ultimate bearing capacity was calculated from the Terzaghi-Meyerhof equation:

$$q_{ult} = \frac{1}{2} \cdot \gamma B \cdot N_\gamma + c \cdot N_c + (p_q + \gamma \cdot D_f) \cdot N_q$$

N_c, N_q, N_γ: bearing capacity factors (as a function of friction angle, ϕ)
B: width of foundation (1,200 ft)
D_f: depth of footing (Approximately a minimum depth of 10 ft)

<u>Material Properties</u>

Final Protective Layer:	Unit Weight, γ = 110 lb/ft^3 Unit Height, h = 3.0 ft	
Compacted Soil Cover:	Unit Weight, γ = 130 lb/ft^3 Unit Height, h = 1.0 ft	
MSW:	Unit Weight, γ = 70 lb/ft^3 Unit Height, h = 100 ft (approximate maximum height)	
Sand Layer:	Unit Weight, γ = 125 lb/ft^3 Unit Height, h = 1.0 ft	
Compacted Soil Liner:	Unit Weight, γ = 130 lb/ft^3 Unit Height, h = 3.0 ft	
Foundation Soil (Gray Silty Clay):	Unit Weight, γ = 135 lb/ft^3	
	<u>Short-Term</u>	<u>Long-Term</u>
	Cohesion, c = 1,100 lb/ft^2	Cohesion, c = 0 lb/ft^2
	Friction Angle, ϕ = 17.2°	Friction Angle, ϕ = 23.0°

<u>Overburden Load</u>

The overburden load on the foundation is the total load from each layer of materials above. Calculated below is the total overburden loading.

$$q = (110 \times 3.0) + (130 \times 1.0) + (70 \times 100) + (125 \times 1.0) + (130 \times 3.0)$$

$$q = 7975 \text{ lb/ft}^2$$

Short-Term & Long-Term Foundation Soil Bearing Capacity

The gray silty clay directly beneath the landfill is the most susceptible insitu layer to experience a bearing capacity failure. Bearing capacity failures in saturated clay soils typically occur during the short-term when loads are first applied and the pore pressure has not had time to dissipate thus the friction angle is assumed to be zero. Because the loading has occurred over many years the short-term condition for the soil bearing capacity is no longer relevant. Only the long-term soil bearing capacity is necessary to design for at this point and for the future filling and capping. The bearing capacity factors listed below are from the Terzaghi Bearing Capacity Factors for General Shear for a $\phi = 20$..

$$N_c = 17.7$$
$$N_q = 7.4$$
$$N_\gamma = 5.0$$

The foundation soil ultimate bearing capacity is calculated below:

$$q_{ult} = \tfrac{1}{2} \cdot \gamma B \cdot N_\gamma + c \cdot N_c + (p_q + \gamma \cdot D_f) \cdot N_q$$

$$q_{ult} = \tfrac{1}{2}(135)(1200)(5.0) + (0)(17.7) + (7975 + (135)(10))x(7.4)$$

$$q_{ult} = 405{,}000 + 0 + 69{,}005 = 474{,}005 \text{ lb/ft}^2$$

The maximum waste depth is approximately 100 feet with 1 foot of drainage sand, 3 feet of clay liner and 4 feet of final cover. The vertical load due to the waste and soil column above the foundation soils is:

$$q = 7{,}975 \text{ lb/ft}^2$$

The factor of safety against large-scale foundation soil failure is:

$$FS = 474{,}005 / 7{,}975 = 59.4 >> 2$$

ATTACHMENT B

UNIFIED HAZARD TOOL

U.S. Geological Survey - Earthquake Hazards Program

Unified Hazard Tool

Please do not use this tool to obtain ground motion parameter values for the design code reference documents covered by the U.S. Seismic Design Maps web tools (e.g., the International Building Code and the ASCE 7 or 41 Standard). The values returned by the two applications are not identical.

Input

Edition

Conterminous U.S. 2014 (v4.0.x)

Latitude

Decimal degrees

39.1019493

Longitude

Decimal degrees, negative values for western longitudes

-88.526923

Site Class

760 m/s (B/C boundary)

Spectral Period

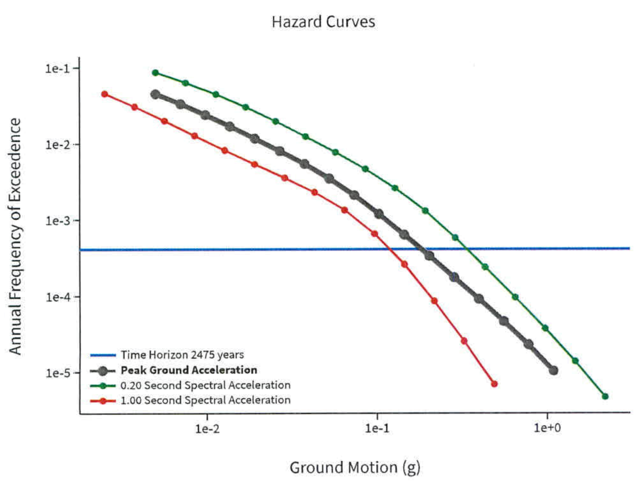
Peak ground acceleration

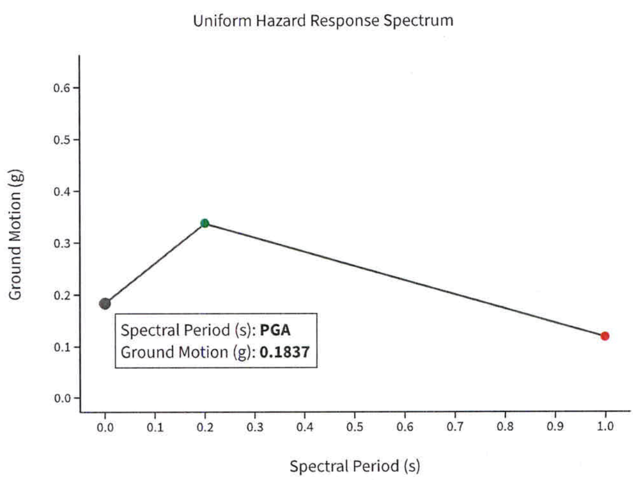
Time Horizon

Return period in years

2475

Hazard Curve





View Raw Data

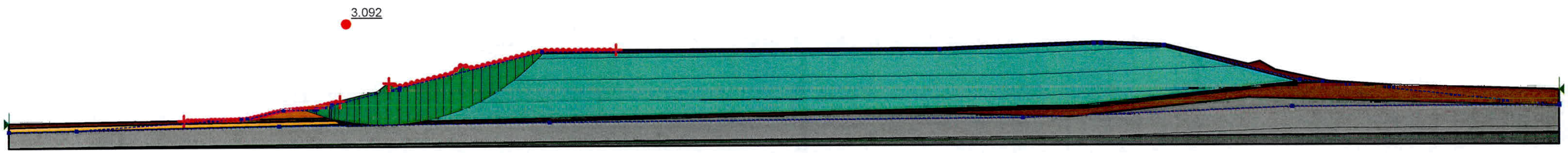
ATTACHMENT C

STABILITY ANALYSIS

ATTACHMENT C.1.

GLOBAL SLOPE STABILITY ANALYSIS

R52



Landfill 33 Short-Term Static Global Analysis

File Information

File Version: 8.14
Created By: Karl Finke
Last Edited By: Karl Finke
Revision Number: 143
Date: 2/14/2019
Time: 4:12:20 PM
Tool Version: 8.14.3.13430
File Name: Short Term Static Global Analysis.gsz
Directory: C:\SlopeW\Landfill 33\Final\
Last Solved Date: 2/14/2019
Last Solved Time: 4:13:18 PM

Project Settings

Length(L) Units: Feet
Time(t) Units: Seconds
Force(F) Units: Pounds
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D
Element Thickness: 1

Analysis Settings

Landfill 33 Short-Term Static Global Analysis

- Kind: SLOPE/W
- Method: Morgenstern-Price
- Settings
  - Side Function
    - Interslice force function option: Half-Sine
  - PWP Conditions Source: Piezometric Line
  - Apply Phreatic Correction: Yes
  - Use Staged Rapid Drawdown: No
- Slip Surface
  - Direction of movement: Right to Left
  - Use Passive Mode: No
  - Slip Surface Option: Entry and Exit
  - Critical slip surfaces saved: 1
  - Resisting Side Maximum Convex Angle: 1 °
  - Driving Side Maximum Convex Angle: 5 °
  - Optimize Critical Slip Surface Location: No
  - Tension Crack
    - Tension Crack Option: (none)
- F of S Distribution
  - F of S Calculation Option: Constant
- Advanced
  - Number of Slices: 30
  - F of S Tolerance: 0.001
  - Minimum Slip Surface Depth: 0.1 ft
  - Search Method: Root Finder
  - Tolerable difference between starting and converged F of S: 3

Maximum iterations to calculate converged lambda: 20
Max Absolute Lambda: 2

Materials

MSW

Model: Mohr-Coulomb
Unit Weight: 70 pcf
Cohesion': 125 psf
Phi': 35 °
Phi-B: 0 °
Constant Unit Wt. Above Water Table: 70 pcf
Pore Water Pressure
Piezometric Line: 1

Gray Shale

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Cohesion': 5,000 psf
Phi': 0 °
Phi-B: 0 °
Constant Unit Wt. Above Water Table: 120 pcf
Pore Water Pressure
Piezometric Line: 1

Gray Silty Clay

Model: Mohr-Coulomb
Unit Weight: 135 pcf
Cohesion': 1,100 psf
Phi': 17.2 °
Phi-B: 0 °
Constant Unit Wt. Above Water Table: 125 pcf
Pore Water Pressure
Piezometric Line: 1

Sand

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Cohesion': 0 psf
Phi': 32 °
Phi-B: 0 °
Constant Unit Wt. Above Water Table: 130 pcf
Pore Water Pressure
Piezometric Line: 1

Brown Silty Clay

Model: Mohr-Coulomb
Unit Weight: 140 pcf
Cohesion': 250 psf
Phi': 28 °
Phi-B: 0 °
Constant Unit Wt. Above Water Table: 135 pcf
Pore Water Pressure
Piezometric Line: 1

Brown Silty Clay Liner

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Cohesion': 0 psf
Phi': 23.4 °

Phi-B: 0 °
Constant Unit Wt. Above Water Table: 120 pcf
Pore Water Pressure
Piezometric Line: 1

Brown Silty Clay Cover

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion': 750 psf
Phi': 0 °
Phi-B: 0 °
Constant Unit Wt. Above Water Table: 120 pcf
Pore Water Pressure
Piezometric Line: 2

Low Permeable Cover

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Cohesion': 1,000 psf
Phi': 0 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Cover Geosynthetic

Model: Mohr-Coulomb
Unit Weight: 62 pcf
Cohesion': 39 psf
Phi': 25 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (259.2381, 40.2804) ft
Left-Zone Right Coordinate: (489.8246, 68.5013) ft
Left-Zone Increment: 40
Right Projection: Range
Right-Zone Left Coordinate: (561.8504, 94.4056) ft
Right-Zone Right Coordinate: (898.4367, 143.5173) ft
Right-Zone Increment: 40
Radius Increments: 40

Slip Surface Limits

Left Coordinate: (0, 37) ft
Right Coordinate: (2,293.7, 82) ft

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
Coordinate 1	0	24
Coordinate 2	400	31

Coordinate 3	800	35
Coordinate 4	1,500	40
Coordinate 5	1,900	56
Coordinate 6	2,293.7	58

Piezometric Line 2

Coordinates

	X (ft)	Y (ft)
Coordinate 1	0	24
Coordinate 2	100	25.8
Coordinate 3	344.4	41.5
Coordinate 4	352.9	42
Coordinate 5	406.5	55
Coordinate 6	452.2769	55.6
Coordinate 7	455.3	56.5
Coordinate 8	478.1217	62.3846
Coordinate 9	578.059	87.5198
Coordinate 10	788.659	140.706
Coordinate 11	1,376.5394	142.4035
Coordinate 12	1,606.8289	151.4981
Coordinate 13	1,617.1758	151.4998
Coordinate 14	1,710.2	148.4
Coordinate 15	1,911	96.1
Coordinate 16	1,944.5	93.7
Coordinate 17	2,293.7	57.2

Seismic Coefficients

Horz Seismic Coef.: 0

Points

	X (ft)	Y (ft)
Point 1	0	0
Point 2	0	24
Point 3	0	31
Point 4	0	37
Point 5	100	38
Point 6	100	33
Point 7	100	25.8
Point 8	100	1
Point 9	344.4	41.5
Point 10	352.9	42
Point 11	406.5	55
Point 12	414.2	32.2
Point 13	452.3	55
Point 14	452.3	59.1
Point 15	475.5	43.4
Point 16	483.3	39.5
Point 17	489.9	36.2
Point 18	494.3	34
Point 19	498.9	31.7
Point 20	545.3	82.4
Point 21	560.7	94.7
Point 22	577.5	90.4
Point 23	654.3	109.6

Point 24	669.7	121.9
Point 25	686.5	117.7
Point 26	788.7	143.2
Point 27	788.7	140.2
Point 28	1,376.6	144.9
Point 29	1,376.6	141.9
Point 30	1,606.8	154
Point 31	1,606.8	151
Point 32	1,617.2	154
Point 33	1,617.2	151
Point 34	1,710.4	150.4
Point 35	1,710.2	147.4
Point 36	1,835.2	120.3
Point 37	1,852	124.5
Point 38	1,874.8	111.7
Point 39	1,953.3	94.8
Point 40	1,980.4	93
Point 41	1,944.5	92.7
Point 42	1,243.2	47
Point 43	1,595.2	54.5
Point 44	1,834.7	82.6
Point 45	1,911.9	91.4
Point 46	1,573.4	42
Point 47	1,834.7	70.4
Point 48	2,293.7	82
Point 49	2,293.7	57.2
Point 50	2,293.7	17.4
Point 51	2,054.6	88.1
Point 52	1,382.9	47
Point 53	2,293.7	0
Point 54	455.3	55
Point 55	486.3	39.5
Point 56	497	34.7
Point 57	1,243.2	50
Point 58	1,592.2	57.5
Point 59	1,832.7	84.6
Point 60	1,911	95.1
Point 61	456.3	55
Point 62	498	35.7
Point 63	1,243.2	51
Point 64	1,591.2	58.5
Point 65	1,831.8	85.5
Point 66	1,909	94.1
Point 67	452.4	54.99
Point 68	455.31	54.99
Point 69	788.7	139.19
Point 70	1,376.6	140.89
Point 71	1,606.8	149.99
Point 72	1,617.2	149.99
Point 73	1,710.2	146.39
Point 74	1,910.99	94.09
Point 75	455.3	56
Point 76	455.3	55.99
Point 77	788.7	140.19
Point 78	1,376.6	141.89
Point 79	1,606.8	150.99
Point 80	1,617.2	150.99
Point 81	1,710.2	147.39

Point 82	1,911	95.09
Point 83	1,917	93.84
Point 84	1,917	93.85

Regions

	Material	Points	Area (ft^2)
Region 1	Gray Shale	1,8,50,53	20,232
Region 2	Gray Silty Clay	1,2,7,12,18,19,42,52,46,47,49,50,8	82,473
Region 3	Sand	2,3,6,16,17,18,12,7	3,245.8
Region 4	Brown Silty Clay	48,49,47,46,52,42,43,44,45,41,40,51	15,374
Region 5	Brown Silty Clay Liner	19,18,17,16,15,13,67,68,55,56,57,58,59,74,83,41,45,44,43,42	4,291.7
Region 6	Brown Silty Clay	16,6,3,4,5,9,15	2,258.8
Region 7	Brown Silty Clay Liner	9,10,11,13,15	1,049.7
Region 8	Brown Silty Clay Cover	11,13,75,27,29,31,33,35,60,84,83,41,40,39,38,37,36,34,32,30,28,26,25,24,23,22,21,20,14	5,799.6
Region 9	Sand	65,66,74,59,58,57,56,55,68,61,62,63,64	1,442.2
Region 10	MSW	68,61,62,63,64,65,66,74,73,72,71,70,69	1.0992e+005
Region 11	Low Permeable Cover	67,68,69,70,71,72,73,74,83,82,81,80,79,78,77,76,13	1,460.9
Region 12	Cover Geosynthetic	84,83,82,81,80,79,78,77,76,13,75,27,29,31,33,35,60	14.632

Current Slip Surface

Slip Surface: 51,595
F of S: 3.092
Volume: 15,183.444 ft^3
Weight: 1,179,949.3 lbs
Resisting Moment: 2.3750606e+008 lbs-ft
Activating Moment: 76,798,369 lbs-ft
Resisting Force: 697,064.72 lbs
Activating Force: 225,436.65 lbs
F of S Rank: 1
Exit: (432.6861, 57.34417) ft
Entry: (794.21285, 143.21594) ft
Radius: 316.79821 ft
Center: (554.1509, 349.9316) ft

Slip Slices

	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
Slice 1	435.07536	56.375012	-62.418849	244.01284	0	750
Slice 2	437.97945	55.202927	13.08149	418.43425	0	750
Slice 3	445.38559	52.480142	-1,311.9091	782.19603	338.48645	0
Slice 4	452.28845	49.956362	-1,150.134	1,196.0263	517.5668	0
Slice 5	453.8	49.451487	-1,117.6898	1,317.9249	570.31702	0
Slice 6	455.8	48.787239	-1,074.997	1,473.3824	637.5895	0
Slice 7	465.26249	46.002733	-895.35718	1,814.996	785.41892	0
Slice 8	474.86249	43.216721	-715.53761	2,199.3484	1,169.4143	250
Slice 9	476.20702	42.872449	-693.21834	2,239.3337	1,190.6749	250
Slice 10	477.51787	42.542443	-671.8101	2,216.6565	959.23291	0

Slice 11	480.41703	41.842573	-626.33366	2,295.326	993.27627	0
Slice 12	485.77778	40.61564	-546.43599	2,478.6978	1,548.8623	0
Slice 13	494.57218	38.840852	-430.21312	2,785.3157	1,950.299	125
Slice 14	506.03015	36.863078	-299.6633	3,163.08	2,214.8125	125
Slice 15	515.14805	35.562043	-212.79781	3,422.5087	2,138.6208	0
Slice 16	525.22772	34.528034	-141.99305	3,672.6032	1,589.2773	0
Slice 17	538.60924	33.585769	-74.852337	4,009.5748	1,735.098	0
Slice 18	553	33.229079	-43.618157	4,787.5801	2,071.7709	0
Slice 19	569.1	33.598059	-56.59483	4,936.1247	2,136.0519	0
Slice 20	577.7795	34.015926	-77.251662	4,468.7563	1,933.8035	0
Slice 21	584.20383	34.622511	-111.09038	4,466.2104	1,932.7018	0
Slice 22	596.49349	36.037093	-191.68352	4,427.3093	1,915.8678	0
Slice 23	606.01573	37.426527	-272.4342	4,381.2988	2,737.7393	0
Slice 24	615.00649	39.086009	-370.36585	4,322.3979	3,026.5756	125
Slice 25	626.23321	41.496822	-513.7808	4,245.1604	2,972.4933	125
Slice 26	637.45993	44.338968	-684.10817	4,142.0267	2,900.2783	125
Slice 27	648.68664	47.624629	-882.10819	4,015.6083	2,811.7592	125
Slice 28	662	52.168933	-1,157.3377	4,290.6492	3,004.3449	125
Slice 29	678.1	58.530851	-1,544.2363	4,032.0291	2,823.2572	125
Slice 30	692.88494	65.215036	-1,952.0628	3,329.712	2,331.4894	125
Slice 31	705.65481	71.804287	-2,355.2234	3,073.8527	2,152.3348	125
Slice 32	718.42469	79.15595	-2,805.9537	2,790.624	1,954.016	125
Slice 33	731.19456	87.334293	-3,308.2637	2,476.2235	1,733.8703	125
Slice 34	743.96444	96.419665	-3,867.1666	2,125.0391	1,487.9684	125
Slice 35	756.73431	106.51414	-4,489.0314	1,729.2849	1,210.8583	125
Slice 36	769.50419	117.75015	-5,182.1207	1,278.4417	895.17451	125
Slice 37	782.27406	130.30425	-5,957.4501	758.37899	531.02268	125
Slice 38	788.6795	136.95874	-6,368.6528	478.92502	335.34691	125
Slice 39	789.6958	138.08854	-6,438.5108	416.62794	291.72602	125
Slice 40	791.13631	139.69705	-6,537.9727	65.283195	0	1,000
Slice 41	791.80904	140.45704	16.102386	58.111257	0	750
Slice 42	793.12496	141.96585	-77.809172	-127.07224	-0	750

R60

Landfill 33 Long-Term Static Global Analysis

File Information

File Version: 8.14
Created By: Karl Finke
Last Edited By: Karl Finke
Revision Number: 133
Date: 2/14/2019
Time: 4:24:24 PM
Tool Version: 8.14.3.13430
File Name: Long Term Static Global Analysis.gsz
Directory: C:\SlopeW\Landfill 33\Final\
Last Solved Date: 2/14/2019
Last Solved Time: 4:25:27 PM

Project Settings

Length(L) Units: Feet
Time(t) Units: Seconds
Force(F) Units: Pounds
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D
Element Thickness: 1

Analysis Settings

Landfill 33 Long-Term Static Global Analysis

- Kind: SLOPE/W
- Method: Morgenstern-Price
- Settings
  - Side Function
    - Interslice force function option: Half-Sine
  - PWP Conditions Source: Piezometric Line
  - Apply Phreatic Correction: Yes
  - Use Staged Rapid Drawdown: No
- Slip Surface
  - Direction of movement: Right to Left
  - Use Passive Mode: No
  - Slip Surface Option: Entry and Exit
  - Critical slip surfaces saved: 1
  - Resisting Side Maximum Convex Angle: 1 °
  - Driving Side Maximum Convex Angle: 5 °
  - Optimize Critical Slip Surface Location: No
  - Tension Crack
    - Tension Crack Option: (none)
- F of S Distribution
  - F of S Calculation Option: Constant
- Advanced
  - Number of Slices: 30
  - F of S Tolerance: 0.001
  - Minimum Slip Surface Depth: 0.1 ft
  - Search Method: Root Finder
  - Tolerable difference between starting and converged F of S: 3

Maximum iterations to calculate converged lambda: 20
Max Absolute Lambda: 2

Materials

MSW

Model: Mohr-Coulomb
Unit Weight: 70 pcf
Cohesion': 125 psf
Phi': 35 °
Phi-B: 0 °
Constant Unit Wt. Above Water Table: 70 pcf
Pore Water Pressure
Piezometric Line: 1

Gray Shale

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Cohesion': 0 psf
Phi': 33.5 °
Phi-B: 0 °
Constant Unit Wt. Above Water Table: 120 pcf
Pore Water Pressure
Piezometric Line: 1

Gray Silty Clay

Model: Mohr-Coulomb
Unit Weight: 135 pcf
Cohesion': 150 psf
Phi': 23 °
Phi-B: 0 °
Constant Unit Wt. Above Water Table: 125 pcf
Pore Water Pressure
Piezometric Line: 1

Sand

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Cohesion': 0 psf
Phi': 32 °
Phi-B: 0 °
Constant Unit Wt. Above Water Table: 130 pcf
Pore Water Pressure
Piezometric Line: 1

Brown Silty Clay

Model: Mohr-Coulomb
Unit Weight: 140 pcf
Cohesion': 250 psf
Phi': 28 °
Phi-B: 0 °
Constant Unit Wt. Above Water Table: 135 pcf
Pore Water Pressure
Piezometric Line: 1

Brown Silty Clay Liner

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Cohesion': 0 psf
Phi': 23.4 °

Phi-B: 0 °
Constant Unit Wt. Above Water Table: 120 pcf
Pore Water Pressure
Piezometric Line: 1

Brown Silty Clay Cover

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion': 100 psf
Phi': 27 °
Phi-B: 0 °
Constant Unit Wt. Above Water Table: 120 pcf
Pore Water Pressure
Piezometric Line: 2

Low Permeable Cover

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Cohesion': 100 psf
Phi': 28 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Cover Geosynthetic

Model: Mohr-Coulomb
Unit Weight: 62 pcf
Cohesion': 39 psf
Phi': 25 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (233.2501, 39.9082) ft
Left-Zone Right Coordinate: (534.902, 79.7949) ft
Left-Zone Increment: 40
Right Projection: Range
Right-Zone Left Coordinate: (627.8768, 102.9942) ft
Right-Zone Right Coordinate: (935.1951, 143.6236) ft
Right-Zone Increment: 40
Radius Increments: 40

Slip Surface Limits

Left Coordinate: (0, 37) ft
Right Coordinate: (2,293.7, 82) ft

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
Coordinate 1	0	24
Coordinate 2	400	31

Coordinate 3	800	35
Coordinate 4	1,500	40
Coordinate 5	1,900	56
Coordinate 6	2,293.7	58

Piezometric Line 2

Coordinates

	X (ft)	Y (ft)
Coordinate 1	0	24
Coordinate 2	100	25.8
Coordinate 3	344.4	41.5
Coordinate 4	352.9	42
Coordinate 5	406.5	55
Coordinate 6	452.2769	55.6
Coordinate 7	455.3	56.5
Coordinate 8	478.1217	62.3846
Coordinate 9	578.059	87.5198
Coordinate 10	788.659	140.706
Coordinate 11	1,376.5394	142.4035
Coordinate 12	1,606.8289	151.4981
Coordinate 13	1,617.1758	151.4998
Coordinate 14	1,710.2	148.4
Coordinate 15	1,911	96.1
Coordinate 16	1,944.5	93.7
Coordinate 17	2,293.7	57.2

Seismic Coefficients

Horz Seismic Coef.: 0

Points

	X (ft)	Y (ft)
Point 1	0	0
Point 2	0	24
Point 3	0	31
Point 4	0	37
Point 5	100	38
Point 6	100	33
Point 7	100	25.8
Point 8	100	1
Point 9	344.4	41.5
Point 10	352.9	42
Point 11	406.5	55
Point 12	414.2	32.2
Point 13	452.3	55
Point 14	452.3	59.1
Point 15	475.5	43.4
Point 16	483.3	39.5
Point 17	489.9	36.2
Point 18	494.3	34
Point 19	498.9	31.7
Point 20	545.3	82.4
Point 21	560.7	94.7
Point 22	577.5	90.4
Point 23	654.3	109.6

Point 24	669.7	121.9
Point 25	686.5	117.7
Point 26	788.7	143.2
Point 27	788.7	140.2
Point 28	1,376.6	144.9
Point 29	1,376.6	141.9
Point 30	1,606.8	154
Point 31	1,606.8	151
Point 32	1,617.2	154
Point 33	1,617.2	151
Point 34	1,710.4	150.4
Point 35	1,710.2	147.4
Point 36	1,835.2	120.3
Point 37	1,852	124.5
Point 38	1,874.8	111.7
Point 39	1,953.3	94.8
Point 40	1,980.4	93
Point 41	1,944.5	92.7
Point 42	1,243.2	47
Point 43	1,595.2	54.5
Point 44	1,834.7	82.6
Point 45	1,911.9	91.4
Point 46	1,573.4	42
Point 47	1,834.7	70.4
Point 48	2,293.7	82
Point 49	2,293.7	57.2
Point 50	2,293.7	17.4
Point 51	2,054.6	88.1
Point 52	1,382.9	47
Point 53	2,293.7	0
Point 54	455.3	55
Point 55	486.3	39.5
Point 56	497	34.7
Point 57	1,243.2	50
Point 58	1,592.2	57.5
Point 59	1,832.7	84.6
Point 60	1,911	95.1
Point 61	456.3	55
Point 62	498	35.7
Point 63	1,243.2	51
Point 64	1,591.2	58.5
Point 65	1,831.8	85.5
Point 66	1,909	94.1
Point 67	452.4	54.99
Point 68	455.31	54.99
Point 69	788.7	139.19
Point 70	1,376.6	140.89
Point 71	1,606.8	149.99
Point 72	1,617.2	149.99
Point 73	1,710.2	146.39
Point 74	1,910.99	94.09
Point 75	455.3	56
Point 76	455.3	55.99
Point 77	788.7	140.19
Point 78	1,376.6	141.89
Point 79	1,606.8	150.99
Point 80	1,617.2	150.99
Point 81	1,710.2	147.39

Point 82	1,911	95.09
Point 83	1,917	93.84
Point 84	1,917	93.85

Regions

	Material	Points	Area (ft²)
Region 1	Gray Shale	1,8,50,53	20,232
Region 2	Gray Silty Clay	1,2,7,12,18,19,42,52,46,47,49,50,8	82,473
Region 3	Sand	2,3,6,16,17,18,12,7	3,245.8
Region 4	Brown Silty Clay	48,49,47,46,52,42,43,44,45,41,40,51	15,374
Region 5	Brown Silty Clay Liner	19,18,17,16,15,13,67,68,55,56,57,58,59,74,83,41,45,44,43,42	4,291.7
Region 6	Brown Silty Clay	16,6,3,4,5,9,15	2,258.8
Region 7	Brown Silty Clay Liner	9,10,11,13,15	1,049.7
Region 8	Brown Silty Clay Cover	11,13,75,27,29,31,33,35,60,84,83,41,40,39,38,37,36,34,32,30,28,26,25,24,23,22,21,20,14	5,799.6
Region 9	Sand	65,66,74,59,58,57,56,55,68,61,62,63,64	1,442.2
Region 10	MSW	68,61,62,63,64,65,66,74,73,72,71,70,69	1.0992e+005
Region 11	Low Permeable Cover	67,68,69,70,71,72,73,74,83,82,81,80,79,78,77,76,13	1,460.9
Region 12	Cover Geosynthetic	84,83,82,81,80,79,78,77,76,13,75,27,29,31,33,35,60	14.632

Current Slip Surface

Slip Surface: 65,889
F of S: 2.790
Volume: 726.49739 ft³
Weight: 87,598.39 lbs
Resisting Moment: 43,703,063 lbs-ft
Activating Moment: 15,666,765 lbs-ft
Resisting Force: 58,357.173 lbs
Activating Force: 20,920.128 lbs
F of S Rank: 1
Exit: (527.48212, 77.935951) ft
Entry: (685.4869, 117.95328) ft
Radius: 724.43945 ft
Center: (429.75295, 795.75315) ft

Slip Slices

	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
Slice 1	530.45177	78.352789	-164.71668	34.821455	17.742418	100
Slice 2	536.39106	79.21158	-127.45013	110.99245	56.553476	100
Slice 3	542.33035	80.120693	-93.136861	181.01133	92.229878	100
Slice 4	547.86667	81.012005	-63.727067	404.98409	206.3497	100
Slice 5	553	81.87928	-38.854776	782.64472	398.7774	100
Slice 6	558.13333	82.784569	-16.213449	1,153.574	587.77531	100
Slice 7	561.39617	83.375383	-2.7257823	1,300.9402	662.86214	100
Slice 8	564.30487	83.922248	8.1138318	1,149.5302	581.58071	100
Slice 9	568.82301	84.791462	23.791732	912.51425	452.82674	100
Slice 10	574.31431	85.891216	-3,316.1081	622.40899	330.94073	100

Slice 11	577.7795	86.598314	-3,358.0646	455.66514	242.28146	100
Slice 12	580.75201	87.230585	-3,395.6597	468.34936	249.02577	100
Slice 13	586.13802	88.399896	-3,465.2569	487.92375	259.43366	100
Slice 14	591.52403	89.612225	-3,537.5381	501.61286	266.71229	100
Slice 15	596.91004	90.867792	-3,612.5171	509.54546	270.93012	100
Slice 16	602.29606	92.16683	-3,690.2084	511.86096	272.1613	100
Slice 17	607.68207	93.509579	-3,770.6271	508.69986	270.48051	100
Slice 18	613.06808	94.896291	-3,853.7887	500.19445	265.95811	100
Slice 19	618.45409	96.327228	-3,939.7097	486.46023	258.65549	100
Slice 20	623.84011	97.802661	-4,028.407	467.58824	248.62108	100
Slice 21	629.22612	99.322874	-4,119.8982	443.63842	235.88673	100
Slice 22	634.61213	100.88816	-4,214.2018	414.63419	220.46491	100
Slice 23	639.99814	102.49882	-4,311.3366	380.55818	202.34637	100
Slice 24	644.86974	103.99302	23.438455	347.79861	165.26976	100
Slice 25	649.13621	105.33392	7.9861102	315.89993	156.88993	100
Slice 26	652.76204	106.49496	-6.4055583	286.48595	145.97188	100
Slice 27	656.86667	107.83995	-24.494793	405.80736	206.76918	100
Slice 28	662	109.55603	-49.112751	669.44949	341.10155	100
Slice 29	667.13333	111.31492	-76.241458	931.28234	474.51205	100
Slice 30	672.33115	113.14013	-106.30528	887.79863	452.356	100
Slice 31	677.59345	115.03311	-139.38972	534.46609	272.32408	100
Slice 32	682.85575	116.97218	-175.17687	171.70284	87.486968	100

R68

Landfill 33 Short-Term Seismic Global Analysis

File Information

- File Version: 8.14
- Created By: Karl Finke
- Last Edited By: Karl Finke
- Revision Number: 139
- Date: 2/14/2019
- Time: 4:06:19 PM
- Tool Version: 8.14.3.13430
- File Name: Short Term Seismic Global Analysis.gsz
- Directory: C:\SlopeW\Landfill 33\Final\
- Last Solved Date: 2/14/2019
- Last Solved Time: 4:07:10 PM

Project Settings

- Length(L) Units: Feet
- Time(t) Units: Seconds
- Force(F) Units: Pounds
- Pressure(p) Units: psf
- Strength Units: psf
- Unit Weight of Water: 62.4 pcf
- View: 2D
- Element Thickness: 1

Analysis Settings

Landfill 33 Short-Term Seismic Global Analysis

- Kind: SLOPE/W
- Method: Morgenstern-Price
- Settings
  - Side Function
    - Interslice force function option: Half-Sine
  - PWP Conditions Source: Piezometric Line
  - Apply Phreatic Correction: Yes
  - Use Staged Rapid Drawdown: No
- Slip Surface
  - Direction of movement: Right to Left
  - Use Passive Mode: No
  - Slip Surface Option: Entry and Exit
  - Critical slip surfaces saved: 1
  - Resisting Side Maximum Convex Angle: 1 °
  - Driving Side Maximum Convex Angle: 5 °
  - Optimize Critical Slip Surface Location: No
  - Tension Crack
    - Tension Crack Option: (none)
- F of S Distribution
  - F of S Calculation Option: Constant
- Advanced
  - Number of Slices: 30
  - F of S Tolerance: 0.001
  - Minimum Slip Surface Depth: 0.1 ft
  - Search Method: Root Finder
  - Tolerable difference between starting and converged F of S: 3

Maximum iterations to calculate converged lambda: 20
Max Absolute Lambda: 2

Materials

MSW

Model: Mohr-Coulomb
Unit Weight: 70 pcf
Cohesion': 125 psf
Phi': 35 °
Phi-B: 0 °
Constant Unit Wt. Above Water Table: 70 pcf
Pore Water Pressure
Piezometric Line: 1

Gray Shale

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Cohesion': 5,000 psf
Phi': 0 °
Phi-B: 0 °
Constant Unit Wt. Above Water Table: 120 pcf
Pore Water Pressure
Piezometric Line: 1

Gray Silty Clay

Model: Mohr-Coulomb
Unit Weight: 135 pcf
Cohesion': 1,100 psf
Phi': 17.2 °
Phi-B: 0 °
Constant Unit Wt. Above Water Table: 125 pcf
Pore Water Pressure
Piezometric Line: 1

Sand

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Cohesion': 0 psf
Phi': 32 °
Phi-B: 0 °
Constant Unit Wt. Above Water Table: 130 pcf
Pore Water Pressure
Piezometric Line: 1

Brown Silty Clay

Model: Mohr-Coulomb
Unit Weight: 140 pcf
Cohesion': 250 psf
Phi': 28 °
Phi-B: 0 °
Constant Unit Wt. Above Water Table: 135 pcf
Pore Water Pressure
Piezometric Line: 1

Brown Silty Clay Liner

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Cohesion': 0 psf
Phi': 23.4 °

Phi-B: 0 °
Constant Unit Wt. Above Water Table: 120 pcf
Pore Water Pressure
Piezometric Line: 1

Brown Silty Clay Cover

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion': 750 psf
Phi': 0 °
Phi-B: 0 °
Constant Unit Wt. Above Water Table: 120 pcf
Pore Water Pressure
Piezometric Line: 2

Low Permeable Cover

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Cohesion': 1,000 psf
Phi': 0 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Cover Geosynthetic

Model: Mohr-Coulomb
Unit Weight: 62 pcf
Cohesion': 39 psf
Phi': 25 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (259.2381, 40.2804) ft
Left-Zone Right Coordinate: (489.8246, 68.5013) ft
Left-Zone Increment: 40
Right Projection: Range
Right-Zone Left Coordinate: (561.8504, 94.4056) ft
Right-Zone Right Coordinate: (898.4367, 143.5173) ft
Right-Zone Increment: 40
Radius Increments: 40

Slip Surface Limits

Left Coordinate: (0, 37) ft
Right Coordinate: (2,293.7, 82) ft

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
Coordinate 1	0	24
Coordinate 2	400	31

Coordinate 3	800	35
Coordinate 4	1,500	40
Coordinate 5	1,900	56
Coordinate 6	2,293.7	58

Piezometric Line 2

Coordinates

	X (ft)	Y (ft)
Coordinate 1	0	24
Coordinate 2	100	25.8
Coordinate 3	344.4	41.5
Coordinate 4	352.9	42
Coordinate 5	406.5	55
Coordinate 6	452.2769	55.6
Coordinate 7	455.3	56.5
Coordinate 8	478.1217	62.3846
Coordinate 9	578.059	87.5198
Coordinate 10	788.659	140.706
Coordinate 11	1,376.5394	142.4035
Coordinate 12	1,606.8289	151.4981
Coordinate 13	1,617.1758	151.4998
Coordinate 14	1,710.2	148.4
Coordinate 15	1,911	96.1
Coordinate 16	1,944.5	93.7
Coordinate 17	2,293.7	57.2

Seismic Coefficients

Horz Seismic Coef.: 0.1837

Points

	X (ft)	Y (ft)
Point 1	0	0
Point 2	0	24
Point 3	0	31
Point 4	0	37
Point 5	100	38
Point 6	100	33
Point 7	100	25.8
Point 8	100	1
Point 9	344.4	41.5
Point 10	352.9	42
Point 11	406.5	55
Point 12	414.2	32.2
Point 13	452.3	55
Point 14	452.3	59.1
Point 15	475.5	43.4
Point 16	483.3	39.5
Point 17	489.9	36.2
Point 18	494.3	34
Point 19	498.9	31.7
Point 20	545.3	82.4
Point 21	560.7	94.7
Point 22	577.5	90.4
Point 23	654.3	109.6

Point 24	669.7	121.9
Point 25	686.5	117.7
Point 26	788.7	143.2
Point 27	788.7	140.2
Point 28	1,376.6	144.9
Point 29	1,376.6	141.9
Point 30	1,606.8	154
Point 31	1,606.8	151
Point 32	1,617.2	154
Point 33	1,617.2	151
Point 34	1,710.4	150.4
Point 35	1,710.2	147.4
Point 36	1,835.2	120.3
Point 37	1,852	124.5
Point 38	1,874.8	111.7
Point 39	1,953.3	94.8
Point 40	1,980.4	93
Point 41	1,944.5	92.7
Point 42	1,243.2	47
Point 43	1,595.2	54.5
Point 44	1,834.7	82.6
Point 45	1,911.9	91.4
Point 46	1,573.4	42
Point 47	1,834.7	70.4
Point 48	2,293.7	82
Point 49	2,293.7	57.2
Point 50	2,293.7	17.4
Point 51	2,054.6	88.1
Point 52	1,382.9	47
Point 53	2,293.7	0
Point 54	455.3	55
Point 55	486.3	39.5
Point 56	497	34.7
Point 57	1,243.2	50
Point 58	1,592.2	57.5
Point 59	1,832.7	84.6
Point 60	1,911	95.1
Point 61	456.3	55
Point 62	498	35.7
Point 63	1,243.2	51
Point 64	1,591.2	58.5
Point 65	1,831.8	85.5
Point 66	1,909	94.1
Point 67	452.4	54.99
Point 68	455.31	54.99
Point 69	788.7	139.19
Point 70	1,376.6	140.89
Point 71	1,606.8	149.99
Point 72	1,617.2	149.99
Point 73	1,710.2	146.39
Point 74	1,910.99	94.09
Point 75	455.3	56
Point 76	455.3	55.99
Point 77	788.7	140.19
Point 78	1,376.6	141.89
Point 79	1,606.8	150.99
Point 80	1,617.2	150.99
Point 81	1,710.2	147.39

Point 82	1,911	95.09
Point 83	1,917	93.84
Point 84	1,917	93.85

Regions

	Material	Points	Area (ft²)
Region 1	Gray Shale	1,8,50,53	20,232
Region 2	Gray Silty Clay	1,2,7,12,18,19,42,52,46,47,49,50,8	82,473
Region 3	Sand	2,3,6,16,17,18,12,7	3,245.8
Region 4	Brown Silty Clay	48,49,47,46,52,42,43,44,45,41,40,51	15,374
Region 5	Brown Silty Clay Liner	19,18,17,16,15,13,67,68,55,56,57,58,59,74,83,41,45,44,43,42	4,291.7
Region 6	Brown Silty Clay	16,6,3,4,5,9,15	2,258.8
Region 7	Brown Silty Clay Liner	9,10,11,13,15	1,049.7
Region 8	Brown Silty Clay Cover	11,13,75,27,29,31,33,35,60,84,83,41,40,39,38,37,36,34,32,30,28,26,25,24,23,22,21,20,14	5,799.6
Region 9	Sand	65,66,74,59,58,57,56,55,68,61,62,63,64	1,442.2
Region 10	MSW	68,61,62,63,64,65,66,74,73,72,71,70,69	1.0992e+005
Region 11	Low Permeable Cover	67,68,69,70,71,72,73,74,83,82,81,80,79,78,77,76,13	1,460.9
Region 12	Cover Geosynthetic	84,83,82,81,80,79,78,77,76,13,75,27,29,31,33,35,60	14.632

Current Slip Surface

Slip Surface: 21,622
F of S: 1.538
Volume: 30,709.563 ft³
Weight: 2,858,594.5 lbs
Resisting Moment: 6.6733403e+008 lbs-ft
Activating Moment: 4.3375186e+008 lbs-ft
Resisting Force: 1,299,955.1 lbs
Activating Force: 845,195.55 lbs
F of S Rank: 1
Exit: (329.28296, 41.283512) ft
Entry: (855.01009, 143.39175) ft
Radius: 485.20527 ft
Center: (515.00093, 489.53901) ft

Slip Slices

	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
Slice 1	330.07482	40.957073	-697.46603	132.42284	70.410473	250
Slice 2	335.33683	38.84864	-560.19573	484.89421	257.82283	250
Slice 3	342.1035	36.190808	-387.01087	875.19461	546.88229	0
Slice 4	348.65	33.763785	-228.46442	1,318.6009	823.95331	0
Slice 5	354.6014	31.616641	-88.02669	1,776.4077	1,110.0227	0
Slice 6	357.39071	30.647028	-24.496411	2,177.0013	673.89448	1,100
Slice 7	368.85896	26.993688	215.92171	3,134.4264	903.42812	1,100
Slice 8	389.61965	20.936591	616.4326	4,787.036	1,291.0174	1,100
Slice 9	403.25	17.389953	851.20983	5,793.8088	1,529.99	1,100
Slice 10	410.35	15.770296	956.69624	6,197.6194	1,622.3367	1,100

Slice 11	423.71922	13.09608	1,131.8922	6,755.805	1,740.8918	1,100
Slice 12	442.75768	9.8386884	1,347.0119	7,414.9521	1,878.3413	1,100
Slice 13	452.28845	8.4035799	1,442.5004	7,691.6859	1,934.446	1,100
Slice 14	453.8	8.2113491	1,455.4375	7,764.8949	1,953.1033	1,100
Slice 15	455.8	7.9591583	1,472.4205	7,855.1941	1,975.7985	1,100
Slice 16	465.9	6.9210014	1,543.4968	7,889.9448	1,964.5538	1,100
Slice 17	476.81085	5.8408124	1,617.7015	7,880.7345	1,938.7326	1,100
Slice 18	480.71085	5.5538752	1,638.038	7,830.609	1,916.921	1,100
Slice 19	484.8	5.276888	1,657.8716	7,777.0759	1,894.2102	1,100
Slice 20	488.1	5.08339	1,672.0037	7,732.9062	1,876.1627	1,100
Slice 21	492.1	4.8794858	1,687.2218	7,672.6439	1,852.7976	1,100
Slice 22	495.65	4.7216486	1,699.2848	7,618.4361	1,832.2834	1,100
Slice 23	497.5	4.6497185	1,704.9271	7,588.9929	1,821.4226	1,100
Slice 24	498.16667	4.6258862	1,706.83	7,574.7844	1,816.4353	1,100
Slice 25	505.46097	4.4799165	1,720.4888	7,650.9037	1,835.7701	1,100
Slice 26	519.4329	4.4022589	1,734.0518	7,745.7336	1,860.9264	1,100
Slice 27	535.7886	4.8727354	1,714.9019	7,748.5069	1,867.7127	1,100
Slice 28	553	5.8856495	1,662.4412	8,158.0478	2,010.7261	1,100
Slice 29	569.1	7.4332118	1,575.9284	7,990.8073	1,985.7367	1,100
Slice 30	577.7795	8.41228	1,520.2561	7,412.4498	1,823.9386	1,100
Slice 31	587.58912	9.8910044	1,434.1135	7,257.2421	1,802.5594	1,100
Slice 32	606.64937	13.166743	1,241.6203	6,922.079	1,758.3957	1,100
Slice 33	625.70962	17.234097	999.73515	6,517.5395	1,708.0457	1,100
Slice 34	644.76987	22.113768	707.16654	6,057.7652	1,656.287	1,100
Slice 35	662	27.207799	400.08135	6,014.1863	1,737.8558	1,100
Slice 36	675.62755	31.735789	126.06572	5,736.7456	1,736.7956	1,100
Slice 37	683.89172	34.683158	-52.675332	5,072.9711	1,570.3469	1,100
Slice 38	686.36418	35.602037	-108.46503	4,886.1111	2,114.4091	0
Slice 39	690.48983	37.201205	-205.66899	4,764.9578	2,061.9813	0
Slice 40	695.77239	39.268093	-331.33391	4,582.0349	2,863.1732	0
Slice 41	706.2245	43.715752	-602.31863	4,360.9273	3,053.5542	125
Slice 42	724.54328	52.031267	-1,109.7251	4,042.5474	2,830.6221	125
Slice 43	742.86206	61.291626	-1,676.0839	3,707.7913	2,596.2234	125
Slice 44	761.18083	71.559802	-2,305.3243	3,352.4166	2,347.3874	125
Slice 45	779.49961	82.912379	-3,002.2245	2,970.2431	2,079.7866	125
Slice 46	788.6795	88.884296	-3,369.1071	2,774.0406	1,942.4041	125
Slice 47	794.35	92.877312	-3,614.7084	2,570.6028	1,799.9555	125
Slice 48	808.47774	103.29795	-4,257.7965	2,048.8241	1,434.6021	125
Slice 49	825.43323	116.8002	-5,092.7367	1,386.3461	970.72999	125
Slice 50	842.38872	131.61529	-6,009.5942	666.19826	466.47704	125
Slice 51	851.38778	139.87127	-6,520.7304	-186.21158	-0	1,000
Slice 52	852.17679	140.63148	16.094563	-131.5921	-0	750
Slice 53	853.72729	142.14096	-77.817056	-320.64524	-0	750

ATTACHMENT C.2.

INTERFACE SURFACE STABILITY ANALYSIS

R77

Landfill 33 Short-Term Static Base Clay to FML

File Information

File Version: 8.14
Created By: Karl Finke
Last Edited By: Karl Finke
Revision Number: 131
Date: 2/14/2019
Time: 3:53:26 PM
Tool Version: 8.14.3.13430
File Name: Short Term Static Base Clay to FML.gsz
Directory: C:\SlopeW\Landfill 33\Final\
Last Solved Date: 2/14/2019
Last Solved Time: 3:54:01 PM

Project Settings

Length(L) Units: Feet
Time(t) Units: Seconds
Force(F) Units: Pounds
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D
Element Thickness: 1

Analysis Settings

Landfill 33 Short-Term Static Base Clay to FML

Kind: SLOPE/W
Method: Morgenstern-Price
Settings
- Side Function
  - Interslice force function option: Half-Sine
- PWP Conditions Source: Piezometric Line
- Apply Phreatic Correction: Yes
- Use Staged Rapid Drawdown: No

Slip Surface
- Direction of movement: Right to Left
- Use Passive Mode: No
- Slip Surface Option: Block
- Critical slip surfaces saved: 1
- Resisting Side Maximum Convex Angle: 1 °
- Driving Side Maximum Convex Angle: 5 °
- Restrict Block Crossing: No
- Optimize Critical Slip Surface Location: No
- Tension Crack
  - Tension Crack Option: (none)

F of S Distribution
- F of S Calculation Option: Constant

Advanced
- Number of Slices: 30
- F of S Tolerance: 0.001
- Minimum Slip Surface Depth: 0.1 ft
- Search Method: Root Finder

Tolerable difference between starting and converged F of S: 3
Maximum iterations to calculate converged lambda: 20
Max Absolute Lambda: 2

Materials

MSW

Model: Mohr-Coulomb
Unit Weight: 70 pcf
Cohesion': 125 psf
Phi': 35 °
Phi-B: 0 °
Constant Unit Wt. Above Water Table: 70 pcf
Pore Water Pressure
Piezometric Line: 1

Gray Shale

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Cohesion': 5,000 psf
Phi': 0 °
Phi-B: 0 °
Constant Unit Wt. Above Water Table: 120 pcf
Pore Water Pressure
Piezometric Line: 1

Gray Silty Clay

Model: Mohr-Coulomb
Unit Weight: 135 pcf
Cohesion': 1,100 psf
Phi': 17.2 °
Phi-B: 0 °
Constant Unit Wt. Above Water Table: 125 pcf
Pore Water Pressure
Piezometric Line: 1

Sand

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Cohesion': 0 psf
Phi': 32 °
Phi-B: 0 °
Constant Unit Wt. Above Water Table: 130 pcf
Pore Water Pressure
Piezometric Line: 1

Brown Silty Clay

Model: Mohr-Coulomb
Unit Weight: 140 pcf
Cohesion': 250 psf
Phi': 28 °
Phi-B: 0 °
Constant Unit Wt. Above Water Table: 135 pcf
Pore Water Pressure
Piezometric Line: 1

Brown Silty Clay Liner

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Cohesion': 0 psf

Phi': 23.4 °
Phi-B: 0 °
Constant Unit Wt. Above Water Table: 120 pcf
Pore Water Pressure
    Piezometric Line: 1

Brown Silty Clay Cover

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion': 750 psf
Phi': 0 °
Phi-B: 0 °
Constant Unit Wt. Above Water Table: 120 pcf
Pore Water Pressure
    Piezometric Line: 2

Low Permeable Cover

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Cohesion': 1,000 psf
Phi': 0 °
Phi-B: 0 °
Pore Water Pressure
    Piezometric Line: 1

Cover Geosynthetic

Model: Mohr-Coulomb
Unit Weight: 62 pcf
Cohesion': 39 psf
Phi': 25 °
Phi-B: 0 °
Pore Water Pressure
    Piezometric Line: 1

Slip Surface Limits

Left Coordinate: (0, 37) ft
Right Coordinate: (2,293.7, 82) ft

Slip Surface Block

Left Grid
    Upper Left: (497, 34.6) ft
    Lower Left: (497, 32) ft
    Lower Right: (522, 32.5) ft
    X Increments: 5
    Y Increments: 3
    Starting Angle: 140 °
    Ending Angle: 165 °
    Angle Increments: 6
Right Grid
    Upper Left: (600, 36.75) ft
    Lower Left: (600, 34) ft
    Lower Right: (750, 37) ft
    X Increments: 6
    Y Increments: 2
    Starting Angle: 45 °
    Ending Angle: 65 °
    Angle Increments: 10

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
Coordinate 1	0	24
Coordinate 2	400	31
Coordinate 3	800	35
Coordinate 4	1,500	40
Coordinate 5	1,900	56
Coordinate 6	2,293.7	58

Piezometric Line 2

Coordinates

	X (ft)	Y (ft)
Coordinate 1	0	24
Coordinate 2	100	25.8
Coordinate 3	344.4	41.5
Coordinate 4	352.9	42
Coordinate 5	406.5	55
Coordinate 6	452.2769	55.6
Coordinate 7	455.3	56.5
Coordinate 8	478.1217	62.3846
Coordinate 9	578.059	87.5198
Coordinate 10	788.659	140.706
Coordinate 11	1,376.5394	142.4035
Coordinate 12	1,606.8289	151.4981
Coordinate 13	1,617.1758	151.4998
Coordinate 14	1,710.2	148.4
Coordinate 15	1,911	96.1
Coordinate 16	1,944.5	93.7
Coordinate 17	2,293.7	57.2

Seismic Coefficients

Horz Seismic Coef.: 0

Points

	X (ft)	Y (ft)
Point 1	0	0
Point 2	0	24
Point 3	0	31
Point 4	0	37
Point 5	100	38
Point 6	100	33
Point 7	100	25.8
Point 8	100	1
Point 9	344.4	41.5
Point 10	352.9	42
Point 11	406.5	55
Point 12	414.2	32.2
Point 13	452.3	55
Point 14	452.3	59.1
Point 15	475.5	43.4

Point 16	483.3	39.5
Point 17	489.9	36.2
Point 18	494.3	34
Point 19	498.9	31.7
Point 20	545.3	82.4
Point 21	560.7	94.7
Point 22	577.5	90.4
Point 23	654.3	109.6
Point 24	669.7	121.9
Point 25	686.5	117.7
Point 26	788.7	143.2
Point 27	788.7	140.2
Point 28	1,376.6	144.9
Point 29	1,376.6	141.9
Point 30	1,606.8	154
Point 31	1,606.8	151
Point 32	1,617.2	154
Point 33	1,617.2	151
Point 34	1,710.4	150.4
Point 35	1,710.2	147.4
Point 36	1,835.2	120.3
Point 37	1,852	124.5
Point 38	1,874.8	111.7
Point 39	1,953.3	94.8
Point 40	1,980.4	93
Point 41	1,944.5	92.7
Point 42	1,243.2	47
Point 43	1,595.2	54.5
Point 44	1,834.7	82.6
Point 45	1,911.9	91.4
Point 46	1,573.4	42
Point 47	1,834.7	70.4
Point 48	2,293.7	82
Point 49	2,293.7	57.2
Point 50	2,293.7	17.4
Point 51	2,054.6	88.1
Point 52	1,382.9	47
Point 53	2,293.7	0
Point 54	455.3	55
Point 55	486.3	39.5
Point 56	497	34.7
Point 57	1,243.2	50
Point 58	1,592.2	57.5
Point 59	1,832.7	84.6
Point 60	1,911	95.1
Point 61	456.3	55
Point 62	498	35.7
Point 63	1,243.2	51
Point 64	1,591.2	58.5
Point 65	1,831.8	85.5
Point 66	1,909	94.1
Point 67	452.4	54.99
Point 68	455.31	54.99
Point 69	788.7	139.19
Point 70	1,376.6	140.89
Point 71	1,606.8	149.99
Point 72	1,617.2	149.99
Point 73	1,710.2	146.39

Point 74	1,910.99	94.09
Point 75	455.3	56
Point 76	455.3	55.99
Point 77	788.7	140.19
Point 78	1,376.6	141.89
Point 79	1,606.8	150.99
Point 80	1,617.2	150.99
Point 81	1,710.2	147.39
Point 82	1,911	95.09
Point 83	1,917	93.84
Point 84	1,917	93.85

Regions

	Material	Points	Area (ft^2)
Region 1	Gray Shale	1,8,50,53	20,232
Region 2	Gray Silty Clay	1,2,7,12,18,19,42,52,46,47,49,50,8	82,473
Region 3	Sand	2,3,6,16,17,18,12,7	3,245.8
Region 4	Brown Silty Clay	48,49,47,46,52,42,43,44,45,41,40,51	15,374
Region 5	Brown Silty Clay Liner	19,18,17,16,15,13,67,68,55,56,57,58,59,74,83,41,45,44,43,42	4,291.7
Region 6	Brown Silty Clay	16,6,3,4,5,9,15	2,258.8
Region 7	Brown Silty Clay Liner	9,10,11,13,15	1,049.7
Region 8	Brown Silty Clay Cover	11,13,75,27,29,31,33,35,60,84,83,41,40,39,38,37,36,34,32,30,28,26,25,24,23,22,21,20,14	5,799.6
Region 9	Sand	65,66,74,59,58,57,56,55,68,61,62,63,64	1,442.2
Region 10	MSW	68,61,62,63,64,65,66,74,73,72,71,70,69	1.0992e+005
Region 11	Low Permeable Cover	67,68,69,70,71,72,73,74,83,82,81,80,79,78,77,76,13	1,460.9
Region 12	Cover Geosynthetic	84,83,82,81,80,79,78,77,76,13,75,27,29,31,33,35,60	14.632

Current Slip Surface

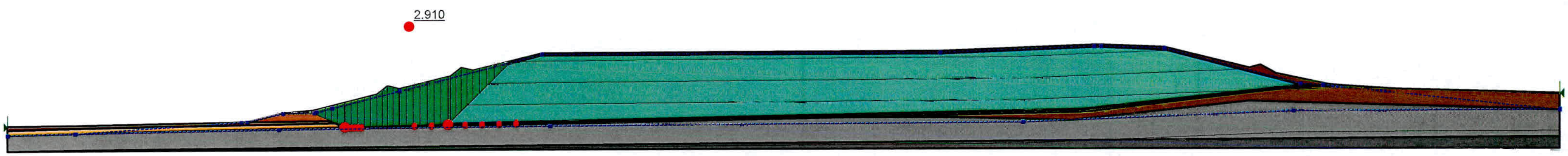
Slip Surface: 30,207
F of S: 2.951
Volume: 12,700.582 ft^3
Weight: 987,112.79 lbs
Resisting Moment: 66,665,794 lbs-ft
Activating Moment: 22,586,747 lbs-ft
Resisting Force: 478,143.06 lbs
Activating Force: 162,009.68 lbs
F of S Rank: 1
Exit: (442.28171, 58.203166) ft
Entry: (744.39557, 132.14557) ft
Radius: 148.72724 ft
Center: (579.76558, 150.63117) ft

Slip Slices

	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
Slice 1	445.35751	56.876394	-85.291565	308.0769	0	750
Slice 2	449.0704	55.274811	17.666228	549.66533	0	750

Slice 3	450.99219	54.445831	-1,431.0576	599.20265	259.29814	0
Slice 4	452.28845	53.88668	-1,395.3613	689.63486	298.43165	0
Slice 5	453.8	53.234661	-1,353.7363	832.99928	360.47098	0
Slice 6	455.8	52.371945	-1,298.6603	1,018.2925	440.65453	0
Slice 7	462.44589	49.505188	-1,115.6459	1,400.0031	605.83544	0
Slice 8	473.35674	44.798707	-815.18317	2,022.1125	875.04623	0
Slice 9	482.21085	40.979417	-571.35889	2,548.3696	1,102.778	0
Slice 10	491.65	36.907765	-311.42378	3,125.7394	1,352.6282	0
Slice 11	497.5	34.610294	-164.42591	3,004.8406	1,300.3107	0
Slice 12	502.73	34.717971	-167.88106	3,078.8537	1,332.339	0
Slice 13	512.19	34.912735	-174.13071	3,238.0595	1,401.2335	0
Slice 14	521.65	35.1075	-180.38036	3,395.1378	1,469.2073	0
Slice 15	531.11	35.302265	-186.63001	3,549.6898	1,536.0879	0
Slice 16	540.57	35.497029	-192.87967	3,701.3347	1,601.7106	0
Slice 17	549.15	35.673676	-198.54796	4,096.1018	1,772.5415	0
Slice 18	556.85	35.832206	-203.63488	4,735.5194	2,049.2422	0
Slice 19	564.9	35.997941	-208.95303	4,855.7603	2,101.2751	0
Slice 20	573.3	36.170882	-214.50241	4,454.4376	1,927.6073	0
Slice 21	577.7795	36.263107	-217.46174	4,256.2271	1,841.834	0
Slice 22	583.19764	36.374657	-221.04119	4,332.0672	1,874.6529	0
Slice 23	593.47493	36.586249	-227.83077	4,472.5082	1,935.4271	0
Slice 24	603.75221	36.79784	-234.62035	4,607.9686	1,994.0461	0
Slice 25	614.0295	37.009431	-241.40994	4,738.5478	2,050.5527	0
Slice 26	624.30679	37.221022	-248.19952	4,864.4615	2,105.0405	0
Slice 27	634.58407	37.432613	-254.98911	4,986.0412	2,157.6527	0
Slice 28	644.90582	37.688663	-264.52491	5,083.8549	2,199.9804	0
Slice 29	650.59107	38.341068	-301.68365	3,617.672	2,260.5724	0
Slice 30	652.69661	40.446609	-431.74255	3,447.9872	2,414.3066	125
Slice 31	658.15	45.9	-768.59754	3,445.3176	2,412.4373	125
Slice 32	665.85	53.6	-1,244.2252	3,556.5631	2,490.3323	125
Slice 33	673.9	61.65	-1,741.4723	3,295.1021	2,307.2553	125
Slice 34	682.3	70.05	-2,260.3388	2,646.9292	1,853.3998	125
Slice 35	691.735	79.485004	-2,843.1373	2,138.3339	1,497.2775	125
Slice 36	702.20501	89.955012	-3,489.8678	1,771.7819	1,240.6151	125
Slice 37	712.67502	100.42502	-4,136.5984	1,393.6345	975.8334	125
Slice 38	723.14503	110.89503	-4,783.3289	1,000.5937	700.62328	125
Slice 39	733.61504	121.36504	-5,430.0595	589.68553	412.90226	125
Slice 40	739.51923	127.26923	-5,794.7607	111.5471	0	1,000
Slice 41	740.54064	128.29064	15.442533	97.973712	0	750
Slice 42	742.64421	130.39421	-76.78793	-93.186846	-0	750

R85



Landfill 33 Long-Term Static Base Clay to FML

File Information

File Version: 8.14
Created By: Karl Finke
Last Edited By: Karl Finke
Revision Number: 127
Date: 2/14/2019
Time: 3:45:11 PM
Tool Version: 8.14.3.13430
File Name: Long Term Static Base Clay to FML.gsz
Directory: C:\SlopeW\Landfill 33\Final\
Last Solved Date: 2/14/2019
Last Solved Time: 3:45:44 PM

Project Settings

Length(L) Units: Feet
Time(t) Units: Seconds
Force(F) Units: Pounds
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D
Element Thickness: 1

Analysis Settings

Landfill 33 Long-Term Static Base Clay to FML

- Kind: SLOPE/W
- Method: Morgenstern-Price
- Settings
  - Side Function
    - Interslice force function option: Half-Sine
  - PWP Conditions Source: Piezometric Line
  - Apply Phreatic Correction: Yes
  - Use Staged Rapid Drawdown: No
- Slip Surface
  - Direction of movement: Right to Left
  - Use Passive Mode: No
  - Slip Surface Option: Block
  - Critical slip surfaces saved: 1
  - Resisting Side Maximum Convex Angle: 1 °
  - Driving Side Maximum Convex Angle: 5 °
  - Restrict Block Crossing: No
  - Optimize Critical Slip Surface Location: No
  - Tension Crack
    - Tension Crack Option: (none)
- F of S Distribution
  - F of S Calculation Option: Constant
- Advanced
  - Number of Slices: 30
  - F of S Tolerance: 0.001
  - Minimum Slip Surface Depth: 0.1 ft
  - Search Method: Root Finder

Tolerable difference between starting and converged F of S: 3
Maximum iterations to calculate converged lambda: 20
Max Absolute Lambda: 2

Materials

MSW

Model: Mohr-Coulomb
Unit Weight: 70 pcf
Cohesion': 125 psf
Phi': 35 °
Phi-B: 0 °
Constant Unit Wt. Above Water Table: 70 pcf
Pore Water Pressure
Piezometric Line: 1

Gray Shale

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Cohesion': 5,000 psf
Phi': 0 °
Phi-B: 0 °
Constant Unit Wt. Above Water Table: 120 pcf
Pore Water Pressure
Piezometric Line: 1

Gray Silty Clay

Model: Mohr-Coulomb
Unit Weight: 135 pcf
Cohesion': 150 psf
Phi': 23 °
Phi-B: 0 °
Constant Unit Wt. Above Water Table: 125 pcf
Pore Water Pressure
Piezometric Line: 1

Sand

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Cohesion': 0 psf
Phi': 32 °
Phi-B: 0 °
Constant Unit Wt. Above Water Table: 130 pcf
Pore Water Pressure
Piezometric Line: 1

Brown Silty Clay

Model: Mohr-Coulomb
Unit Weight: 140 pcf
Cohesion': 250 psf
Phi': 28 °
Phi-B: 0 °
Constant Unit Wt. Above Water Table: 135 pcf
Pore Water Pressure
Piezometric Line: 1

Brown Silty Clay Liner

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Cohesion': 0 psf

Phi': 23.4 °
Phi-B: 0 °
Constant Unit Wt. Above Water Table: 120 pcf
Pore Water Pressure
Piezometric Line: 1

Brown Silty Clay Cover

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion': 100 psf
Phi': 27 °
Phi-B: 0 °
Constant Unit Wt. Above Water Table: 120 pcf
Pore Water Pressure
Piezometric Line: 2

Low Permeable Cover

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Cohesion': 100 psf
Phi': 28 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Cover Geosynthetic

Model: Mohr-Coulomb
Unit Weight: 62 pcf
Cohesion': 39 psf
Phi': 25 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Slip Surface Limits

Left Coordinate: (0, 37) ft
Right Coordinate: (2,293.7, 82) ft

Slip Surface Block

Left Grid
Upper Left: (497, 34.6) ft
Lower Left: (497, 32) ft
Lower Right: (522, 32.5) ft
X Increments: 5
Y Increments: 3
Starting Angle: 140 °
Ending Angle: 165 °
Angle Increments: 6
Right Grid
Upper Left: (600, 36.75) ft
Lower Left: (600, 34) ft
Lower Right: (750, 37) ft
X Increments: 6
Y Increments: 2
Starting Angle: 45 °
Ending Angle: 65 °
Angle Increments: 10

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
Coordinate 1	0	24
Coordinate 2	400	31
Coordinate 3	800	35
Coordinate 4	1,500	40
Coordinate 5	1,900	56
Coordinate 6	2,293.7	58

Piezometric Line 2

Coordinates

	X (ft)	Y (ft)
Coordinate 1	0	24
Coordinate 2	100	25.8
Coordinate 3	344.4	41.5
Coordinate 4	352.9	42
Coordinate 5	406.5	55
Coordinate 6	452.2769	55.6
Coordinate 7	455.3	56.5
Coordinate 8	478.1217	62.3846
Coordinate 9	578.059	87.5198
Coordinate 10	788.659	140.706
Coordinate 11	1,376.5394	142.4035
Coordinate 12	1,606.8289	151.4981
Coordinate 13	1,617.1758	151.4998
Coordinate 14	1,710.2	148.4
Coordinate 15	1,911	96.1
Coordinate 16	1,944.5	93.7
Coordinate 17	2,293.7	57.2

Seismic Coefficients

Horz Seismic Coef.: 0

Points

	X (ft)	Y (ft)
Point 1	0	0
Point 2	0	24
Point 3	0	31
Point 4	0	37
Point 5	100	38
Point 6	100	33
Point 7	100	25.8
Point 8	100	1
Point 9	344.4	41.5
Point 10	352.9	42
Point 11	406.5	55
Point 12	414.2	32.2
Point 13	452.3	55
Point 14	452.3	59.1
Point 15	475.5	43.4

Point 16	483.3	39.5
Point 17	489.9	36.2
Point 18	494.3	34
Point 19	498.9	31.7
Point 20	545.3	82.4
Point 21	560.7	94.7
Point 22	577.5	90.4
Point 23	654.3	109.6
Point 24	669.7	121.9
Point 25	686.5	117.7
Point 26	788.7	143.2
Point 27	788.7	140.2
Point 28	1,376.6	144.9
Point 29	1,376.6	141.9
Point 30	1,606.8	154
Point 31	1,606.8	151
Point 32	1,617.2	154
Point 33	1,617.2	151
Point 34	1,710.4	150.4
Point 35	1,710.2	147.4
Point 36	1,835.2	120.3
Point 37	1,852	124.5
Point 38	1,874.8	111.7
Point 39	1,953.3	94.8
Point 40	1,980.4	93
Point 41	1,944.5	92.7
Point 42	1,243.2	47
Point 43	1,595.2	54.5
Point 44	1,834.7	82.6
Point 45	1,911.9	91.4
Point 46	1,573.4	42
Point 47	1,834.7	70.4
Point 48	2,293.7	82
Point 49	2,293.7	57.2
Point 50	2,293.7	17.4
Point 51	2,054.6	88.1
Point 52	1,382.9	47
Point 53	2,293.7	0
Point 54	455.3	55
Point 55	486.3	39.5
Point 56	497	34.7
Point 57	1,243.2	50
Point 58	1,592.2	57.5
Point 59	1,832.7	84.6
Point 60	1,911	95.1
Point 61	456.3	55
Point 62	498	35.7
Point 63	1,243.2	51
Point 64	1,591.2	58.5
Point 65	1,831.8	85.5
Point 66	1,909	94.1
Point 67	452.4	54.99
Point 68	455.31	54.99
Point 69	788.7	139.19
Point 70	1,376.6	140.89
Point 71	1,606.8	149.99
Point 72	1,617.2	149.99
Point 73	1,710.2	146.39

Point 74	1,910.99	94.09
Point 75	455.3	56
Point 76	455.3	55.99
Point 77	788.7	140.19
Point 78	1,376.6	141.89
Point 79	1,606.8	150.99
Point 80	1,617.2	150.99
Point 81	1,710.2	147.39
Point 82	1,911	95.09
Point 83	1,917	93.84
Point 84	1,917	93.85

Regions

	Material	Points	Area (ft^2)
Region 1	Gray Shale	1,8,50,53	20,232
Region 2	Gray Silty Clay	1,2,7,12,18,19,42,52,46,47,49,50,8	82,473
Region 3	Sand	2,3,6,16,17,18,12,7	3,245.8
Region 4	Brown Silty Clay	48,49,47,46,52,42,43,44,45,41,40,51	15,374
Region 5	Brown Silty Clay Liner	19,18,17,16,15,13,67,68,55,56,57,58,59,74,83,41,45,44,43,42	4,291.7
Region 6	Brown Silty Clay	16,6,3,4,5,9,15	2,258.8
Region 7	Brown Silty Clay Liner	9,10,11,13,15	1,049.7
Region 8	Brown Silty Clay Cover	11,13,75,27,29,31,33,35,60,84,83,41,40,39,38,37,36,34,32,30,28,26,25,24,23,22,21,20,14	5,799.6
Region 9	Sand	65,66,74,59,58,57,56,55,68,61,62,63,64	1,442.2
Region 10	MSW	68,61,62,63,64,65,66,74,73,72,71,70,69	1.0992e+005
Region 11	Low Permeable Cover	67,68,69,70,71,72,73,74,83,82,81,80,79,78,77,76,13	1,460.9
Region 12	Cover Geosynthetic	84,83,82,81,80,79,78,77,76,13,75,27,29,31,33,35,60	14.632

Current Slip Surface

Slip Surface: 30,207
F of S: 2.910
Volume: 12,700.582 ft^3
Weight: 987,112.79 lbs
Resisting Moment: 65,331,865 lbs-ft
Activating Moment: 22,449,850 lbs-ft
Resisting Force: 470,407.98 lbs
Activating Force: 161,656.3 lbs
F of S Rank: 1
Exit: (442.28171, 58.203166) ft
Entry: (744.39557, 132.14557) ft
Radius: 148.72724 ft
Center: (579.76558, 150.63117) ft

Slip Slices

	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
Slice 1	445.35751	56.876394	-85.291565	227.10771	115.71716	100
Slice 2	449.0704	55.274811	17.666228	483.79282	237.50336	100

Slice 3	450.99219	54.445831	-1,431.0576	596.08206	257.94774	0
Slice 4	452.28845	53.88668	-1,395.3613	686.78174	297.197	0
Slice 5	453.8	53.234661	-1,353.7363	830.58211	359.42498	0
Slice 6	455.8	52.371945	-1,298.6603	1,016.5063	439.88154	0
Slice 7	462.44589	49.505188	-1,115.6459	1,400.4368	606.02313	0
Slice 8	473.35674	44.798707	-815.18317	2,027.3865	877.32847	0
Slice 9	482.21085	40.979417	-571.35889	2,558.9146	1,107.3412	0
Slice 10	491.65	36.907765	-311.42378	3,143.1991	1,360.1837	0
Slice 11	497.5	34.610294	-164.42591	3,010.8252	1,302.9004	0
Slice 12	502.73	34.717971	-167.88106	3,085.3491	1,335.1498	0
Slice 13	512.19	34.912735	-174.13071	3,245.4612	1,404.4365	0
Slice 14	521.65	35.1075	-180.38036	3,403.3587	1,472.7648	0
Slice 15	531.11	35.302265	-186.63001	3,558.6112	1,539.9486	0
Slice 16	540.57	35.497029	-192.87967	3,710.8074	1,605.8098	0
Slice 17	549.15	35.673676	-198.54796	4,106.3789	1,776.9888	0
Slice 18	556.85	35.832206	-203.63488	4,746.9408	2,054.1847	0
Slice 19	564.9	35.997941	-208.95303	4,867.2724	2,106.2569	0
Slice 20	573.3	36.170882	-214.50241	4,464.831	1,932.1049	0
Slice 21	577.7795	36.263107	-217.46174	4,265.9535	1,846.0429	0
Slice 22	583.19764	36.374657	-221.04119	4,341.4759	1,878.7244	0
Slice 23	593.47493	36.586249	-227.83077	4,481.097	1,939.1438	0
Slice 24	603.75221	36.79784	-234.62035	4,615.4167	1,997.2692	0
Slice 25	614.0295	37.009431	-241.40994	4,744.537	2,053.1445	0
Slice 26	624.30679	37.221022	-248.19952	4,868.6844	2,106.8679	0
Slice 27	634.58407	37.432613	-254.98911	4,988.21	2,158.5912	0
Slice 28	644.90582	37.688663	-264.52491	5,083.184	2,199.6902	0
Slice 29	650.59107	38.341068	-301.68365	3,586.4218	2,241.0451	0
Slice 30	652.69661	40.446609	-431.74255	3,418.2631	2,393.4936	125
Slice 31	658.15	45.9	-768.59754	3,416.0332	2,391.9322	125
Slice 32	665.85	53.6	-1,244.2252	3,527.399	2,469.9114	125
Slice 33	673.9	61.65	-1,741.4723	3,268.6558	2,288.7375	125
Slice 34	682.3	70.05	-2,260.3388	2,625.4514	1,838.3609	125
Slice 35	691.735	79.485004	-2,843.1373	2,120.8294	1,485.0207	125
Slice 36	702.20501	89.955012	-3,489.8678	1,757.3353	1,230.4994	125
Slice 37	712.67502	100.42502	-4,136.5984	1,381.9968	967.68455	125
Slice 38	723.14503	110.89503	-4,783.3289	991.41035	694.193	125
Slice 39	733.61504	121.36504	-5,430.0595	582.49167	407.86506	125
Slice 40	739.51923	127.26923	-5,794.7607	342.15609	181.92762	100
Slice 41	740.54064	128.29064	15.442533	266.25665	127.79618	100
Slice 42	742.64421	130.39421	-76.78793	104.56797	53.280042	100


1.540

Landfill 33 Short-Term Seismic Base Clay to FML

File Information

File Version: 8.14
Created By: Karl Finke
Last Edited By: Karl Finke
Revision Number: 134
Date: 2/14/2019
Time: 3:57:33 PM
Tool Version: 8.14.3.13430
File Name: Short Term Seismic Base Clay to FML.gsz
Directory: C:\SlopeW\Landfill 33\Final\
Last Solved Date: 2/14/2019
Last Solved Time: 3:58:02 PM

Project Settings

Length(L) Units: Feet
Time(t) Units: Seconds
Force(F) Units: Pounds
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D
Element Thickness: 1

Analysis Settings

Landfill 33 Short-Term Seismic Base Clay to FML

- Kind: SLOPE/W
- Method: Morgenstern-Price
- Settings
  - Side Function
    - Interslice force function option: Half-Sine
  - PWP Conditions Source: Piezometric Line
  - Apply Phreatic Correction: Yes
  - Use Staged Rapid Drawdown: No
- Slip Surface
  - Direction of movement: Right to Left
  - Use Passive Mode: No
  - Slip Surface Option: Block
  - Critical slip surfaces saved: 1
  - Resisting Side Maximum Convex Angle: 1 °
  - Driving Side Maximum Convex Angle: 5 °
  - Restrict Block Crossing: No
  - Optimize Critical Slip Surface Location: No
  - Tension Crack
    - Tension Crack Option: (none)
- F of S Distribution
  - F of S Calculation Option: Constant
- Advanced
  - Number of Slices: 30
  - F of S Tolerance: 0.001
  - Minimum Slip Surface Depth: 0.1 ft
  - Search Method: Root Finder

Tolerable difference between starting and converged F of S: 3
Maximum iterations to calculate converged lambda: 20
Max Absolute Lambda: 2

Materials

MSW

Model: Mohr-Coulomb
Unit Weight: 70 pcf
Cohesion': 125 psf
Phi': 35 °
Phi-B: 0 °
Constant Unit Wt. Above Water Table: 70 pcf
Pore Water Pressure
Piezometric Line: 1

Gray Shale

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Cohesion': 5,000 psf
Phi': 0 °
Phi-B: 0 °
Constant Unit Wt. Above Water Table: 120 pcf
Pore Water Pressure
Piezometric Line: 1

Gray Silty Clay

Model: Mohr-Coulomb
Unit Weight: 135 pcf
Cohesion': 1,100 psf
Phi': 17.2 °
Phi-B: 0 °
Constant Unit Wt. Above Water Table: 125 pcf
Pore Water Pressure
Piezometric Line: 1

Sand

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Cohesion': 0 psf
Phi': 32 °
Phi-B: 0 °
Constant Unit Wt. Above Water Table: 130 pcf
Pore Water Pressure
Piezometric Line: 1

Brown Silty Clay

Model: Mohr-Coulomb
Unit Weight: 140 pcf
Cohesion': 250 psf
Phi': 28 °
Phi-B: 0 °
Constant Unit Wt. Above Water Table: 135 pcf
Pore Water Pressure
Piezometric Line: 1

Brown Silty Clay Liner

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Cohesion': 0 psf

Phi': 23.4 °
Phi-B: 0 °
Constant Unit Wt. Above Water Table: 120 pcf
Pore Water Pressure
Piezometric Line: 1

Brown Silty Clay Cover

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion': 750 psf
Phi': 0 °
Phi-B: 0 °
Constant Unit Wt. Above Water Table: 120 pcf
Pore Water Pressure
Piezometric Line: 2

Low Permeable Cover

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Cohesion': 1,000 psf
Phi': 0 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Cover Geosynthetic

Model: Mohr-Coulomb
Unit Weight: 62 pcf
Cohesion': 39 psf
Phi': 25 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Slip Surface Limits

Left Coordinate: (0, 37) ft
Right Coordinate: (2,293.7, 82) ft

Slip Surface Block

Left Grid
Upper Left: (497, 34.6) ft
Lower Left: (497, 32) ft
Lower Right: (522, 32.5) ft
X Increments: 5
Y Increments: 3
Starting Angle: 140 °
Ending Angle: 165 °
Angle Increments: 6
Right Grid
Upper Left: (600, 36.75) ft
Lower Left: (600, 34) ft
Lower Right: (750, 37) ft
X Increments: 6
Y Increments: 2
Starting Angle: 45 °
Ending Angle: 65 °
Angle Increments: 10

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
Coordinate 1	0	24
Coordinate 2	400	31
Coordinate 3	800	35
Coordinate 4	1,500	40
Coordinate 5	1,900	56
Coordinate 6	2,293.7	58

Piezometric Line 2

Coordinates

	X (ft)	Y (ft)
Coordinate 1	0	24
Coordinate 2	100	25.8
Coordinate 3	344.4	41.5
Coordinate 4	352.9	42
Coordinate 5	406.5	55
Coordinate 6	452.2769	55.6
Coordinate 7	455.3	56.5
Coordinate 8	478.1217	62.3846
Coordinate 9	578.059	87.5198
Coordinate 10	788.659	140.706
Coordinate 11	1,376.5394	142.4035
Coordinate 12	1,606.8289	151.4981
Coordinate 13	1,617.1758	151.4998
Coordinate 14	1,710.2	148.4
Coordinate 15	1,911	96.1
Coordinate 16	1,944.5	93.7
Coordinate 17	2,293.7	57.2

Seismic Coefficients

Horz Seismic Coef.: 0.1837

Points

	X (ft)	Y (ft)
Point 1	0	0
Point 2	0	24
Point 3	0	31
Point 4	0	37
Point 5	100	38
Point 6	100	33
Point 7	100	25.8
Point 8	100	1
Point 9	344.4	41.5
Point 10	352.9	42
Point 11	406.5	55
Point 12	414.2	32.2
Point 13	452.3	55
Point 14	452.3	59.1
Point 15	475.5	43.4

Point 16	483.3	39.5
Point 17	489.9	36.2
Point 18	494.3	34
Point 19	498.9	31.7
Point 20	545.3	82.4
Point 21	560.7	94.7
Point 22	577.5	90.4
Point 23	654.3	109.6
Point 24	669.7	121.9
Point 25	686.5	117.7
Point 26	788.7	143.2
Point 27	788.7	140.2
Point 28	1,376.6	144.9
Point 29	1,376.6	141.9
Point 30	1,606.8	154
Point 31	1,606.8	151
Point 32	1,617.2	154
Point 33	1,617.2	151
Point 34	1,710.4	150.4
Point 35	1,710.2	147.4
Point 36	1,835.2	120.3
Point 37	1,852	124.5
Point 38	1,874.8	111.7
Point 39	1,953.3	94.8
Point 40	1,980.4	93
Point 41	1,944.5	92.7
Point 42	1,243.2	47
Point 43	1,595.2	54.5
Point 44	1,834.7	82.6
Point 45	1,911.9	91.4
Point 46	1,573.4	42
Point 47	1,834.7	70.4
Point 48	2,293.7	82
Point 49	2,293.7	57.2
Point 50	2,293.7	17.4
Point 51	2,054.6	88.1
Point 52	1,382.9	47
Point 53	2,293.7	0
Point 54	455.3	55
Point 55	486.3	39.5
Point 56	497	34.7
Point 57	1,243.2	50
Point 58	1,592.2	57.5
Point 59	1,832.7	84.6
Point 60	1,911	95.1
Point 61	456.3	55
Point 62	498	35.7
Point 63	1,243.2	51
Point 64	1,591.2	58.5
Point 65	1,831.8	85.5
Point 66	1,909	94.1
Point 67	452.4	54.99
Point 68	455.31	54.99
Point 69	788.7	139.19
Point 70	1,376.6	140.89
Point 71	1,606.8	149.99
Point 72	1,617.2	149.99
Point 73	1,710.2	146.39

Point 74	1,910.99	94.09
Point 75	455.3	56
Point 76	455.3	55.99
Point 77	788.7	140.19
Point 78	1,376.6	141.89
Point 79	1,606.8	150.99
Point 80	1,617.2	150.99
Point 81	1,710.2	147.39
Point 82	1,911	95.09
Point 83	1,917	93.84
Point 84	1,917	93.85

Regions

	Material	Points	Area (ft^2)
Region 1	Gray Shale	1,8,50,53	20,232
Region 2	Gray Silty Clay	1,2,7,12,18,19,42,52,46,47,49,50,8	82,473
Region 3	Sand	2,3,6,16,17,18,12,7	3,245.8
Region 4	Brown Silty Clay	48,49,47,46,52,42,43,44,45,41,40,51	15,374
Region 5	Brown Silty Clay Liner	19,18,17,16,15,13,67,68,55,56,57,58,59,74,83,41,45,44,43,42	4,291.7
Region 6	Brown Silty Clay	16,6,3,4,5,9,15	2,258.8
Region 7	Brown Silty Clay Liner	9,10,11,13,15	1,049.7
Region 8	Brown Silty Clay Cover	11,13,75,27,29,31,33,35,60,84,83,41,40,39,38,37,36,34,32,30,28,26,25,24,23,22,21,20,14	5,799.6
Region 9	Sand	65,66,74,59,58,57,56,55,68,61,62,63,64	1,442.2
Region 10	MSW	68,61,62,63,64,65,66,74,73,72,71,70,69	1.0992e+005
Region 11	Low Permeable Cover	67,68,69,70,71,72,73,74,83,82,81,80,79,78,77,76,13	1,460.9
Region 12	Cover Geosynthetic	84,83,82,81,80,79,78,77,76,13,75,27,29,31,33,35,60	14.632

Current Slip Surface

Slip Surface: 2,751
F of S: 1.540
Volume: 20,534.008 ft^3
Weight: 1,574,366.5 lbs
Resisting Moment: 1.1103727e+008 lbs-ft
Activating Moment: 72,119,314 lbs-ft
Resisting Force: 714,220.15 lbs
Activating Force: 463,781.01 lbs
F of S Rank: 1
Exit: (441.6228, 58.144181) ft
Entry: (829.06673, 143.31673) ft
Radius: 182.23567 ft
Center: (621.30203, 164.60986) ft

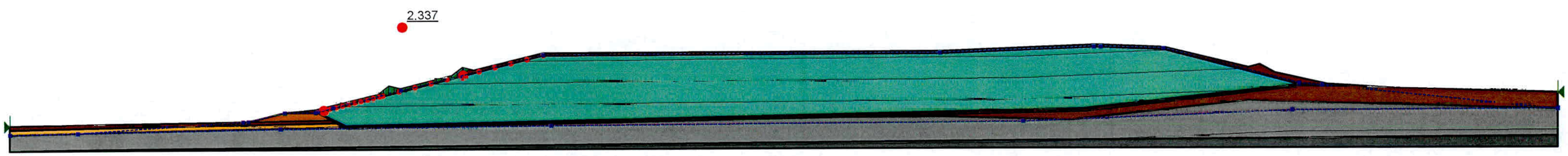
Slip Slices

	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
Slice 1	444.64197	56.841841	-83.720949	415.35627	0	750
Slice 2	448.28648	55.26975	17.340911	665.24179	0	750

Slice 3	450.59437	54.274226	-1,420.5987	681.38473	294.8615	0
Slice 4	452.28845	53.54347	-1,373.9471	812.13342	351.44151	0
Slice 5	453.8	52.89145	-1,332.3221	971.03083	420.20256	0
Slice 6	455.8	52.028735	-1,277.2461	1,177.6142	509.59918	0
Slice 7	464.94589	48.083583	-1,025.3868	1,791.2338	775.13608	0
Slice 8	475.85674	43.377101	-724.92403	2,552.8256	1,104.7063	0
Slice 9	482.21085	40.636206	-549.94469	3,036.8631	1,314.168	0
Slice 10	491.65	36.564554	-290.00958	3,802.2206	1,645.3678	0
Slice 11	497.5	34.041111	-128.91241	4,298.4152	1,860.0903	0
Slice 12	500	32.962716	-60.067458	4,583.9668	1,983.6596	0
Slice 13	509.21667	32.331386	-14.925819	3,682.2171	1,593.4376	0
Slice 14	523.65	32.794159	-34.794454	3,903.0458	1,688.9987	0
Slice 15	538.08333	33.256932	-54.66309	4,116.9784	1,781.5756	0
Slice 16	553	33.735202	-75.197072	4,847.0253	2,097.4952	0
Slice 17	569.1	34.251413	-97.360007	5,063.7233	2,191.2688	0
Slice 18	577.7795	34.529701	-109.30803	4,654.4738	2,014.1707	0
Slice 19	584.41242	34.742371	-118.43877	4,736.5837	2,049.7028	0
Slice 20	597.11925	35.149788	-135.93074	4,888.036	2,115.2421	0
Slice 21	609.82608	35.557204	-153.42271	5,030.8765	2,177.0547	0
Slice 22	622.53292	35.96462	-170.91468	5,165.2851	2,235.2185	0
Slice 23	635.23975	36.372037	-188.40665	5,291.7168	2,289.9303	0
Slice 24	647.94658	36.779453	-205.89862	5,410.8932	2,341.5026	0
Slice 25	662	37.230045	-225.24427	6,056.4928	2,620.8785	0
Slice 26	678.1	37.746256	-247.40721	6,192.8832	2,679.8999	0
Slice 27	692.91667	38.221319	-267.80353	5,793.6821	2,507.1501	0
Slice 28	705.75	38.632791	-285.46964	5,894.37	2,550.7217	0
Slice 29	718.64708	39.108014	-307.07359	5,946.2953	2,573.1917	0
Slice 30	725.6307	39.880705	-350.92731	3,311.472	2,069.2374	0
Slice 31	732.38642	46.636418	-768.22653	3,060.7689	2,143.1734	125
Slice 32	744.89144	59.141436	-1,540.6593	2,789.6514	1,953.3349	125
Slice 33	757.39645	71.646454	-2,313.0921	2,515.55	1,761.4071	125
Slice 34	769.90147	84.151473	-3,085.5248	2,232.5	1,563.2134	125
Slice 35	782.40649	96.656491	-3,857.9576	1,934.5493	1,354.586	125
Slice 36	788.6795	102.9295	-4,245.4402	1,778.6111	1,245.3969	125
Slice 37	794.35	108.6	-4,595.706	1,568.8494	1,098.5202	125
Slice 38	806.26127	120.51127	-5,332.8407	1,103.6283	772.76887	125
Slice 39	818.78382	133.03382	-6,108.6267	571.20545	399.96236	125
Slice 40	825.54655	139.79655	-6,527.585	-200.32528	-0	1,000
Slice 41	826.30673	140.55673	16.097916	-140.70541	-0	750
Slice 42	827.81609	142.06609	-77.813692	-328.75447	-0	750

ATTACHMENT C.3.

FINAL COVER INTERFACE STABILITY ANALYSIS


2.337

Landfill 33 Short-Term Static Infinite Slope Cover Failure Analysis

File Information

File Version: 8.14
Created By: Karl Finke
Last Edited By: Karl Finke
Revision Number: 113
Date: 2/14/2019
Time: 2:36:50 PM
Tool Version: 8.14.3.13430
File Name: Short Term Static Infinite Slope Cover FML.gsz
Directory: C:\SlopeW\Landfill 33\Final\
Last Solved Date: 2/14/2019
Last Solved Time: 2:40:35 PM

Project Settings

Length(L) Units: Feet
Time(t) Units: Seconds
Force(F) Units: Pounds
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D
Element Thickness: 1

Analysis Settings

Landfill 33 Short-Term Static Infinite Slope Cover Failure Analysis

- Kind: SLOPE/W
- Method: Morgenstern-Price
- Settings
  - Side Function
    - Interslice force function option: Half-Sine
  - PWP Conditions Source: Piezometric Line
  - Apply Phreatic Correction: Yes
  - Use Staged Rapid Drawdown: No
- Slip Surface
  - Direction of movement: Right to Left
  - Use Passive Mode: No
  - Slip Surface Option: Block
  - Critical slip surfaces saved: 1
  - Resisting Side Maximum Convex Angle: 1 °
  - Driving Side Maximum Convex Angle: 5 °
  - Restrict Block Crossing: No
  - Optimize Critical Slip Surface Location: No
  - Tension Crack
    - Tension Crack Option: (none)
- F of S Distribution
  - F of S Calculation Option: Constant
- Advanced
  - Number of Slices: 30
  - F of S Tolerance: 0.001

Minimum Slip Surface Depth: 0.1 ft
Search Method: Root Finder
Tolerable difference between starting and converged F of S: 3
Maximum iterations to calculate converged lambda: 20
Max Absolute Lambda: 2

Materials

MSW

Model: Mohr-Coulomb
Unit Weight: 70 pcf
Cohesion': 125 psf
Phi': 35 °
Phi-B: 0 °
Constant Unit Wt. Above Water Table: 70 pcf
Pore Water Pressure
    Piezometric Line: 1

Gray Shale

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Cohesion': 5,000 psf
Phi': 0 °
Phi-B: 0 °
Constant Unit Wt. Above Water Table: 120 pcf
Pore Water Pressure
    Piezometric Line: 1

Gray Silty Clay

Model: Mohr-Coulomb
Unit Weight: 135 pcf
Cohesion': 1,100 psf
Phi': 17.2 °
Phi-B: 0 °
Constant Unit Wt. Above Water Table: 125 pcf
Pore Water Pressure
    Piezometric Line: 1

Sand

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Cohesion': 0 psf
Phi': 32 °
Phi-B: 0 °
Constant Unit Wt. Above Water Table: 130 pcf
Pore Water Pressure
    Piezometric Line: 1

Brown Silty Clay

Model: Mohr-Coulomb
Unit Weight: 140 pcf
Cohesion': 0 psf
Phi': 28 °
Phi-B: 0 °
Constant Unit Wt. Above Water Table: 135 pcf
Pore Water Pressure
    Piezometric Line: 1

Brown Silty Clay Liner

Model: Mohr-Coulomb

Unit Weight: 130 pcf
Cohesion': 0 psf
Phi': 23.4 °
Phi-B: 0 °
Constant Unit Wt. Above Water Table: 120 pcf
Pore Water Pressure
Piezometric Line: 1

Brown Silty Clay Cover

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion': 750 psf
Phi': 0 °
Phi-B: 0 °
Constant Unit Wt. Above Water Table: 120 pcf
Pore Water Pressure
Piezometric Line: 2

Low Permeable Cover

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Cohesion': 1,000 psf
Phi': 0 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Cover Geosynthetic

Model: Mohr-Coulomb
Unit Weight: 62 pcf
Cohesion': 39 psf
Phi': 25 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Slip Surface Limits

Left Coordinate: (0, 37) ft
Right Coordinate: (2,293.7, 82) ft

Slip Surface Block

Left Grid
Upper Left: (455.3, 56) ft
Lower Left: (455.29, 56) ft
Lower Right: (547, 79.15) ft
X Increments: 10
Y Increments: 3
Starting Angle: 135 °
Ending Angle: 180 °
Angle Increments: 15
Right Grid
Upper Left: (552, 80.421) ft
Lower Left: (552, 80.42) ft
Lower Right: (788.6704, 140.1864) ft
X Increments: 10
Y Increments: 3
Starting Angle: 45 °
Ending Angle: 65 °
Angle Increments: 10

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
Coordinate 1	0	24
Coordinate 2	400	31
Coordinate 3	800	35
Coordinate 4	1,500	40
Coordinate 5	1,900	56
Coordinate 6	2,293.7	58

Piezometric Line 2

Coordinates

	X (ft)	Y (ft)
Coordinate 1	0	24
Coordinate 2	100	25.8
Coordinate 3	344.4	41.5
Coordinate 4	352.9	42
Coordinate 5	406.5	55
Coordinate 6	452.2769	55.6
Coordinate 7	455.3	56.5
Coordinate 8	478.1217	62.3846
Coordinate 9	578.059	87.5198
Coordinate 10	788.659	140.706
Coordinate 11	1,376.5394	142.4035
Coordinate 12	1,606.8289	151.4981
Coordinate 13	1,617.1758	151.4998
Coordinate 14	1,710.2	148.4
Coordinate 15	1,911	96.1
Coordinate 16	1,944.5	93.7
Coordinate 17	2,293.7	57.2

Seismic Coefficients

Horz Seismic Coef.: 0

Points

	X (ft)	Y (ft)
Point 1	0	0
Point 2	0	24
Point 3	0	31
Point 4	0	37
Point 5	100	38
Point 6	100	33
Point 7	100	25.8
Point 8	100	1
Point 9	344.4	41.5
Point 10	352.9	42
Point 11	406.5	55
Point 12	414.2	32.2
Point 13	452.3	55
Point 14	452.3	59.1
Point 15	475.5	43.4

Point 16	483.3	39.5
Point 17	489.9	36.2
Point 18	494.3	34
Point 19	498.9	31.7
Point 20	545.3	82.4
Point 21	560.7	94.7
Point 22	577.5	90.4
Point 23	654.3	109.6
Point 24	669.7	121.9
Point 25	686.5	117.7
Point 26	788.7	143.2
Point 27	788.7	140.2
Point 28	1,376.6	144.9
Point 29	1,376.6	141.9
Point 30	1,606.8	154
Point 31	1,606.8	151
Point 32	1,617.2	154
Point 33	1,617.2	151
Point 34	1,710.4	150.4
Point 35	1,710.2	147.4
Point 36	1,835.2	120.3
Point 37	1,852	124.5
Point 38	1,874.8	111.7
Point 39	1,953.3	94.8
Point 40	1,980.4	93
Point 41	1,944.5	92.7
Point 42	1,243.2	47
Point 43	1,595.2	54.5
Point 44	1,834.7	82.6
Point 45	1,911.9	91.4
Point 46	1,573.4	42
Point 47	1,834.7	70.4
Point 48	2,293.7	82
Point 49	2,293.7	57.2
Point 50	2,293.7	17.4
Point 51	2,054.6	88.1
Point 52	1,382.9	47
Point 53	2,293.7	0
Point 54	455.3	55
Point 55	486.3	39.5
Point 56	497	34.7
Point 57	1,243.2	50
Point 58	1,592.2	57.5
Point 59	1,832.7	84.6
Point 60	1,911	95.1
Point 61	456.3	55
Point 62	498	35.7
Point 63	1,243.2	51
Point 64	1,591.2	58.5
Point 65	1,831.8	85.5
Point 66	1,909	94.1
Point 67	452.4	54.99
Point 68	455.31	54.99
Point 69	788.7	139.19
Point 70	1,376.6	140.89
Point 71	1,606.8	149.99
Point 72	1,617.2	149.99
Point 73	1,710.2	146.39

Point 74	1,910.99	94.09
Point 75	455.3	56
Point 76	455.3	55.99
Point 77	788.7	140.19
Point 78	1,376.6	141.89
Point 79	1,606.8	150.99
Point 80	1,617.2	150.99
Point 81	1,710.2	147.39
Point 82	1,911	95.09
Point 83	1,917	93.84
Point 84	1,917	93.85

Regions

	Material	Points	Area (ft²)
Region 1	Gray Shale	1,8,50,53	20,232
Region 2	Gray Silty Clay	1,2,7,12,18,19,42,52,46,47,49,50,8	82,473
Region 3	Sand	2,3,6,16,17,18,12,7	3,245.8
Region 4	Brown Silty Clay	48,49,47,46,52,42,43,44,45,41,40,51	15,374
Region 5	Brown Silty Clay Liner	19,18,17,16,15,13,67,68,55,56,57,58,59,74,83,41,45,44,43,42	4,291.7
Region 6	Brown Silty Clay	16,6,3,4,5,9,15	2,258.8
Region 7	Brown Silty Clay Liner	9,10,11,13,15	1,049.7
Region 8	Brown Silty Clay Cover	11,13,75,27,29,31,33,35,60,84,83,41,40,39,38,37,36,34,32,30,28,26,25,24,23,22,21,20,14	5,799.6
Region 9	Sand	65,66,74,59,58,57,56,55,68,61,62,63,64	1,442.2
Region 10	MSW	68,61,62,63,64,65,66,74,73,72,71,70,69	1.0992e+005
Region 11	Low Permeable Cover	67,68,69,70,71,72,73,74,83,82,81,80,79,78,77,76,13	1,460.9
Region 12	Cover Geosynthetic	84,83,82,81,80,79,78,77,76,13,75,27,29,31,33,35,60	14.632

Current Slip Surface

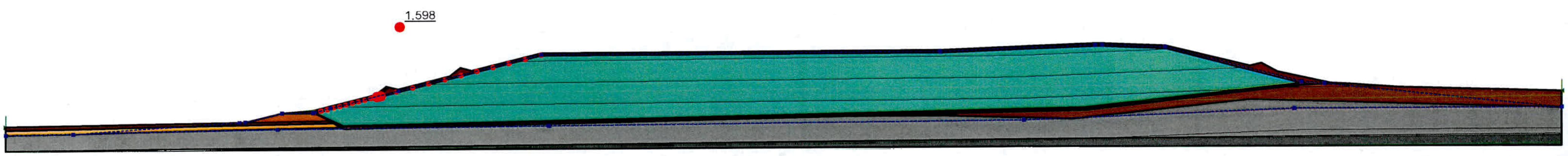
Slip Surface: 180,104
F of S: 2.337
Volume: 1,004.5231 ft³
Weight: 120,518.25 lbs
Resisting Moment: 4,383,628.9 lbs-ft
Activating Moment: 1,875,943.9 lbs-ft
Resisting Force: 67,962.026 lbs
Activating Force: 29,085.881 lbs
F of S Rank: 1
Exit: (460.20801, 61.081254) ft
Entry: (679.4856, 119.4536) ft
Radius: 98.273002 ft
Center: (558.19264, 134.04669) ft

Slip Slices

	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
Slice 1	462.03534	59.894573	-97.001087	417.09431	0	750
Slice 2	464.16517	58.511446	16.057815	663.93903	0	750

Slice 3	467.88117	59.177021	-1,715.7167	445.7919	207.87618	39
Slice 4	474.70819	60.901063	-1,819.0265	443.57364	206.84179	39
Slice 5	481.85383	62.705567	-1,927.1579	441.15185	205.71249	39
Slice 6	489.31808	64.590533	-2,040.1107	438.5284	204.48915	39
Slice 7	496.78234	66.475498	-2,153.0636	435.82352	203.22784	39
Slice 8	504.24659	68.360464	-2,266.0165	433.05262	201.93575	39
Slice 9	511.71085	70.245429	-2,378.9693	430.23102	200.62002	39
Slice 10	519.17511	72.130395	-2,491.9222	427.37373	199.28765	39
Slice 11	526.63936	74.01536	-2,604.875	424.49535	197.94543	39
Slice 12	534.10362	75.900326	-2,717.8279	421.60987	196.59991	39
Slice 13	541.56787	77.785292	-2,830.7808	418.73058	195.25728	39
Slice 14	549.15	79.700024	-2,945.5173	652.66889	304.3445	39
Slice 15	556.85	81.644522	-3,062.0376	1,123.0862	523.70369	39
Slice 16	564.9	83.677407	-3,183.8542	1,118.0391	521.35018	39
Slice 17	573.3	85.798679	-3,310.9672	638.08679	297.54475	39
Slice 18	577.7795	86.929897	-3,378.7533	398.10671	185.64021	39
Slice 19	581.87105	87.963145	-3,440.6687	396.64399	184.95813	39
Slice 20	589.49515	89.888477	-3,556.0404	393.96083	183.70695	39
Slice 21	597.11925	91.813808	-3,671.4121	391.34046	182.48505	39
Slice 22	604.74335	93.73914	-3,786.7838	388.78391	181.29291	39
Slice 23	612.36745	95.664471	-3,902.1555	386.29138	180.13063	39
Slice 24	619.99155	97.589803	-4,017.5272	383.86232	178.99794	39
Slice 25	627.61565	99.515134	-4,132.8989	381.49542	177.89424	39
Slice 26	635.23975	101.44047	-4,248.2706	379.18876	176.81862	39
Slice 27	642.86385	103.3658	-4,363.6423	376.9398	175.76991	39
Slice 28	650.48795	105.29113	-4,479.014	374.74547	174.74668	39
Slice 29	658.15	107.22604	-4,594.96	612.82955	285.76711	39
Slice 30	665.85	109.17054	-4,711.4803	1,093.1095	509.72531	39
Slice 31	670.02016	110.22556	-4,774.7048	1,314.0257	612.74023	39
Slice 32	670.686	110.654	15.156268	968.36477	0	750
Slice 33	675.25864	115.22664	-185.32981	313.51651	0	750

R110



Landfill 33 Long-Term Static Infinite Slope Cover Failure Analysis

File Information

File Version: 8.14
Created By: Karl Finke
Last Edited By: Karl Finke
Revision Number: 122
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Time: 3:18:26 PM
Tool Version: 8.14.3.13430
File Name: Long Term Static Infinite Slope Cover FML.gsz
Directory: C:\SlopeW\Landfill 33\Final\
Last Solved Date: 2/14/2019
Last Solved Time: 3:21:18 PM

Project Settings

Length(L) Units: Feet
Time(t) Units: Seconds
Force(F) Units: Pounds
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D
Element Thickness: 1

Analysis Settings

Landfill 33 Long-Term Static Infinite Slope Cover Failure Analysis

Kind: SLOPE/W
Method: Morgenstern-Price
Settings
- Side Function
  - Interslice force function option: Half-Sine
- PWP Conditions Source: Piezometric Line
- Apply Phreatic Correction: Yes
- Use Staged Rapid Drawdown: No

Slip Surface
- Direction of movement: Right to Left
- Use Passive Mode: No
- Slip Surface Option: Block
- Critical slip surfaces saved: 1
- Resisting Side Maximum Convex Angle: 1 °
- Driving Side Maximum Convex Angle: 5 °
- Restrict Block Crossing: No
- Optimize Critical Slip Surface Location: No
- Tension Crack
  - Tension Crack Option: (none)

F of S Distribution
- F of S Calculation Option: Constant

Advanced
- Number of Slices: 30
- F of S Tolerance: 0.001

Minimum Slip Surface Depth: 0.1 ft
Search Method: Root Finder
Tolerable difference between starting and converged F of S: 3
Maximum iterations to calculate converged lambda: 20
Max Absolute Lambda: 2

Materials

MSW

Model: Mohr-Coulomb
Unit Weight: 70 pcf
Cohesion': 125 psf
Phi': 35 °
Phi-B: 0 °
Constant Unit Wt. Above Water Table: 70 pcf
Pore Water Pressure
Piezometric Line: 1

Gray Shale

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Cohesion': 5,000 psf
Phi': 0 °
Phi-B: 0 °
Constant Unit Wt. Above Water Table: 120 pcf
Pore Water Pressure
Piezometric Line: 1

Gray Silty Clay

Model: Mohr-Coulomb
Unit Weight: 135 pcf
Cohesion': 150 psf
Phi': 23 °
Phi-B: 0 °
Constant Unit Wt. Above Water Table: 125 pcf
Pore Water Pressure
Piezometric Line: 1

Sand

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Cohesion': 0 psf
Phi': 32 °
Phi-B: 0 °
Constant Unit Wt. Above Water Table: 130 pcf
Pore Water Pressure
Piezometric Line: 1

Brown Silty Clay

Model: Mohr-Coulomb
Unit Weight: 140 pcf
Cohesion': 250 psf
Phi': 28 °
Phi-B: 0 °
Constant Unit Wt. Above Water Table: 135 pcf
Pore Water Pressure
Piezometric Line: 1

Brown Silty Clay Liner

Model: Mohr-Coulomb

Unit Weight: 130 pcf
Cohesion': 0 psf
Phi': 23.4 °
Phi-B: 0 °
Constant Unit Wt. Above Water Table: 120 pcf
Pore Water Pressure
Piezometric Line: 1

Brown Silty Clay Cover
Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion': 100 psf
Phi': 27 °
Phi-B: 0 °
Constant Unit Wt. Above Water Table: 120 pcf
Pore Water Pressure
Piezometric Line: 2

Low Permeable Cover
Model: Mohr-Coulomb
Unit Weight: 130 pcf
Cohesion': 100 psf
Phi': 28 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Cover Geosynthetic
Model: Mohr-Coulomb
Unit Weight: 62 pcf
Cohesion': 39 psf
Phi': 25 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Slip Surface Limits
Left Coordinate: (0, 37) ft
Right Coordinate: (2,293.7, 82) ft

Slip Surface Block
Left Grid
Upper Left: (455.3, 56) ft
Lower Left: (455.29, 56) ft
Lower Right: (547, 79.15) ft
X Increments: 10
Y Increments: 3
Starting Angle: 135 °
Ending Angle: 180 °
Angle Increments: 15
Right Grid
Upper Left: (552, 80.421) ft
Lower Left: (552, 80.42) ft
Lower Right: (788.6704, 140.1864) ft
X Increments: 10
Y Increments: 3
Starting Angle: 45 °
Ending Angle: 65 °
Angle Increments: 10

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
Coordinate 1	0	24
Coordinate 2	400	31
Coordinate 3	800	35
Coordinate 4	1,500	40
Coordinate 5	1,900	56
Coordinate 6	2,293.7	58

Piezometric Line 2

Coordinates

	X (ft)	Y (ft)
Coordinate 1	0	24
Coordinate 2	100	25.8
Coordinate 3	344.4	41.5
Coordinate 4	352.9	42
Coordinate 5	406.5	55
Coordinate 6	452.2769	55.6
Coordinate 7	455.3	56.5
Coordinate 8	478.1217	62.3846
Coordinate 9	578.059	87.5198
Coordinate 10	788.659	140.706
Coordinate 11	1,376.5394	142.4035
Coordinate 12	1,606.8289	151.4981
Coordinate 13	1,617.1758	151.4998
Coordinate 14	1,710.2	148.4
Coordinate 15	1,911	96.1
Coordinate 16	1,944.5	93.7
Coordinate 17	2,293.7	57.2

Seismic Coefficients

Horz Seismic Coef.: 0

Points

	X (ft)	Y (ft)
Point 1	0	0
Point 2	0	24
Point 3	0	31
Point 4	0	37
Point 5	100	38
Point 6	100	33
Point 7	100	25.8
Point 8	100	1
Point 9	344.4	41.5
Point 10	352.9	42
Point 11	406.5	55
Point 12	414.2	32.2
Point 13	452.3	55
Point 14	452.3	59.1
Point 15	475.5	43.4

Point 16	483.3	39.5
Point 17	489.9	36.2
Point 18	494.3	34
Point 19	498.9	31.7
Point 20	545.3	82.4
Point 21	560.7	94.7
Point 22	577.5	90.4
Point 23	654.3	109.6
Point 24	669.7	121.9
Point 25	686.5	117.7
Point 26	788.7	143.2
Point 27	788.7	140.2
Point 28	1,376.6	144.9
Point 29	1,376.6	141.9
Point 30	1,606.8	154
Point 31	1,606.8	151
Point 32	1,617.2	154
Point 33	1,617.2	151
Point 34	1,710.4	150.4
Point 35	1,710.2	147.4
Point 36	1,835.2	120.3
Point 37	1,852	124.5
Point 38	1,874.8	111.7
Point 39	1,953.3	94.8
Point 40	1,980.4	93
Point 41	1,944.5	92.7
Point 42	1,243.2	47
Point 43	1,595.2	54.5
Point 44	1,834.7	82.6
Point 45	1,911.9	91.4
Point 46	1,573.4	42
Point 47	1,834.7	70.4
Point 48	2,293.7	82
Point 49	2,293.7	57.2
Point 50	2,293.7	17.4
Point 51	2,054.6	88.1
Point 52	1,382.9	47
Point 53	2,293.7	0
Point 54	455.3	55
Point 55	486.3	39.5
Point 56	497	34.7
Point 57	1,243.2	50
Point 58	1,592.2	57.5
Point 59	1,832.7	84.6
Point 60	1,911	95.1
Point 61	456.3	55
Point 62	498	35.7
Point 63	1,243.2	51
Point 64	1,591.2	58.5
Point 65	1,831.8	85.5
Point 66	1,909	94.1
Point 67	452.4	54.99
Point 68	455.31	54.99
Point 69	788.7	139.19
Point 70	1,376.6	140.89
Point 71	1,606.8	149.99
Point 72	1,617.2	149.99
Point 73	1,710.2	146.39

Point 74	1,910.99	94.09
Point 75	455.3	56
Point 76	455.3	55.99
Point 77	788.7	140.19
Point 78	1,376.6	141.89
Point 79	1,606.8	150.99
Point 80	1,617.2	150.99
Point 81	1,710.2	147.39
Point 82	1,911	95.09
Point 83	1,917	93.84
Point 84	1,917	93.85

Regions

	Material	Points	Area (ft²)
Region 1	Gray Shale	1,8,50,53	20,232
Region 2	Gray Silty Clay	1,2,7,12,18,19,42,52,46,47,49,50,8	82,473
Region 3	Sand	2,3,6,16,17,18,12,7	3,245.8
Region 4	Brown Silty Clay	48,49,47,46,52,42,43,44,45,41,40,51	15,374
Region 5	Brown Silty Clay Liner	19,18,17,16,15,13,67,68,55,56,57,58,59,74,83,41,45,44,43,42	4,291.7
Region 6	Brown Silty Clay	16,6,3,4,5,9,15	2,258.8
Region 7	Brown Silty Clay Liner	9,10,11,13,15	1,049.7
Region 8	Brown Silty Clay Cover	11,13,75,27,29,31,33,35,60,84,83,41,40,39,38,37,36,34,32,30,28,26,25,24,23,22,21,20,14	5,799.6
Region 9	Sand	65,66,74,59,58,57,56,55,68,61,62,63,64	1,442.2
Region 10	MSW	68,61,62,63,64,65,66,74,73,72,71,70,69	1.0992e+005
Region 11	Low Permeable Cover	67,68,69,70,71,72,73,74,83,82,81,80,79,78,77,76,13	1,460.9
Region 12	Cover Geosynthetic	84,83,82,81,80,79,78,77,76,13,75,27,29,31,33,35,60	14.632

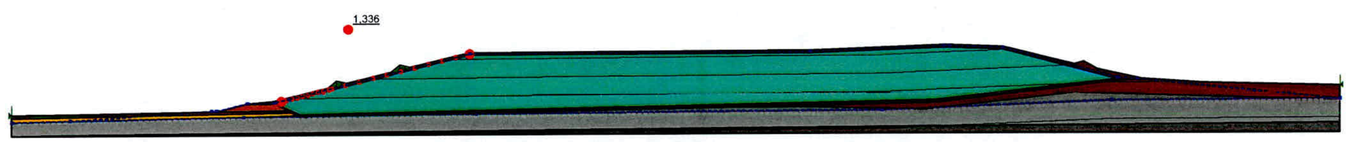
Current Slip Surface

Slip Surface: 168,796
F of S: 1.598
Volume: 115.69911 ft³
Weight: 13,882.501 lbs
Resisting Moment: 157,308.28 lbs-ft
Activating Moment: 98,451.316 lbs-ft
Resisting Force: 8,109.4099 lbs
Activating Force: 5,073.3919 lbs
F of S Rank: 1
Exit: (538.01201, 80.574085) ft
Entry: (565.14205, 93.563047) ft
Radius: 18.058502 ft
Center: (546.91302, 96.810288) ft

Slip Slices

	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
Slice 1	538.46751	80.501941	-172.52885	38.638614	19.687357	100
Slice 2	539.37851	80.357653	-150.61415	98.190093	50.030351	100

Slice 3	540.28951	80.213365	-128.69945	162.56741	82.832232	100
Slice 4	541.20051	80.069077	-106.78474	231.73956	118.0772	100
Slice 5	542.11151	79.924789	-84.870043	305.41953	155.61902	100
Slice 6	543.0225	79.780501	-62.955341	383.00993	195.15331	100
Slice 7	543.9335	79.636213	-41.04064	463.55797	236.19458	100
Slice 8	544.8445	79.491925	-19.125938	545.73004	278.06334	100
Slice 9	545.46978	79.39289	-4.0842939	616.98165	314.36785	100
Slice 10	546.30973	79.259855	16.121276	762.8053	380.45451	100
Slice 11	547.408	79.257773	-2,919.0105	613.63419	286.14232	39
Slice 12	548.2525	79.46775	-2,931.5849	652.31623	304.18005	39
Slice 13	549.08528	79.679583	-2,944.2824	694.08157	323.65555	39
Slice 14	549.91806	79.891417	-2,956.9798	734.91589	342.69691	39
Slice 15	550.75083	80.10325	-2,969.6773	774.86682	361.32633	39
Slice 16	551.58361	80.315083	-2,982.3748	813.99516	379.57218	39
Slice 17	552.36387	80.784872	15.983824	497.20591	245.1949	100
Slice 18	553.17065	81.591646	-19.455448	479.04991	244.08812	100
Slice 19	554.05645	82.477453	-58.366344	463.05592	235.93877	100
Slice 20	554.94226	83.363259	-97.27724	449.37898	228.97003	100
Slice 21	555.82807	84.249065	-136.18814	437.86193	223.1018	100
Slice 22	556.71387	85.134872	-175.09903	428.35569	218.25812	100
Slice 23	557.59968	86.020678	-214.00993	420.71615	214.36559	100
Slice 24	558.48548	86.906484	-252.92082	414.80046	211.35139	100
Slice 25	559.37129	87.792291	-291.83172	410.46258	209.14113	100
Slice 26	560.2571	88.678097	-330.74261	407.54827	207.65621	100
Slice 27	561.1442	89.565205	-369.71069	367.38971	187.19441	100
Slice 28	562.03261	90.453614	-408.73593	286.12798	145.78949	100
Slice 29	562.92102	91.342024	-447.76118	199.50972	101.65528	100
Slice 30	563.80943	92.230433	-486.78642	106.39368	54.210286	100
Slice 31	564.69784	93.118843	-525.81167	5.6900727	2.8992368	100


1.336

Landfill 33 Short-Term Seismic Infinite Slope Cover Failure Analysis

File Information

File Version: 8.14
Created By: Karl Finke
Last Edited By: Karl Finke
Revision Number: 110
Date: 2/14/2019
Time: 2:27:33 PM
Tool Version: 8.14.3.13430
File Name: Short Term Seismic Infinite Slope Cover FML.gsz
Directory: C:\SlopeW\Landfill 33\Final\
Last Solved Date: 2/14/2019
Last Solved Time: 2:31:25 PM

Project Settings

Length(L) Units: Feet
Time(t) Units: Seconds
Force(F) Units: Pounds
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D
Element Thickness: 1

Analysis Settings

Landfill 33 Short-Term Seismic Infinite Slope Cover Failure Analysis

- Kind: SLOPE/W
- Method: Morgenstern-Price
- Settings
  - Side Function
    - Interslice force function option: Half-Sine
  - PWP Conditions Source: Piezometric Line
  - Apply Phreatic Correction: Yes
  - Use Staged Rapid Drawdown: No
- Slip Surface
  - Direction of movement: Right to Left
  - Use Passive Mode: No
  - Slip Surface Option: Block
  - Critical slip surfaces saved: 1
  - Resisting Side Maximum Convex Angle: 1 °
  - Driving Side Maximum Convex Angle: 5 °
  - Restrict Block Crossing: No
  - Optimize Critical Slip Surface Location: No
  - Tension Crack
    - Tension Crack Option: (none)
- F of S Distribution
  - F of S Calculation Option: Constant
- Advanced
  - Number of Slices: 30
  - F of S Tolerance: 0.001

Minimum Slip Surface Depth: 0.1 ft
Search Method: Root Finder
Tolerable difference between starting and converged F of S: 3
Maximum iterations to calculate converged lambda: 20
Max Absolute Lambda: 2

Materials

MSW

Model: Mohr-Coulomb
Unit Weight: 70 pcf
Cohesion': 125 psf
Phi': 35 °
Phi-B: 0 °
Constant Unit Wt. Above Water Table: 70 pcf
Pore Water Pressure
Piezometric Line: 1

Gray Shale

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Cohesion': 5,000 psf
Phi': 0 °
Phi-B: 0 °
Constant Unit Wt. Above Water Table: 120 pcf
Pore Water Pressure
Piezometric Line: 1

Gray Silty Clay

Model: Mohr-Coulomb
Unit Weight: 135 pcf
Cohesion': 1,100 psf
Phi': 17.2 °
Phi-B: 0 °
Constant Unit Wt. Above Water Table: 125 pcf
Pore Water Pressure
Piezometric Line: 1

Sand

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Cohesion': 0 psf
Phi': 32 °
Phi-B: 0 °
Constant Unit Wt. Above Water Table: 130 pcf
Pore Water Pressure
Piezometric Line: 1

Brown Silty Clay

Model: Mohr-Coulomb
Unit Weight: 140 pcf
Cohesion': 0 psf
Phi': 28 °
Phi-B: 0 °
Constant Unit Wt. Above Water Table: 135 pcf
Pore Water Pressure
Piezometric Line: 1

Brown Silty Clay Liner

Model: Mohr-Coulomb

Unit Weight: 130 pcf
Cohesion': 0 psf
Phi': 23.4 °
Phi-B: 0 °
Constant Unit Wt. Above Water Table: 120 pcf
Pore Water Pressure
Piezometric Line: 1

Brown Silty Clay Cover

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion': 750 psf
Phi': 0 °
Phi-B: 0 °
Constant Unit Wt. Above Water Table: 120 pcf
Pore Water Pressure
Piezometric Line: 2

Low Permeable Cover

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Cohesion': 1,000 psf
Phi': 0 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Cover Geosynthetic

Model: Mohr-Coulomb
Unit Weight: 62 pcf
Cohesion': 39 psf
Phi': 25 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Slip Surface Limits

Left Coordinate: (0, 37) ft
Right Coordinate: (2,293.7, 82) ft

Slip Surface Block

Left Grid
Upper Left: (455.3, 56) ft
Lower Left: (455.29, 56) ft
Lower Right: (547, 79.15) ft
X Increments: 10
Y Increments: 3
Starting Angle: 135 °
Ending Angle: 180 °
Angle Increments: 15
Right Grid
Upper Left: (552, 80.421) ft
Lower Left: (552, 80.42) ft
Lower Right: (788.6704, 140.1864) ft
X Increments: 10
Y Increments: 3
Starting Angle: 45 °
Ending Angle: 65 °
Angle Increments: 10

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
Coordinate 1	0	24
Coordinate 2	400	31
Coordinate 3	800	35
Coordinate 4	1,500	40
Coordinate 5	1,900	56
Coordinate 6	2,293.7	58

Piezometric Line 2

Coordinates

	X (ft)	Y (ft)
Coordinate 1	0	24
Coordinate 2	100	25.8
Coordinate 3	344.4	41.5
Coordinate 4	352.9	42
Coordinate 5	406.5	55
Coordinate 6	452.2769	55.6
Coordinate 7	455.3	56.5
Coordinate 8	478.1217	62.3846
Coordinate 9	578.059	87.5198
Coordinate 10	788.659	140.706
Coordinate 11	1,376.5394	142.4035
Coordinate 12	1,606.8289	151.4981
Coordinate 13	1,617.1758	151.4998
Coordinate 14	1,710.2	148.4
Coordinate 15	1,911	96.1
Coordinate 16	1,944.5	93.7
Coordinate 17	2,293.7	57.2

Seismic Coefficients

Horz Seismic Coef.: 0.184

Points

	X (ft)	Y (ft)
Point 1	0	0
Point 2	0	24
Point 3	0	31
Point 4	0	37
Point 5	100	38
Point 6	100	33
Point 7	100	25.8
Point 8	100	1
Point 9	344.4	41.5
Point 10	352.9	42
Point 11	406.5	55
Point 12	414.2	32.2
Point 13	452.3	55
Point 14	452.3	59.1
Point 15	475.5	43.4

Point 16	483.3	39.5
Point 17	489.9	36.2
Point 18	494.3	34
Point 19	498.9	31.7
Point 20	545.3	82.4
Point 21	560.7	94.7
Point 22	577.5	90.4
Point 23	654.3	109.6
Point 24	669.7	121.9
Point 25	686.5	117.7
Point 26	788.7	143.2
Point 27	788.7	140.2
Point 28	1,376.6	144.9
Point 29	1,376.6	141.9
Point 30	1,606.8	154
Point 31	1,606.8	151
Point 32	1,617.2	154
Point 33	1,617.2	151
Point 34	1,710.4	150.4
Point 35	1,710.2	147.4
Point 36	1,835.2	120.3
Point 37	1,852	124.5
Point 38	1,874.8	111.7
Point 39	1,953.3	94.8
Point 40	1,980.4	93
Point 41	1,944.5	92.7
Point 42	1,243.2	47
Point 43	1,595.2	54.5
Point 44	1,834.7	82.6
Point 45	1,911.9	91.4
Point 46	1,573.4	42
Point 47	1,834.7	70.4
Point 48	2,293.7	82
Point 49	2,293.7	57.2
Point 50	2,293.7	17.4
Point 51	2,054.6	88.1
Point 52	1,382.9	47
Point 53	2,293.7	0
Point 54	455.3	55
Point 55	486.3	39.5
Point 56	497	34.7
Point 57	1,243.2	50
Point 58	1,592.2	57.5
Point 59	1,832.7	84.6
Point 60	1,911	95.1
Point 61	456.3	55
Point 62	498	35.7
Point 63	1,243.2	51
Point 64	1,591.2	58.5
Point 65	1,831.8	85.5
Point 66	1,909	94.1
Point 67	452.4	54.99
Point 68	455.31	54.99
Point 69	788.7	139.19
Point 70	1,376.6	140.89
Point 71	1,606.8	149.99
Point 72	1,617.2	149.99
Point 73	1,710.2	146.39

Point 74	1,910.99	94.09
Point 75	455.3	56
Point 76	455.3	55.99
Point 77	788.7	140.19
Point 78	1,376.6	141.89
Point 79	1,606.8	150.99
Point 80	1,617.2	150.99
Point 81	1,710.2	147.39
Point 82	1,911	95.09
Point 83	1,917	93.84
Point 84	1,917	93.85

Regions

	Material	Points	Area (ft^2)
Region 1	Gray Shale	1,8,50,53	20,232
Region 2	Gray Silty Clay	1,2,7,12,18,19,42,52,46,47,49,50,8	82,473
Region 3	Sand	2,3,6,16,17,18,12,7	3,245.8
Region 4	Brown Silty Clay	48,49,47,46,52,42,43,44,45,41,40,51	15,374
Region 5	Brown Silty Clay Liner	19,18,17,16,15,13,67,68,55,56,57,58,59,74,83,41,45,44,43,42	4,291.7
Region 6	Brown Silty Clay	16,6,3,4,5,9,15	2,258.8
Region 7	Brown Silty Clay Liner	9,10,11,13,15	1,049.7
Region 8	Brown Silty Clay Cover	11,13,75,27,29,31,33,35,60,84,83,41,40,39,38,37,36,34,32,30,28,26,25,24,23,22,21,20,14	5,799.6
Region 9	Sand	65,66,74,59,58,57,56,55,68,61,62,63,64	1,442.2
Region 10	MSW	68,61,62,63,64,65,66,74,73,72,71,70,69	1.0992e+005
Region 11	Low Permeable Cover	67,68,69,70,71,72,73,74,83,82,81,80,79,78,77,76,13	1,460.9
Region 12	Cover Geosynthetic	84,83,82,81,80,79,78,77,76,13,75,27,29,31,33,35,60	14.632

Current Slip Surface

Slip Surface: 180,038
F of S: 1.336
Volume: 1,398.1064 ft^3
Weight: 167,721.86 lbs
Resisting Moment: 6,745,615.6 lbs-ft
Activating Moment: 5,051,326.4 lbs-ft
Resisting Force: 88,014.764 lbs
Activating Force: 65,868.622 lbs
F of S Rank: 1
Exit: (460.54429, 61.165504) ft
Entry: (791.69165, 143.20865) ft
Radius: 143.4378 ft
Center: (610.87307, 163.71944) ft

Slip Slices

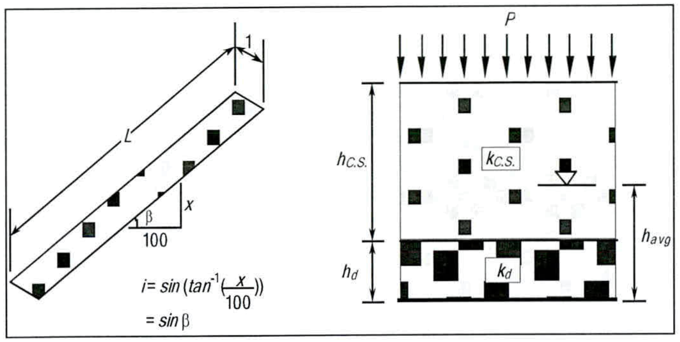
	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
Slice 1	462.22718	59.94281	-96.929139	625.60821	0	750
Slice 2	464.18887	58.517558	16.057815	882.62054	0	750

Slice 3	471.29468	60.039058	-1,767.3726	436.11682	203.36461	39
Slice 4	483.71989	63.176852	-1,955.3988	432.22719	201.55085	39
Slice 5	494.91627	66.004326	-2,124.8297	428.36623	199.75046	39
Slice 6	506.11266	68.8318	-2,294.2606	424.18854	197.80236	39
Slice 7	517.30904	71.659274	-2,463.6915	419.72114	195.71918	39
Slice 8	528.50542	74.486748	-2,633.1224	415.00281	193.51899	39
Slice 9	539.70181	77.314222	-2,802.5533	410.08282	191.22476	39
Slice 10	553	80.672475	-3,003.7901	844.65552	393.86934	39
Slice 11	564.9	83.677637	-3,183.8685	1,052.922	490.98558	39
Slice 12	573.3	85.798927	-3,310.9828	604.18572	281.73643	39
Slice 13	577.7795	86.930156	-3,378.7694	381.17493	177.74479	39
Slice 14	583.50479	88.375988	-3,465.4082	378.77231	176.62443	39
Slice 15	594.39636	91.126487	-3,630.2264	374.32267	174.54953	39
Slice 16	605.28793	93.876985	-3,795.0447	370.07995	172.57111	39
Slice 17	616.1795	96.627484	-3,959.863	366.07753	170.70476	39
Slice 18	627.07107	99.377982	-4,124.6813	362.34042	168.96211	39
Slice 19	637.96264	102.12848	-4,289.4995	358.88419	167.35044	39
Slice 20	648.85421	104.87898	-4,454.3178	355.71432	165.87231	39
Slice 21	662	108.19874	-4,653.2483	789.91046	368.3413	39
Slice 22	673.9	111.20391	-4,833.3268	1,011.1036	471.48533	39
Slice 23	682.3	113.3252	-4,960.441	576.12561	268.65179	39
Slice 24	692.1755	115.8191	-5,109.8834	356.55763	166.26555	39
Slice 25	703.5265	118.68562	-5,281.6541	354.70878	165.40342	39
Slice 26	714.8775	121.55214	-5,453.4247	352.88814	164.55444	39
Slice 27	726.2285	124.41866	-5,625.1954	351.03155	163.6887	39
Slice 28	737.5795	127.28518	-5,796.966	349.0768	162.77719	39
Slice 29	748.9305	130.1517	-5,968.7366	346.96611	161.79295	39
Slice 30	760.2815	133.01822	-6,140.5073	344.64829	160.71214	39
Slice 31	771.6325	135.88474	-6,312.2779	342.08068	159.51484	39
Slice 32	782.9835	138.75126	-6,484.0486	339.23046	158.18576	39
Slice 33	788.6647	140.18596	-6,570.0202	337.7035	157.47373	39
Slice 34	788.67383	140.19083	-6,570.3182	253.26492	118.09937	39
Slice 35	788.68863	140.20563	31.22829	-177.31262	-0	750
Slice 36	788.94527	140.46227	15.260366	-208.93315	-0	750
Slice 37	790.44109	141.95809	-77.808846	-399.11559	-0	750

ATTACHMENT C.4.

COVER STABILITY ANALYSIS

Calculation of DLC and PSR



L =	28.9	m	i =	*0.2436*	
β =	14.1	°	$L(\cos\beta)$ =	*28.03*	m
			x =	*7.04*	m
$h_{C.S.}$ =	914.4	mm	$h_{C.S.}$ =	*0.9*	m
h_d or t_{GS} =	5.0	mm	h_d or t_{GS} =	*0.01*	m
			$h_{C.S.} + h_d$ =	*0.92*	m
$k_{C.S.}$ =	2.5E-05	cm/s	$k_{C.S.}$ =	*2.5E-07*	m/s
k_d or k_{GS} =	7.0E+00	cm/s	k_d or k_{GS} =	*7.0E-02*	m/s
P =	51.82	mm/hr	*P (RC)* =	*25.9*	mm/hr
RC =	0.5		*Actual runoff* =	*50.92*	mm/hr
			PERC =	*0.90*	mm/hr
			$FLUX_{actual}$ =	*0.025*	m^3/hr
			$FLUX_{allow}$ =	*0.307*	m^3/hr

DLC =	***12.168***
PSR	***0.000***
FS	***2.008***

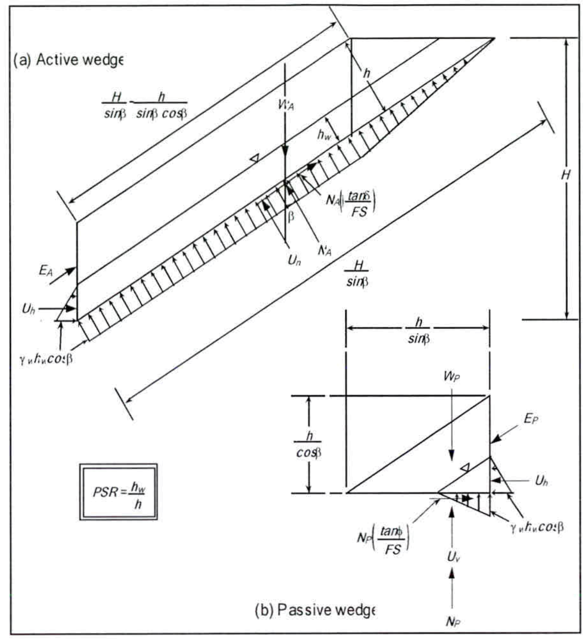
DLC = *12.1680*

* Note: if only one soil layer above GM treat it as the drainage layer.

q = *7.0E-06* m^3/sec

h_{avg} = *0.00* m

PSR = *0.000*



Calculation of FS

Active Wedge:

W_A = *467.157* kN
U_n = *0.11298* kN
U_h = *8.3E-07* kN
N_A = *452.969* kN

Passive Wedge:

W_P = *33.7188* kN
U_V = *3.3E-06* kN

$$FS = \frac{-b + \sqrt{b^2 - 4ac}}{2a}$$

where a = *110.4*
b = *-234.7*
c = *26.2*

FS = ***2.008***

thickness of cover soil = h = *0.92* m
length of slope measured along the geomembrane = L = *29* m
soil slope angle beneath the geomembrane = β = *14.1* ° = *0.25* (rad.)
vertical height of the slope measured from the toe = H = *7.0* m
parallel submergence ratio = *PSR* = *0.00*
depth of the water surface measured from the geomembrane = h_w = *0.00* m

moist unit weight of the cover soil = γ_{dry} = 18.9 kN/m^3
saturated unit weight of the cover soil = $\gamma_{sat'd}$ = 20.4 kN/m^3
unit weight of water = γ_w = 9.81 kN/m^3
friction angle of the cover soil = ϕ = 27.0 ° = *0.47* (rad.)
interface friction angle between cover soil and geomembrane = δ = 25.0 ° = *0.44* (rad.)

Note: numbers in boxes are input values

numbers in Italics are calculated values

Performed by : Karl Finke

Constructed by Te-Yang Soong

5

Attachment 5

Revised Stormwater Design

Landfill 33 Drainage Summary
Attachment 5 to the Significant Modification Permit Application
February 2019

The drainage verification included in this attachment is for a proposed Significant Modification Permit (Sig Mod) at Landfill 33 Facility (Landfill 33). As discussed below, the verification of Landfill 33 site drainage features is adequate to convey the peak runoff from the 25-yr and 100-yr recurrence interval storms. WinTR-55 was used in order to compute the maximum flow rates of runoff from these areas. The proposed final cover area is approximately 40.6 acres. For each drainage section, two scenarios were considered:

- 25-yr rainfall event with no vegetation on constructed areas (initial cover construction)
- 100-yr rainfall event with fully vegetated slopes (final cover conditions)

The site rainfall intensity (i) is the rate of rainfall in in/hr and is assumed constant over the entire drainage area. Rainfall data from the Natural Resources Conservation Service (NRCS) for Effingham County, IL were used for these calculations:

25-yr = 5.37 in
100-yr = 7.41 in

The following runoff curve numbers (CN) were selected and used to determine the weighted CN for each drainage area:

Meadow – cont. grass (non grazed) (hydrologic soil group D):	78
Pasture, grassland or range (hydrologic soil group D):	89
Newly graded area (pervious only) (hydrologic soil group D):	94

The event producing the highest peak flow rate was used as the design criteria for the drainage structures. For all drainage sections, the 100-yr rainfall scenario produced the highest rate of stormwater flow. The inputs and results of each WinTR-55 run are included in Exhibit 1.

The Chezy-Manning Equation was then used to determine the appropriate dimensions of each drainage structure:

$$Q = vA = \left(\frac{1.49}{n}\right) AR^{2/3}\sqrt{S}$$

Where:
Q = Flow Quantity
v = Velocity
A = Area
n = Manning roughness coefficient (0.04)
R = Hydraulic Radius (R=A/P)
P = Wetted Perimeter
S = Slope

The flow areas, wetted perimeters, and hydraulic radii were calculated through an iterative process and to determine the correct design depths of each drainage structure during design flow rates.

$$A = d\frac{a + [a + d(z_1 + z_2)]}{2}$$
$$R = a + d\left[\sqrt{1 + z_1{}^2} + \sqrt{1 + z_2{}^2}\right]$$

Where:
a = base of trapezoid
d = flow depth
z_1 = first slope of trapezoid
z_2 = second slope of trapezoid

A spreadsheet including the final calculated values for these quantities are included in Exhibit 2.

Exhibit 1
WinTR-55 Reports

WinTR-55 Current Data Description

--- Identification Data ---

User: PMV
Project: LF33 Vertical Expansion 2018
SubTitle: Ditch 1 25 year
State: Illinois
County: Effingham
Filename: J:\L\Landfill 33\ENG\2018\2018 Vertical Expansion\Stormwater Drainage\Ditch 1 - 25 yr.w55

Date: 7/17/2018
Units: English
Areal Units: Acres

--- Sub-Area Data ---

Name	Description	Reach	Area(ac)	RCN	Tc
D1	Ditch 1	Outlet	1.8	88	0.1
D2	Ditch 2	D1	1.4	94	.179
T4	Terrace 4	D1	7	93	.21

Total area: 10.20 (ac)

--- Storm Data --

Rainfall Depth by Rainfall Return Period

2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	50-Yr (in)	100-Yr (in)	1-Yr (in)
3.03	3.8	4.44	5.37	6.23	7.41	2.55

Storm Data Source: Effingham County, IL (NRCS)
Rainfall Distribution Type: Type II
Dimensionless Unit Hydrograph: <standard>

PMV

LF33 Vertical Expansion 2018
Ditch 1 25 year
Effingham County, Illinois

Hydrograph Peak/Peak Time Table

Sub-Area or Reach Identifier	Peak Flow and Peak Time (hr) by Rainfall Return Period 25-Yr (cfs) (hr)
SUBAREAS	
D1	10.78
	11.93
D2	8.21
	11.98
T4	38.87
	12.00
REACHES	
D1	46.95
	12.00
Down	46.89
	12.03
OUTLET	55.57

WinTR-55 Current Data Description

--- Identification Data ---

User: PMV
Date: 7/17/2018
Project: LF33 Vertical Expansion 2018
Units: English
SubTitle: Ditch 1 - 100 yr
Areal Units: Acres
State: Illinois
County: Effingham
Filename: J:\L\Landfill 33\ENG\2018\2018 Vertical Expansion\Stormwater Drainage\Ditch 1 - 100 yr.w55

--- Sub-Area Data ---

Name	Description	Reach	Area(ac)	RCN	Tc
D1	Ditch 1	Outlet	1.8	78	0.1
D2	Ditch 2	D1	1.4	78	0.179
T4	Terrace 4	D1	7	78	.21

Total area: 10.20 (ac)

--- Storm Data --

Rainfall Depth by Rainfall Return Period

2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	50-Yr (in)	100-Yr (in)	1-Yr (in)
3.03	3.8	4.44	5.37	6.23	7.41	2.55

Storm Data Source: Effingham County, IL (NRCS)
Rainfall Distribution Type: Type II
Dimensionless Unit Hydrograph: <standard>

PMV

LF33 Vertical Expansion 2018
Ditch 1
Effingham County, Illinois

Hydrograph Peak/Peak Time Table

Sub-Area or Reach Identifier	Peak Flow and Peak Time (hr) by Rainfall Return Period 100-Yr (cfs) (hr)
SUBAREAS	
D1	13.29
	11.93
D2	9.16
	11.99
T4	44.01
	12.02
REACHES	
D1	53.03
	12.01
Down	52.97
	12.03
OUTLET	63.61

WinTR-55 Current Data Description

--- Identification Data ---

User: PMV
Project: LF33 2018 Vertical Expansion
SubTitle: Ditch 4 25 yr
State: Illinois
County: Effingham
Filename: J:\L\Landfill 33\ENG\2018\2018 Vertical Expansion\Stormwater Drainage\Ditch 4 - 25 yr.w55

Date: 7/17/2018
Units: English
Areal Units: Acres

--- Sub-Area Data ---

Name	Description	Reach	Area(ac)	RCN	Tc
D4	Ditch 4	Outlet	0.4	94	0.1
D3	Ditch 3	D4	0.8	94	0.1

Total area: 1.20 (ac)

--- Storm Data --

Rainfall Depth by Rainfall Return Period

2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	50-Yr (in)	100-Yr (in)	1-Yr (in)
3.03	3.8	4.44	5.37	6.23	7.41	2.55

Storm Data Source: Effingham County, IL (NRCS)
Rainfall Distribution Type: Type II
Dimensionless Unit Hydrograph: <standard>

PMV

LF33 2018 Vertical Expansion
Ditch 4 25 yr
Effingham County, Illinois

Hydrograph Peak/Peak Time Table

Sub-Area or Reach Identifier	Peak Flow and Peak Time (hr) by Rainfall Return Period 25-Yr (cfs) (hr)
SUBAREAS	
D4	2.67
	11.93
D3	5.29
	11.93
REACHES	
D4	5.29
	11.93
Down	5.29
	11.94
OUTLET	7.94

WinTR-55 Current Data Description

--- Identification Data ---

User:	PMV	Date:	7/17/2018
Project:	LF33 2018 Vertical Expansion	Units:	English
SubTitle:	Ditch 4 100 yr	Areal Units:	Acres
State:	Illinois		
County:	Effingham		

Filename: J:\L\Landfill 33\ENG\2018\2018 Vertical Expansion\Stormwater Drainage\Ditch 4 - 100 yr.w55

--- Sub-Area Data ---

Name	Description	Reach	Area(ac)	RCN	Tc
D4	Ditch 4	Outlet	0.4	78	0.1
D3	Ditch 3	D4	0.8	78	0.1

Total area: 1.20 (ac)

--- Storm Data --

Rainfall Depth by Rainfall Return Period

2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	50-Yr (in)	100-Yr (in)	1-Yr (in)
3.03	3.8	4.44	5.37	6.23	7.41	2.55

Storm Data Source: Effingham County, IL (NRCS)
Rainfall Distribution Type: Type II
Dimensionless Unit Hydrograph: <standard>

PMV

LF33 2018 Vertical Expansion
Ditch 4 100 yr
Effingham County, Illinois

Hydrograph Peak/Peak Time Table

Sub-Area or Reach Identifier	Peak Flow and Peak Time (hr) by Rainfall Return Period 100-Yr (cfs) (hr)
SUBAREAS	
D4	2.98 11.93
D3	5.91 11.93
REACHES	
D4	5.91 11.93
Down	5.91 11.94
OUTLET	8.87

WinTR-55 Current Data Description

--- Identification Data ---

User:	PMV	Date:	7/17/2018
Project:	LF33 2018 Vertical Expansion	Units:	English
SubTitle:	Ditch 5 - 25 yr	Areal Units:	Acres
State:	Illinois		
County:	Effingham		
Filename:	J:\L\Landfill 33\ENG\2018\2018 Vertical Expansion\Stormwater Drainage\Ditch 5 - 25 yr.w55		

--- Sub-Area Data ---

Name	Description	Reach	Area(ac)	RCN	Tc
D5	Ditch 5	Outlet	0.7	78	0.1

Total area: .70 (ac)

--- Storm Data --

Rainfall Depth by Rainfall Return Period

2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	50-Yr (in)	100-Yr (in)	1-Yr (in)
3.03	3.8	4.44	5.37	6.23	7.41	2.55

Storm Data Source:	Effingham County, IL (NRCS)
Rainfall Distribution Type:	Type II
Dimensionless Unit Hydrograph:	<standard>

PMV

LF33 2018 Vertical Expansion
Ditch 5 - 25 yr
Effingham County, Illinois

Hydrograph Peak/Peak Time Table

Sub-Area or Reach Identifier	Peak Flow and Peak Time (hr) by Rainfall Return Period 25-Yr (cfs) (hr)
SUBAREAS	
D5	3.25 11.93
REACHES	
OUTLET	3.25

WinTR-55 Current Data Description

--- Identification Data ---

User:	PMV	Date:	7/17/2018
Project:	LF33 2018 Vertical Expansion	Units:	English
SubTitle:	Ditch 5 100 yr	Areal Units:	Acres
State:	Illinois		
County:	Effingham		

Filename: J:\L\Landfill 33\ENG\2018\2018 Vertical Expansion\Stormwater Drainage\Ditch 5 - 100 yr.w55

--- Sub-Area Data ---

Name	Description	Reach	Area(ac)	RCN	Tc
D5	Ditch 5	Outlet	0.7	78	0.1

Total area: .70 (ac)

--- Storm Data --

Rainfall Depth by Rainfall Return Period

2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	50-Yr (in)	100-Yr (in)	1-Yr (in)
3.03	3.8	4.44	5.37	6.23	7.41	2.55

Storm Data Source:	Effingham County, IL (NRCS)
Rainfall Distribution Type:	Type II
Dimensionless Unit Hydrograph:	<standard>

WinTR-55 Current Data Description

--- Identification Data ---

User: PMV
Project: LF33 2018 Vertical Expansion
SubTitle: Ditch 5 100 yr
State: Illinois
County: Effingham
Filename: J:\L\Landfill 33\ENG\2018\2018 Vertical Expansion\Stormwater Drainage\Ditch 5 - 100 yr.w55

Date: 7/17/2018
Units: English
Areal Units: Acres

--- Sub-Area Data ---

Name	Description	Reach	Area(ac)	RCN	Tc
D5	Ditch 5	Outlet	0.7	78	0.1

Total area: .70 (ac)

--- Storm Data --

Rainfall Depth by Rainfall Return Period

2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	50-Yr (in)	100-Yr (in)	1-Yr (in)
3.03	3.8	4.44	5.37	6.23	7.41	2.55

Storm Data Source: Effingham County, IL (NRCS)
Rainfall Distribution Type: Type II
Dimensionless Unit Hydrograph: <standard>

WinTR-55 Current Data Description

--- Identification Data ---

User: PMV　　Date: 7/17/2018
Project: LF33 2018 Vertical Expansion　　Units: English
SubTitle: Ditch 6 - 25 yr　　Areal Units: Acres
State: Illinois
County: Effingham
Filename: J:\L\Landfill 33\ENG\2018\2018 Vertical Expansion\Stormwater Drainage\Ditch 6 - 25 yr.w55

--- Sub-Area Data ---

Name	Description	Reach	Area(ac)	RCN	Tc
D6	Ditch 6	Outlet	0.2	94	0.1

Total area: .20 (ac)

--- Storm Data --

Rainfall Depth by Rainfall Return Period

2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	50-Yr (in)	100-Yr (in)	1-Yr (in)
3.03	3.8	4.44	5.37	6.23	7.41	2.55

Storm Data Source: Effingham County, IL (NRCS)
Rainfall Distribution Type: Type II
Dimensionless Unit Hydrograph: <standard>

PMV

LF33 2018 Vertical Expansion
Ditch 6 - 25 yr
Effingham County, Illinois

Hydrograph Peak/Peak Time Table

Sub-Area or Reach Identifier	Peak Flow and Peak Time (hr) by Rainfall Return Period 25-Yr (cfs) (hr)
SUBAREAS	
D6	1.31 11.93
REACHES	
OUTLET	1.31

WinTR-55 Current Data Description

--- Identification Data ---

User: PMV
Project: LF33 2018 Vertical Expansion
SubTitle: Ditch 6 - 100 yr
State: Illinois
County: Effingham
Filename: J:\L\Landfill 33\ENG\2018\2018 Vertical Expansion\Stormwater Drainage\Ditch 6 - 100 yr.w55

Date: 7/17/2018
Units: English
Areal Units: Acres

--- Sub-Area Data ---

Name	Description	Reach	Area(ac)	RCN	Tc
D6	Ditch 6	Outlet	0.2	78	0.1

Total area: .20 (ac)

--- Storm Data --

Rainfall Depth by Rainfall Return Period

2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	50-Yr (in)	100-Yr (in)	1-Yr (in)
3.03	3.8	4.44	5.37	6.23	7.41	2.55

Storm Data Source: Effingham County, IL (NRCS)
Rainfall Distribution Type: Type II
Dimensionless Unit Hydrograph: <standard>

PMV

LF33 2018 Vertical Expansion
Ditch 6 - 100 yr
Effingham County, Illinois

Hydrograph Peak/Peak Time Table

Sub-Area or Reach Identifier	Peak Flow and Peak Time (hr) by Rainfall Return Period 100-Yr (cfs) (hr)
SUBAREAS	
D6	1.47 11.93
REACHES	
OUTLET	1.47

WinTR-55 Current Data Description

--- Identification Data ---

User:	PMV	Date:	7/17/2018
Project:	LF33 2018 Vertical Expansion	Units:	English
SubTitle:	Ditch 7 25 yr	Areal Units:	Acres
State:	Illinois		
County:	Effingham		

Filename: J:\L\Landfill 33\ENG\2018\2018 Vertical Expansion\Stormwater Drainage\Ditch 7 - 25 yr.w55

--- Sub-Area Data ---

Name	Description	Reach	Area(ac)	RCN	Tc
D7	Ditch 7	Outlet	1.3	94	0.1

Total area: 1.30 (ac)

--- Storm Data --

Rainfall Depth by Rainfall Return Period

2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	50-Yr (in)	100-Yr (in)	1-Yr (in)
3.03	3.8	4.44	5.37	6.23	7.41	2.55

Storm Data Source: Effingham County, IL (NRCS)
Rainfall Distribution Type: Type II
Dimensionless Unit Hydrograph: <standard>

PMV

LF33 2018 Vertical Expansion
Ditch 7 25 yr
Effingham County, Illinois

Hydrograph Peak/Peak Time Table

Sub-Area or Reach Identifier	Peak Flow and Peak Time (hr) by Rainfall Return Period 25-Yr (cfs) (hr)
SUBAREAS	
D7	8.59 11.93
REACHES	
OUTLET	8.59

WinTR-55 Current Data Description

--- Identification Data ---

User: PMV
Project: LF33 2018 Vertical Expansion
SubTitle: Ditch 7 100 yr
State: Illinois
County: Effingham
Filename: J:\L\Landfill 33\ENG\2018\2018 Vertical Expansion\Stormwater Drainage\Ditch 7 - 100 yr.w55

Date: 7/17/2018
Units: English
Areal Units: Acres

--- Sub-Area Data ---

Name	Description	Reach	Area(ac)	RCN	Tc
D7	Ditch 7	Outlet	1.3	78	0.1

Total area: 1.30 (ac)

--- Storm Data --

Rainfall Depth by Rainfall Return Period

2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	50-Yr (in)	100-Yr (in)	1-Yr (in)
3.03	3.8	4.44	5.37	6.23	7.41	2.55

Storm Data Source: Effingham County, IL (NRCS)
Rainfall Distribution Type: Type II
Dimensionless Unit Hydrograph: <standard>

PMV

LF33 2018 Vertical Expansion
Ditch 7 100 yr
Effingham County, Illinois

Hydrograph Peak/Peak Time Table

```
 Sub-Area       Peak Flow and Peak Time (hr) by Rainfall Return Period
 or Reach     100-Yr
Identifier     (cfs)
            (hr)
--------------------------------------------------------------------------------
SUBAREAS
D7              9.60
           11.93


REACHES

OUTLET          9.60
```

WinTR-55 Current Data Description

--- Identification Data ---

User: PMV
Project: LF33 2018 Vertical Expansion
SubTitle: Ditch 8 100 yr
State: Illinois
County: Effingham
Filename: J:\L\Landfill 33\ENG\2018\2018 Vertical Expansion\Stormwater Drainage\Ditch 8 - 25 yr.w55

Date: 7/17/2018
Units: English
Areal Units: Acres

--- Sub-Area Data ---

Name	Description	Reach	Area(ac)	RCN	Tc
D8	Ditch 8	Outlet	0.1	94	0.1

Total area: .10 (ac)

--- Storm Data --

Rainfall Depth by Rainfall Return Period

2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	50-Yr (in)	100-Yr (in)	1-Yr (in)
3.03	3.8	4.44	5.37	6.23	7.41	2.55

Storm Data Source: Effingham County, IL (NRCS)
Rainfall Distribution Type: Type II
Dimensionless Unit Hydrograph: <standard>

PMV

LF33 2018 Vertical Expansion
Ditch 8 100 yr
Effingham County, Illinois

Hydrograph Peak/Peak Time Table

Sub-Area or Reach Identifier	Peak Flow and Peak Time (hr) by Rainfall Return Period 25-Yr (cfs) (hr)
SUBAREAS	
D8	0.68 11.93
REACHES	
OUTLET	0.68

PMV

LF33 2018 Vertical Expansion
Ditch 8 100 yr
Effingham County, Illinois

Hydrograph Peak/Peak Time Table

Sub-Area or Reach Identifier	Peak Flow and Peak Time (hr) by Rainfall Return Period 100-Yr (cfs) (hr)
SUBAREAS	
D8	0.76 11.93
REACHES	
OUTLET	0.76

PMV

LF33 2018 Vertical Expansion
Ditch 8 100 yr
Effingham County, Illinois

Hydrograph Peak/Peak Time Table

Sub-Area or Reach Identifier	Peak Flow and Peak Time (hr) by Rainfall Return Period 100-Yr (cfs) (hr)
SUBAREAS	
D8	0.76 11.93
REACHES	
OUTLET	0.76

WinTR-55 Current Data Description

--- Identification Data ---

User: PMV
Project: LF33 2018 Vertical Expansion
SubTitle: Ditch 9 25 yr
State: Illinois
County: Effingham
Filename: J:\L\Landfill 33\ENG\2018\2018 Vertical Expansion\Stormwater Drainage\Ditch 9 - 25 yr.w55

Date: 7/17/2018
Units: English
Areal Units: Acres

--- Sub-Area Data ---

Name	Description	Reach	Area(ac)	RCN	Tc
D9	Ditch 9	Outlet	0.9	94	0.1

Total area: .90 (ac)

--- Storm Data --

Rainfall Depth by Rainfall Return Period

2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	50-Yr (in)	100-Yr (in)	1-Yr (in)
3.03	3.8	4.44	5.37	6.23	7.41	2.55

Storm Data Source: Effingham County, IL (NRCS)
Rainfall Distribution Type: Type II
Dimensionless Unit Hydrograph: <standard>

PMV

LF33 2018 Vertical Expansion
Ditch 9 25 yr
Effingham County, Illinois

Hydrograph Peak/Peak Time Table

Sub-Area or Reach Identifier	Peak Flow and Peak Time (hr) by Rainfall Return Period 25-Yr (cfs) (hr)
SUBAREAS	
D9	5.97 11.93
REACHES	
OUTLET	5.97

WinTR-55 Current Data Description

--- Identification Data ---

User:	PMV	Date:	7/17/2018
Project:	LF33 2018 Vertical Expansion	Units:	English
SubTitle:	Ditch 9 100 yr	Areal Units:	Acres
State:	Illinois		
County:	Effingham		

Filename: J:\L\Landfill 33\ENG\2018\2018 Vertical Expansion\Stormwater Drainage\Ditch 9 - 100 yr.w55

--- Sub-Area Data ---

Name	Description	Reach	Area(ac)	RCN	Tc
D9	Ditch 9	Outlet	0.9	78	0.1

Total area: .90 (ac)

--- Storm Data --

Rainfall Depth by Rainfall Return Period

2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	50-Yr (in)	100-Yr (in)	1-Yr (in)
3.03	3.8	4.44	5.37	6.23	7.41	2.55

Storm Data Source:	Effingham County, IL (NRCS)
Rainfall Distribution Type:	Type II
Dimensionless Unit Hydrograph:	<standard>

PMV

LF33 2018 Vertical Expansion
Ditch 9 100 yr
Effingham County, Illinois

Hydrograph Peak/Peak Time Table

Sub-Area or Reach Identifier	Peak Flow and Peak Time (hr) by Rainfall Return Period 100-Yr (cfs) (hr)
SUBAREAS	
D9	6.67
	11.93
REACHES	
OUTLET	6.67

WinTR-55 Current Data Description

--- Identification Data ---

User: PMV
Project: LF33 2018 Vertical Expansion
SubTitle: Ditch 10 25 yr
State: Illinois
County: Effingham
Filename: J:\L\Landfill 33\ENG\2018\2018 Vertical Expansion\Stormwater Drainage\Ditch 10 - 25 yr.w55

Date: 7/17/2018
Units: English
Areal Units: Acres

--- Sub-Area Data ---

Name	Description	Reach	Area(ac)	RCN	Tc
D10	Ditch 10	Outlet	0.3	94	0.1

Total area: .30 (ac)

--- Storm Data --

Rainfall Depth by Rainfall Return Period

2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	50-Yr (in)	100-Yr (in)	1-Yr (in)
3.03	3.8	4.44	5.37	6.23	7.41	2.55

Storm Data Source: Effingham County, IL (NRCS)
Rainfall Distribution Type: Type II
Dimensionless Unit Hydrograph: <standard>

PMV

LF33 2018 Vertical Expansion
Ditch 10 25 yr
Effingham County, Illinois

Hydrograph Peak/Peak Time Table

Sub-Area or Reach Identifier	Peak Flow and Peak Time (hr) by Rainfall Return Period 25-Yr (cfs) (hr)
SUBAREAS	
D10	1.99 11.93
REACHES	
OUTLET	1.99

WinTR-55 Current Data Description

--- Identification Data ---

User: PMV
Project: LF33 2018 Vertical Expansion
SubTitle: Ditch 10 - 100 yr
State: Illinois
County: Effingham
Filename: J:\L\Landfill 33\ENG\2018\2018 Vertical Expansion\Stormwater Drainage\Ditch 10 - 100 yr.w55

Date: 7/17/2018
Units: English
Areal Units: Acres

--- Sub-Area Data ---

Name	Description	Reach	Area(ac)	RCN	Tc
D10	Ditch 10	Outlet	0.3	78	0.1

Total area: .30 (ac)

--- Storm Data --

Rainfall Depth by Rainfall Return Period

2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	50-Yr (in)	100-Yr (in)	1-Yr (in)
3.03	3.8	4.44	5.37	6.23	7.41	2.55

Storm Data Source: Effingham County, IL (NRCS)
Rainfall Distribution Type: Type II
Dimensionless Unit Hydrograph: <standard>

PMV

LF33 2018 Vertical Expansion
Ditch 10 - 100 yr
Effingham County, Illinois

Hydrograph Peak/Peak Time Table

Sub-Area or Reach Identifier	Peak Flow and Peak Time (hr) by Rainfall Return Period 100-Yr (cfs) (hr)
SUBAREAS	
D10	2.22 11.93
REACHES	
OUTLET	2.22

WinTR-55 Current Data Description

--- Identification Data ---

User:	PMV	Date:	7/17/2018
Project:	LF33 2018 Vertical Expansion	Units:	English
SubTitle:	Ditch 11 25 yr	Areal Units:	Acres
State:	Illinois		
County:	Effingham		
Filename:	J:\L\Landfill 33\ENG\2018\2018 Vertical Expansion\Stormwater Drainage\Ditch 11 - 25 yr.w55		

--- Sub-Area Data ---

Name	Description	Reach	Area(ac)	RCN	Tc
D11	Ditch 11	Outlet	0.3	94	0.1
T5	Terrace 5	D11	1.7	94	.112
D13	Ditch 13	D11	1	94	.159

Total area: 3 (ac)

--- Storm Data --

Rainfall Depth by Rainfall Return Period

2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	50-Yr (in)	100-Yr (in)	1-Yr (in)
3.03	3.8	4.44	5.37	6.23	7.41	2.55

Storm Data Source: Effingham County, IL (NRCS)
Rainfall Distribution Type: Type II
Dimensionless Unit Hydrograph: <standard>

PMV

LF33 2018 Vertical Expansion
Ditch 11 25 yr
Effingham County, Illinois

Hydrograph Peak/Peak Time Table

Sub-Area or Reach Identifier	Peak Flow and Peak Time (hr) by Rainfall Return Period 25-Yr (cfs) (hr)
SUBAREAS	
D11	1.99
	11.93
T5	11.04
	11.94
D13	6.01
	11.97
REACHES	
D11	16.87
	11.94
Down	16.79
	11.98
OUTLET	18.55

WinTR-55 Current Data Description

--- Identification Data ---

User:	PMV	Date:	7/17/2018
Project:	LF33 2018 Vertical Expansion	Units:	English
SubTitle:	Ditch 11 100 yr	Areal Units:	Acres
State:	Illinois		
County:	Effingham		

Filename: J:\L\Landfill 33\ENG\2018\2018 Vertical Expansion\Stormwater Drainage\Ditch 11 - 100 yr.w55

--- Sub-Area Data ---

Name	Description	Reach	Area(ac)	RCN	Tc
D11	Ditch 11	Outlet	0.3	78	0.1
T5	Terrace 5	D11	1.7	78	0.112
D13	Ditch 13	D11	1	78	.159

Total area: 3 (ac)

--- Storm Data --

Rainfall Depth by Rainfall Return Period

2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	50-Yr (in)	100-Yr (in)	1-Yr (in)
3.03	3.8	4.44	5.37	6.23	7.41	2.55

Storm Data Source:	Effingham County, IL (NRCS)
Rainfall Distribution Type:	Type II
Dimensionless Unit Hydrograph:	<standard>

PMV

LF33 2018 Vertical Expansion
Ditch 11 100 yr
Effingham County, Illinois

Hydrograph Peak/Peak Time Table

Sub-Area or Reach Identifier	Peak Flow and Peak Time (hr) by Rainfall Return Period 100-Yr (cfs) (hr)
SUBAREAS	
D11	2.22
	11.93
T5	12.33
	11.94
D13	6.70
	11.97
REACHES	
D11	18.79
	11.95
Down	18.72
	11.98
OUTLET	20.71

WinTR-55 Current Data Description

--- Identification Data ---

User: PMV
Project: LF33 2018 Vertical Expansion
SubTitle: Terrace 1 - 25 yr
State: Illinois
County: Effingham
Filename: J:\L\Landfill 33\ENG\2018\2018 Vertical Expansion\Stormwater Drainage\Terrace 1 - 25 yr.w55

Date: 7/17/2018
Units: English
Areal Units: Acres

--- Sub-Area Data ---

Name	Description	Reach	Area(ac)	RCN	Tc
T1	Terrace 1	Outlet	1.3	94	.113

Total area: 1.30 (ac)

--- Storm Data --

Rainfall Depth by Rainfall Return Period

2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	50-Yr (in)	100-Yr (in)	1-Yr (in)
3.03	3.8	4.44	5.37	6.23	7.41	2.55

Storm Data Source: Effingham County, IL (NRCS)
Rainfall Distribution Type: Type II
Dimensionless Unit Hydrograph: <standard>

PMV

LF33 2018 Vertical Expansion
Terrace 1 - 25 yr
Effingham County, Illinois

Hydrograph Peak/Peak Time Table

Sub-Area or Reach Identifier	Peak Flow and Peak Time (hr) by Rainfall Return Period 25-Yr (cfs) (hr)
SUBAREAS	
T1	8.41 11.93
REACHES	
OUTLET	8.41

WinTR-55 Current Data Description

--- Identification Data ---

User: PMV
Project: LF33 2018 Vertical Expansion
SubTitle: Terrace 1 - 100 yr
State: Illinois
County: Effingham
Filename: J:\L\Landfill 33\ENG\2018\2018 Vertical Expansion\Stormwater Drainage\Terrace 1 - 100 yr.w55

Date: 7/17/2018
Units: English
Areal Units: Acres

--- Sub-Area Data ---

Name	Description	Reach	Area(ac)	RCN	Tc
T1	Terrace 1	Outlet	1.3	78	.11

Total area: 1.30 (ac)

--- Storm Data --

Rainfall Depth by Rainfall Return Period

2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	50-Yr (in)	100-Yr (in)	1-Yr (in)
3.03	3.8	4.44	5.37	6.23	7.41	2.55

Storm Data Source: Effingham County, IL (NRCS)
Rainfall Distribution Type: Type II
Dimensionless Unit Hydrograph: <standard>

PMV

LF33 2018 Vertical Expansion
Terrace 1 - 100 yr
Effingham County, Illinois

Hydrograph Peak/Peak Time Table

Sub-Area or Reach Identifier	Peak Flow and Peak Time (hr) by Rainfall Return Period 100-Yr (cfs) (hr)
SUBAREAS	
T1	9.44 11.94
REACHES	
OUTLET	9.44

WinTR-55 Current Data Description

--- Identification Data ---

User: PMV
Date: 7/17/2018
Project: LF33 2018 Vertical Expansion
Units: English
SubTitle: Terrace 2 - 25 yr
Areal Units: Acres
State: Illinois
County: Effingham
Filename: J:\L\Landfill 33\ENG\2018\2018 Vertical Expansion\Stormwater Drainage\Terrace 2 - 25 yr.w55

--- Sub-Area Data ---

Name	Description	Reach	Area(ac)	RCN	Tc
T2	Terrace 2	Outlet	8.22	94	.197

Total area: 8.22 (ac)

--- Storm Data --

Rainfall Depth by Rainfall Return Period

2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	50-Yr (in)	100-Yr (in)	1-Yr (in)
3.03	3.8	4.44	5.37	6.23	7.41	2.55

Storm Data Source: Effingham County, IL (NRCS)
Rainfall Distribution Type: Type II
Dimensionless Unit Hydrograph: <standard>

PMV

LF33 2018 Vertical Expansion
Terrace 2 - 25 yr
Effingham County, Illinois

Hydrograph Peak/Peak Time Table

Sub-Area or Reach Identifier	Peak Flow and Peak Time (hr) by Rainfall Return Period 25-Yr (cfs) (hr)
SUBAREAS	
T2	47.00 12.00
REACHES	
OUTLET	47.00

WinTR-55 Current Data Description

--- Identification Data ---

User:	PMV	Date:	7/17/2018
Project:	LF33 2018 Vertical Expansion	Units:	English
SubTitle:	Terrace 2 - 100 yr	Areal Units:	Acres
State:	Illinois		
County:	Effingham		

Filename: J:\L\Landfill 33\ENG\2018\2018 Vertical Expansion\Stormwater Drainage\Terrace 2 - 100 yr.w55

--- Sub-Area Data ---

Name	Description	Reach	Area(ac)	RCN	Tc
T2	Terrace 2	Outlet	8.22	78	.197

Total area: 8.22 (ac)

--- Storm Data --

Rainfall Depth by Rainfall Return Period

2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	50-Yr (in)	100-Yr (in)	1-Yr (in)
3.03	3.8	4.44	5.37	6.23	7.41	2.55

Storm Data Source: Effingham County, IL (NRCS)
Rainfall Distribution Type: Type II
Dimensionless Unit Hydrograph: <standard>

PMV

LF33 2018 Vertical Expansion
Terrace 2 - 100 yr
Effingham County, Illinois

Hydrograph Peak/Peak Time Table

Sub-Area or Reach Identifier	Peak Flow and Peak Time (hr) by Rainfall Return Period 100-Yr (cfs) (hr)
SUBAREAS	
T2	52.50 12.00
REACHES	
OUTLET	52.50

WinTR-55 Current Data Description

--- Identification Data ---

User: PMV
Project: LF33 2018 Vertical Expansion
SubTitle: Terrace 3 - 25 yr
State: Illinois
County: Effingham
Filename: J:\L\Landfill 33\ENG\2018\2018 Vertical Expansion\Stormwater Drainage\Terrace 3 - 25 yr.w55

Date: 7/17/2018
Units: English
Areal Units: Acres

--- Sub-Area Data ---

Name	Description	Reach	Area(ac)	RCN	Tc
T3	Terrace 3	Outlet	12.38	94	.185

Total area: 12.38 (ac)

--- Storm Data --

Rainfall Depth by Rainfall Return Period

2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	50-Yr (in)	100-Yr (in)	1-Yr (in)
3.03	3.8	4.44	5.37	6.23	7.41	2.55

Storm Data Source: Effingham County, IL (NRCS)
Rainfall Distribution Type: Type II
Dimensionless Unit Hydrograph: <standard>

PMV

LF33 2018 Vertical Expansion
Terrace 3 - 25 yr
Effingham County, Illinois

Hydrograph Peak/Peak Time Table

Sub-Area or Reach Identifier	Peak Flow and Peak Time (hr) by Rainfall Return Period 25-Yr (cfs) (hr)
SUBAREAS	
T3	71.91
	11.98
REACHES	
OUTLET	71.91

WinTR-55 Current Data Description

--- Identification Data ---

User: PMV
Project: LF33 2018 Vertical Expansion
SubTitle: Terrace 3 - 100 yr
State: Illinois
County: Effingham
Filename: J:\L\Landfill 33\ENG\2018\2018 Vertical Expansion\Stormwater Drainage\Terrace 3 - 100 yr.w55

Date: 7/17/2018
Units: English
Areal Units: Acres

--- Sub-Area Data ---

Name	Description	Reach	Area(ac)	RCN	Tc
T3	Terrace 3	Outlet	12.38	78	.185

Total area: 12.38 (ac)

--- Storm Data --

Rainfall Depth by Rainfall Return Period

2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	50-Yr (in)	100-Yr (in)	1-Yr (in)
3.03	3.8	4.44	5.37	6.23	7.41	2.55

Storm Data Source: Effingham County, IL (NRCS)
Rainfall Distribution Type: Type II
Dimensionless Unit Hydrograph: <standard>

PMV

LF33 2018 Vertical Expansion
Terrace 3 - 100 yr
Effingham County, Illinois

Hydrograph Peak/Peak Time Table

Sub-Area or Reach Identifier	Peak Flow and Peak Time (hr) by Rainfall Return Period 100-Yr (cfs) (hr)
SUBAREAS	
T3	80.28 12.00
REACHES	
OUTLET	80.28

WinTR-55 Current Data Description

--- Identification Data ---

User:	PMV	Date:	7/17/2018
Project:	LF33 2018 Vertical Expansion	Units:	English
SubTitle:	Terrace 6 - 25 yr	Areal Units:	Acres
State:	Illinois		
County:	Effingham		

Filename: J:\L\Landfill 33\ENG\2018\2018 Vertical Expansion\Stormwater Drainage\Terrace 6 - 25 yr.w55

--- Sub-Area Data ---

Name	Description	Reach	Area(ac)	RCN	Tc
T6	Terrace 6	Outlet	5.13	94	.112

Total area: 5.13 (ac)

--- Storm Data --

Rainfall Depth by Rainfall Return Period

2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	50-Yr (in)	100-Yr (in)	1-Yr (in)
3.03	3.8	4.44	5.37	6.23	7.41	2.55

Storm Data Source: Effingham County, IL (NRCS)
Rainfall Distribution Type: Type II
Dimensionless Unit Hydrograph: <standard>

PMV

LF33 2018 Vertical Expansion
Terrace 6 - 25 yr
Effingham County, Illinois

Hydrograph Peak/Peak Time Table

Sub-Area or Reach Identifier	Peak Flow and Peak Time (hr) by Rainfall Return Period 25-Yr (cfs) (hr)
SUBAREAS	
T6	33.30 11.94
REACHES	
OUTLET	33.30

WinTR-55 Current Data Description

--- Identification Data ---

User: PMV
Project: LF33 2018 Vertical Expansion
SubTitle: Terrace 6 - 100 yr
State: Illinois
County: Effingham
Filename: J:\L\Landfill 33\ENG\2018\2018 Vertical Expansion\Stormwater Drainage\Terrace 6 - 100 yr.w55

Date: 7/17/2018
Units: English
Areal Units: Acres

--- Sub-Area Data ---

Name	Description	Reach	Area(ac)	RCN	Tc
T6	Terrace 6	Outlet	5.13	78	0.112

Total area: 5.13 (ac)

--- Storm Data --

Rainfall Depth by Rainfall Return Period

2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	50-Yr (in)	100-Yr (in)	1-Yr (in)
3.03	3.8	4.44	5.37	6.23	7.41	2.55

Storm Data Source: Effingham County, IL (NRCS)
Rainfall Distribution Type: Type II
Dimensionless Unit Hydrograph: <standard>

PMV

LF33 2018 Vertical Expansion
Terrace 6 - 100 yr
Effingham County, Illinois

Hydrograph Peak/Peak Time Table

Sub-Area or Reach Identifier	Peak Flow and Peak Time (hr) by Rainfall Return Period 100-Yr (cfs) (hr)
SUBAREAS	
T6	37.17 11.94
REACHES	
OUTLET	37.17

WinTR-55 Current Data Description

--- Identification Data ---

User: PMV
Project: LF33 2018 Vertical Expansion
SubTitle: Terrace 7 - 25 yr
State: Illinois
County: Effingham
Filename: J:\L\Landfill 33\ENG\2018\2018 Vertical Expansion\Stormwater Drainage\Terrace 7 - 25 yr.w55

Date: 7/17/2018
Units: English
Areal Units: Acres

--- Sub-Area Data ---

Name	Description	Reach	Area(ac)	RCN	Tc
T7	Terrace 7	Outlet	1.35	94	0.1

Total area: 1.35 (ac)

--- Storm Data --

Rainfall Depth by Rainfall Return Period

2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	50-Yr (in)	100-Yr (in)	1-Yr (in)
3.03	3.8	4.44	5.37	6.23	7.41	2.55

Storm Data Source: Effingham County, IL (NRCS)
Rainfall Distribution Type: Type II
Dimensionless Unit Hydrograph: <standard>

PMV

LF33 2018 Vertical Expansion
Terrace 7 - 25 yr
Effingham County, Illinois

Hydrograph Peak/Peak Time Table

Sub-Area or Reach Identifier	Peak Flow and Peak Time (hr) by Rainfall Return Period 25-Yr (cfs) (hr)
SUBAREAS	
T7	8.93 11.93
REACHES	
OUTLET	8.93

WinTR-55 Current Data Description

--- Identification Data ---

User: PMV
Project: LF33 2018 Vertical Expansion
SubTitle: Terrace 7 - 100 yr
State: Illinois
County: Effingham
Filename: J:\L\Landfill 33\ENG\2018\2018 Vertical Expansion\Stormwater Drainage\Terrace 7 - 100 yr.w55

Date: 7/17/2018
Units: English
Areal Units: Acres

--- Sub-Area Data ---

Name	Description	Reach	Area(ac)	RCN	Tc
T7	Terrace 7	Outlet	1.35	78	0.1

Total area: 1.35 (ac)

--- Storm Data --

Rainfall Depth by Rainfall Return Period

2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	50-Yr (in)	100-Yr (in)	1-Yr (in)
3.03	3.8	4.44	5.37	6.23	7.41	2.55

Storm Data Source: Effingham County, IL (NRCS)
Rainfall Distribution Type: Type II
Dimensionless Unit Hydrograph: <standard>

PMV

LF33 2018 Vertical Expansion
Terrace 7 - 100 yr
Effingham County, Illinois

Hydrograph Peak/Peak Time Table

Sub-Area or Reach Identifier	Peak Flow and Peak Time (hr) by Rainfall Return Period 100-Yr (cfs) (hr)
SUBAREAS	
T7	9.98
	11.93
REACHES	
OUTLET	9.98

Exhibit 2
Drainage Structures Calculations

Landfill 33 Drainage Calculations
Final Cover Modification

Channel	Design Q (cfs)	Design V (feet/sec)	d (feet)	D (feet)	B (feet)	Z_1 (min.)	Z_2 (min.)	Slope (%)	n	T (feet)	A (sf)	P (feet)	R (feet)	d V (feet/sec)	Calculated Q (cfs)
D-1	63.6	4.54	2.0	2.5	0	4	3	1.7	0.04	14.0	14.00	14.57	0.96	4.729	66.2
D-2	9.2	2.17	1.1	1.5	0	4	3	1.1	0.04	7.7	4.24	8.01	0.53	2.554	10.8
D-3	5.9	3.07	0.8	1.0	0	3	3	3.9	0.04	4.8	1.92	5.06	0.38	3.856	7.4
D-4	8.9	4.64	0.8	1.0	0	3	3	7.4	0.04	4.8	1.92	5.06	0.38	5.311	10.2
D-5	5.2	3.54	0.7	1.0	0	3	3	8.5	0.04	4.2	1.47	4.43	0.33	5.207	7.7
D-6	1.5	3.13	0.4	1.0	0	3	3	18.6	0.04	2.4	0.48	2.53	0.19	5.305	2.5
D-7	9.6	3.95	0.9	1.0	0	3	3	5.7	0.04	5.4	2.43	5.69	0.43	5.042	12.3
D-8	0.8	1.67	0.4	1.0	0	3	3	4.9	0.04	2.4	0.48	2.53	0.19	2.723	1.3
D-9	6.7	3.49	0.8	1.0	0	3	3	4.7	0.04	4.8	1.92	5.06	0.38	4.233	8.1
D-10	2.2	1.75	0.6	1.0	0	4	3	2.4	0.04	4.2	1.26	4.37	0.29	2.518	3.2
D-11	20.7	3.02	1.4	1.5	0	4	3	1.2	0.04	9.8	6.86	10.20	0.67	3.132	21.5
D-12	22.9	2.91	1.5	2.0	0	4	3	1.2	0.04	10.5	7.88	10.93	0.72	3.280	25.8
D-13	6.7	1.85	1.1	1.5	0	3	3	0.9	0.04	6.6	3.63	6.96	0.52	2.290	8.3
T-1	9.4	3.13	1.0	1.5	0	4	2	2.0	0.04	6.0	3.00	6.36	0.47	3.192	9.6
T-2	52.5	4.10	1.6	2.0	0	4	6	2.0	0.04	16.0	12.80	16.33	0.78	4.479	57.3
T-3	80.3	4.45	1.9	2.0	0	4	6	2.0	0.04	19.0	18.05	19.39	0.93	5.022	90.6
T-4	44.0	4.35	1.7	2.0	0	4	3	2.0	0.04	11.9	10.12	12.39	0.82	4.603	46.6
T-5	12.3	3.39	1.1	1.5	0	4	2	2.0	0.04	6.6	3.63	7.00	0.52	3.402	12.3
T-6	37.2	4.15	1.6	2.0	0	4	3	2.0	0.04	11.2	8.96	11.66	0.77	4.420	39.6
T-7	10.0	2.75	1.1	1.5	0	4	2	2.0	0.04	6.6	3.63	7.00	0.52	3.402	12.3
TO-1	47.2	8.58	0.5	1.0	10	2	2	25.0	0.04	12.0	5.50	12.24	0.45	10.929	60.1
TO-2	180.0	15.00	1.0	1.5	10	2	2	25.0	0.04	14.0	12.00	14.47	0.83	16.438	197.3
TO-3	189.4	15.78	1.0	1.5	10	2	2	25.0	0.04	14.0	12.00	14.47	0.83	16.438	197.3

6

Attachment 6

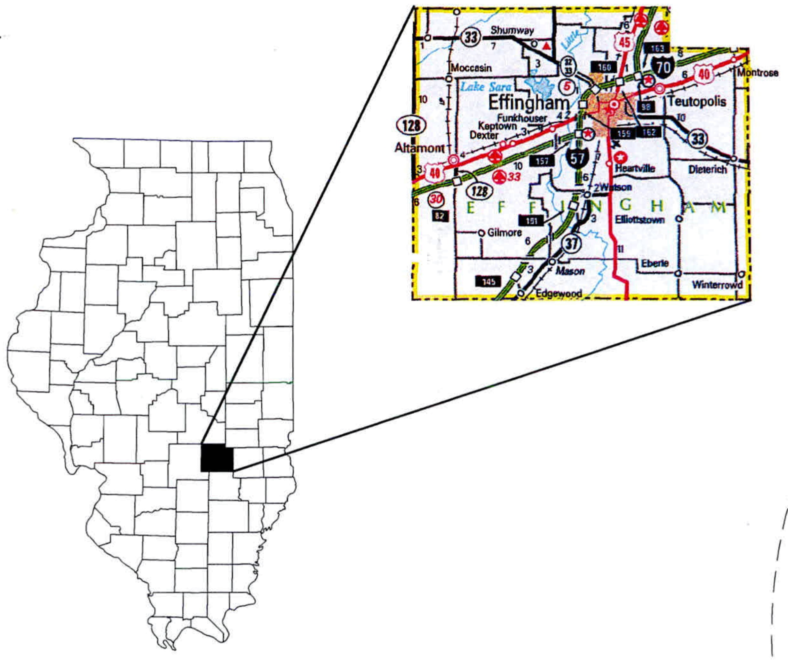
Revised Plan Drawings (Reduced Copy)

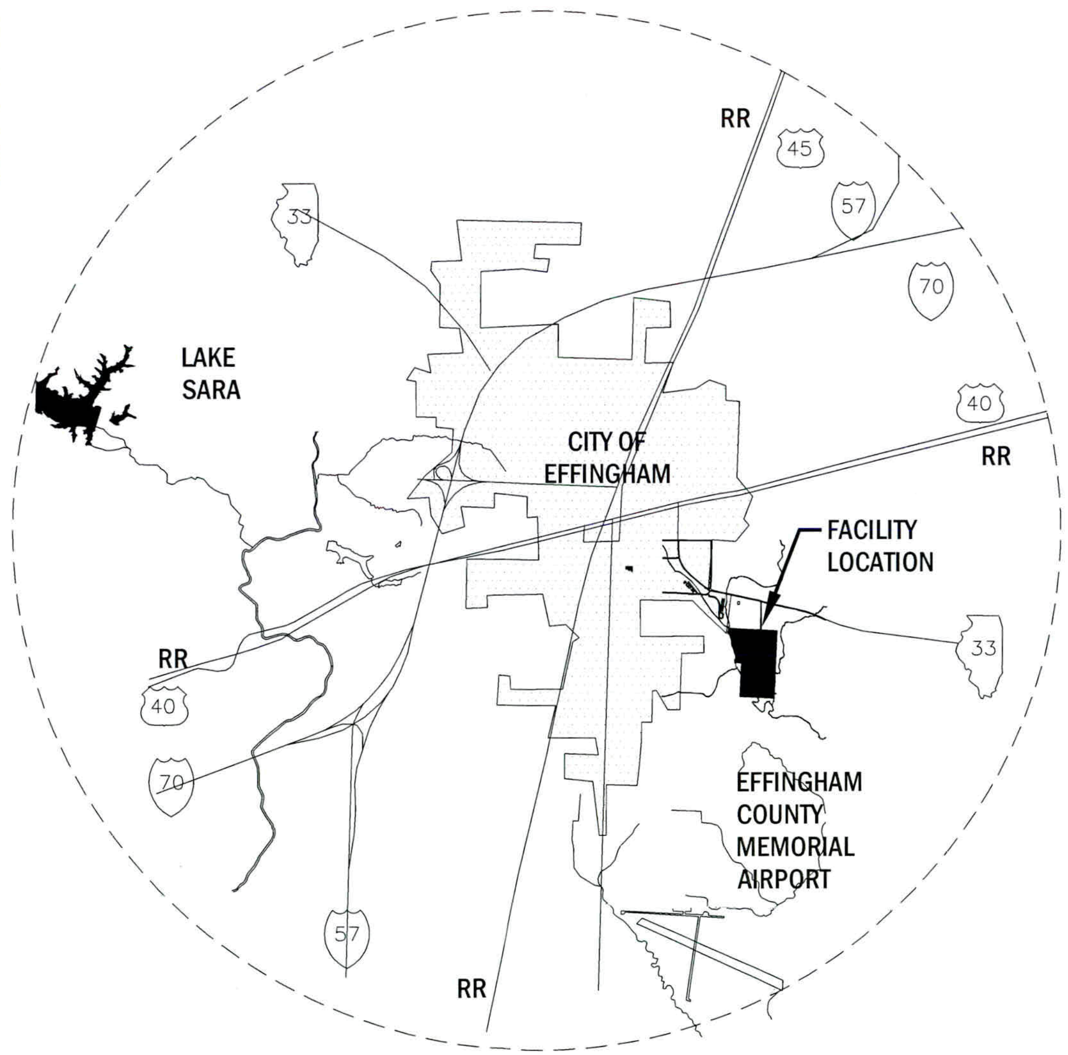
R193

FINAL COVER MODIFICATION

LANDFILL 33, LTD.

EFFINGHAM COUNTY, ILLINOIS
IEPA SITE NO. 0498100007
FEBRUARY 2019





N

VICINITY MAP
NOT TO SCALE

INDEX OF SHEETS

PREPARED FOR:

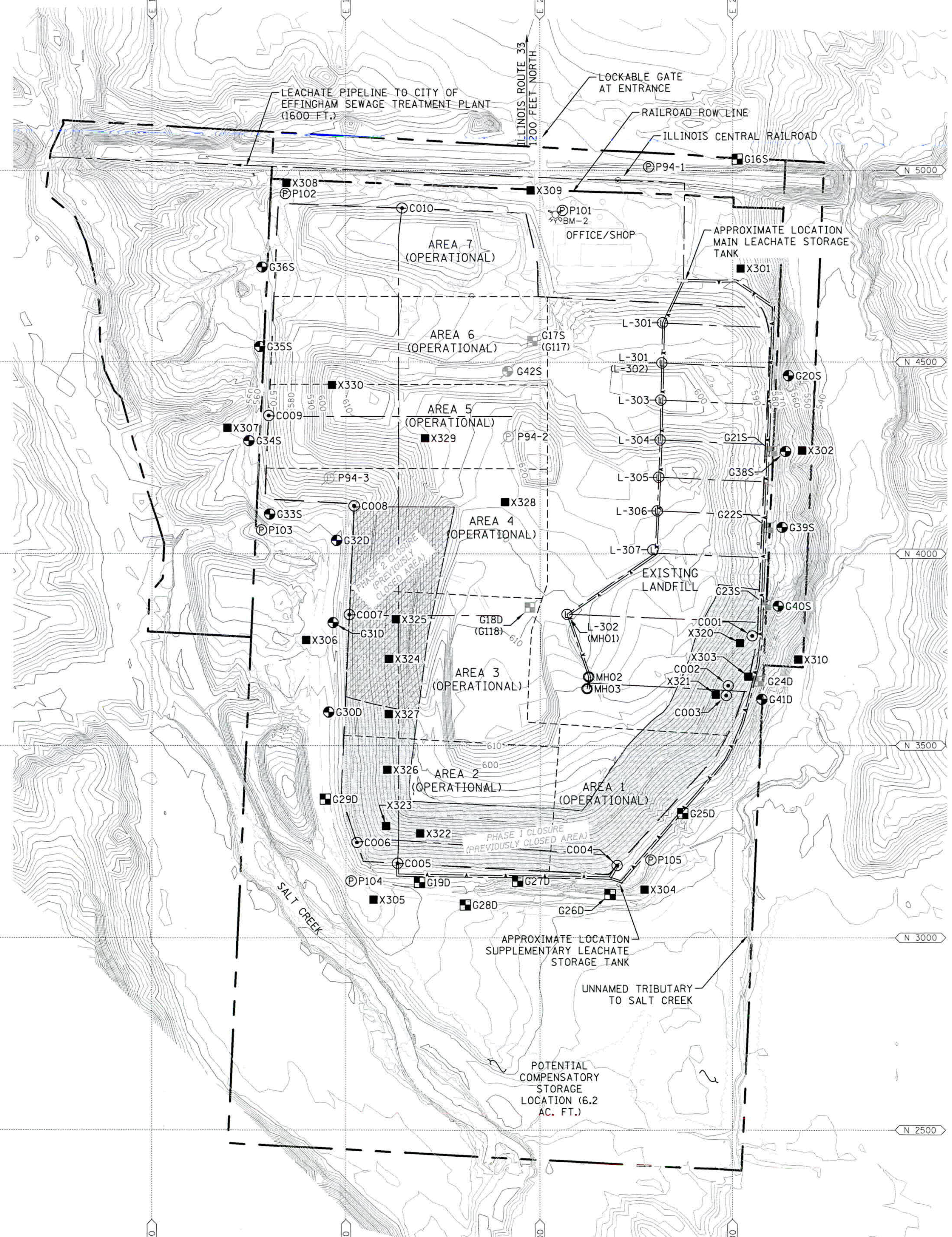
LANDFILL 33, LTD.
EFFINGHAM, ILLINOIS

PREPARED BY:

ANDREWS ENGINEERING
3300 GINGER CREEK DRIVE
SPRINGFIELD, ILLINOIS 62711-7233
PH (217) 787-2334 WWW.ANDREWS-ENG.COM
PONTIAC, IL • LOMBARD, IL • INDIANAPOLIS, IN • WARRENTON, MO

NO.	DATE	REVISION DESCRIPTION	BY

DATE: FEBRUARY 2019
PROJECT ID: 180130/0006
SHEET NUMBER: B2-0



LEGEND

- PROPERTY BOUNDARY (FACILITY BOUNDARY)
- WASTE BOUNDARY
- CELL BOUNDARY
- DITCH, STREAM, OR WATERWAY
- UNPAVED ROAD
- TREE LINE
- EXISTING LEACHATE COLLECTION/TRANSFER PIPE
- EXISTING 2" HDPE SDR11 AIR LINE
- EXISTING MONITORING WELL (SS)
- ABANDONED MONITORING WELL LOCATION (SS)
- EXISTING MONITORING WELL (PVC)
- ABANDONED MONITORING WELL LOCATION (PVC)
- EXISTING GROUNDWATER PIEZOMETER
- ABANDONED GROUNDWATER PIEZOMETER
- EXISTING GAS PROBE
- LEACHATE COLLECTION CLEANOUT
- LEACHATE COLLECTION MANHOLE
- FIRE HYDRANT

BENCHMARK

BM-2	TOP BOLT OF FIRE HYDRANT BETWEEN SCALE AND P101, ELEVATION 578.92

NOTES

1. CONTOURS WERE DEVELOPED USING AERIAL PHOTOGRAMMETRIC METHODS BY SIDWELL COMPANY FROM PHOTOGRAPHS DATED MARCH 30, 2016 MERGED WITH NOVEMBER 29, 2018 TOPO SURVEYED BY ANDREWS ENGINEERING, INC. CONTOURS ARE SHOWN AT AN INTERVAL OF 2 FEET.
2. PROPERTY BOUNDARIES WERE ESTABLISHED BY MILANO AND GRUNLOH, INC. BENCHMARKS (VERTICAL CONTROL MONUMENTS), HORIZONTAL CONTROL, AND PROPERTY BOUNDARIES WILL BE MAINTAINED BY A PROFESSIONAL LAND SURVEYOR.
3. CURRENT TOPOGRAPHY MAY DIFFER FROM THAT SHOWN DUE TO LANDFILLING ACTIVITIES CONDUCTED SINCE THE DATE OF PHOTOGRAPHY.
4. FOR CLARITY, NOT ALL SITE FEATURES ARE SHOWN.

N

0 150 300 600

SCALE: IN FEET

NO	DATE	REVISION DESCRIPTION	BY

ANDREWS ENGINEERING
3300 GINGER CREEK DRIVE
SPRINGFIELD, ILLINOIS 62711-7233
PH (217) 787-2334 WWW.ANDREWS-ENG.COM
PONTIAC, IL • LOMBARD, IL • INDIANAPOLIS, IN • WARRENTON, MO

APPROVED BY: DWM | DESIGNED BY: DWM | DRAWN BY: MPN

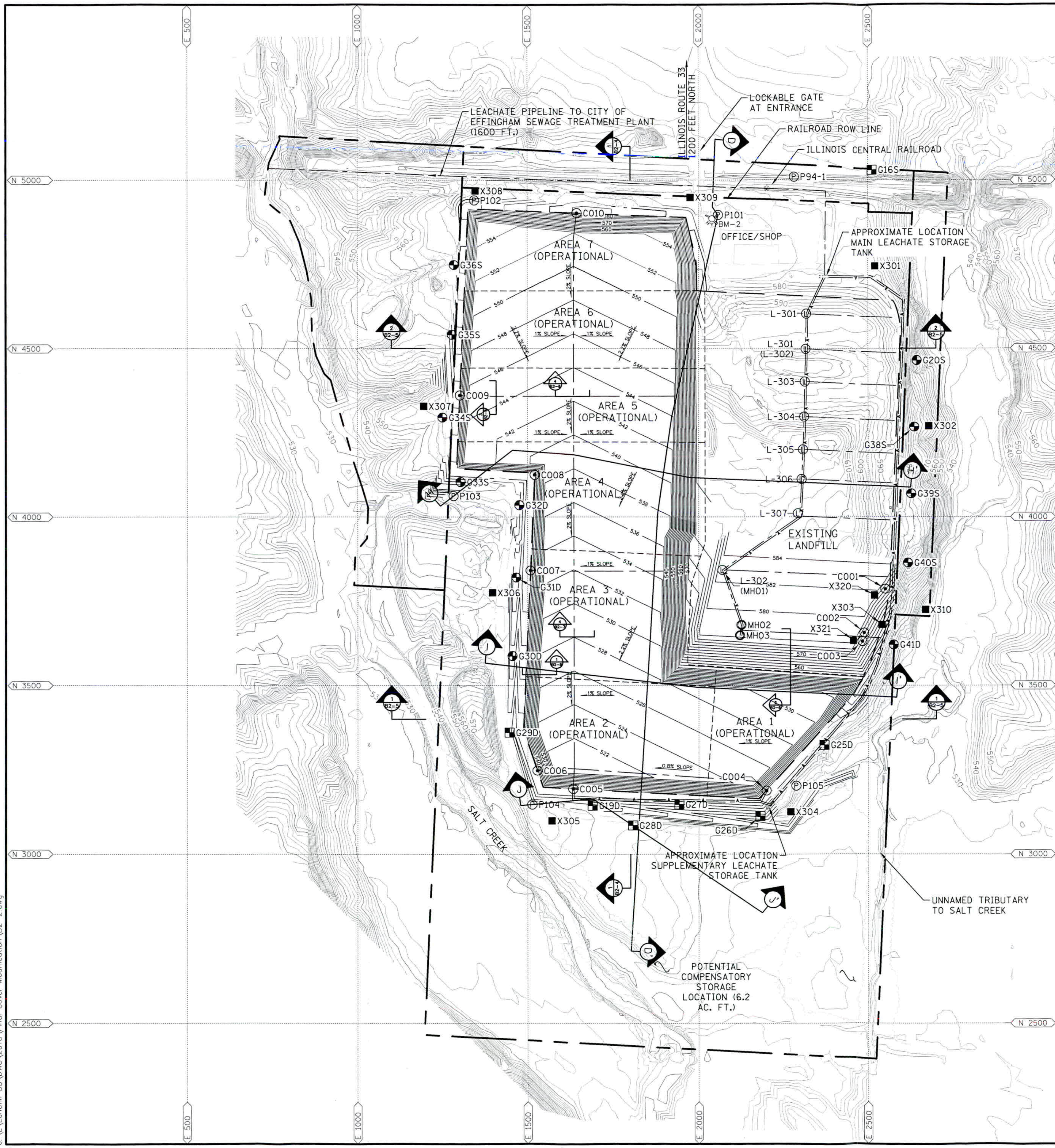
EXISTING SITE CONDITIONS

SIGNIFICANT MODIFICATION TO PERMIT FOR
LANDFILL 33, LTD.
EFFINGHAM COUNTY, ILLINOIS

DATE: FEBRUARY 2019

PROJECT ID: 180130/0006

SHEET NUMBER: B2-1



LEGEND

- PROPERTY BOUNDARY (FACILITY BOUNDARY)
- WASTE BOUNDARY
- CELL BOUNDARY
- DITCH, STREAM, OR WATERWAY
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- EXISTING GROUNDWATER PIEZOMETER
- EXISTING GAS PROBE
- LEACHATE COLLECTION CLEANOUT
- LEACHATE COLLECTION MANHOLE
- FIRE HYDRANT

N

0 150 300 600
SCALE: IN FEET

NOTES

1. EXCEPT FOR THE PROPERTY AND WASTE BOUNDARIES, ALL PROPOSED LOCATIONS SHOWN ARE APPROXIMATE. ACTUAL LOCATIONS WILL BE DETERMINED IN THE FIELD.
2. FOR CLARITY, NOT ALL EXISTING LANDFILL FEATURES ARE SHOWN.
3. ROADWAY MATERIALS AND THE TRAVEL LENGTH FROM THE SITE TO ROUTE 33 WILL ASSURE THAT NO MUD BE INTRODUCED ONTO OFF-SITE ROADS.
4. ALL EXISTING STRUCTURES AND UTILITIES WITHIN AREAS DESIGNATED FOR FILLING AND/OR BORROWING ACTIVITIES SHALL BE RELOCATED OR DEMOLISHED. ANY FIELD TILES ENCOUNTERED WITHIN THE LANDFILL AREA SHALL BE REMOVED TO A POINT BEYOND THE OUTSIDE LIMIT OF THE LANDFILL LINER AND SHALL BE REROUTED AS NECESSARY. WATER WELL REMOVAL/PLUGGING SHALL BE IN ACCORDANCE WITH THE REGULATIONS, REQUIREMENTS AND/OR GUIDELINES OF THE ILLINOIS EPA AND/OR ILLINOIS DEPARTMENT OF PUBLIC HEALTH AS APPROPRIATE.
5. TEMPORARY DRAINAGE DIVERSION BERMS, DITCHES, CULVERTS, ETC. WILL BE USED AS NECESSARY TO DIVERT STORM WATER RUNOFF FROM UNDISTURBED AREAS AWAY FROM DISTURBED AREAS. UNCONTAMINATED STORM WATER COLLECTED IN BELOW GRADE EXCAVATED AREAS WILL BE PUMPED TO TEMPORARY DITCHES OR TO THE PERIMETER DITCHES.
6. MONITORING WELLS WILL BE INSTALLED IN ACCORDANCE WITH THE GROUNDWATER MONITORING PROGRAM. THE GROUNDWATER MONITORING WELL LOCATIONS SHOWN ARE APPROXIMATE. THE ACTUAL LOCATIONS OF WELLS AT THE ZONE OF ATTENUATION MAY VARY 50 FEET ALONG THE ZONE OF ATTENUATION BUT WILL BE LOCATED DOWNGRADIENT OF THE LEACHATE STORAGE TANK. THE ACTUAL LOCATIONS OF THE OTHER DOWNGRADIENT WELLS WILL FALL ON A LINE PERPENDICULAR TO THE WASTE BOUNDARY AT, OR CLOSER THAN, HALF THE DISTANCE TO THE ZONE OF ATTENUATION.
7. DURING THE OPERATION OF THE FACILITY, THE OPERATOR WILL COMPLY WITH THE SAFETY STANDARDS RELATING TO THE CONSTRUCTION ESTABLISHED PURSUANT TO THE FEDERAL OCCUPATIONAL SAFETY AND HEALTH ACT OF 1970, TITLE 29, UNITED STATES CODE, SECTION 651 THROUGH 678, PUBLIC LAW 91-596, AS AMENDED. THE OPERATOR WILL ALSO COMPLY WITH THE OCCUPATIONAL SAFETY AND HEALTH STANDARDS, 29 CFR 1910.146, AS AMENDED, TO INCLUDE PERMIT-REQUIRED CONFINED SPACES.
8. ACTUAL LOCATIONS AND SIZES OF ON-SITE HAUL ROADS WILL BE DETERMINED AS NEEDED AND WILL DEPEND ON FIELD CONDITIONS AND SITE REQUIREMENTS. ROADWAYS FOR ACCESS TO ACTIVE FILL AREAS WILL BE EXTENDED OR REMOVED AS NECESSARY AS LANDFILLING PROGRESSES AND MAY INCLUDE TEMPORARY ROADWAYS CONSTRUCTED OVER PREVIOUSLY FILLED AREAS.
9. THE TYPICAL DETAILS SHOWN ON THESE DRAWINGS ARE MEANT TO INDICATE A GENERAL DESIGN CONCEPT FOR THE PARTICULAR ITEMS. ADJUSTMENTS MAY BE MADE IN THE FIELD BY THE CONSTRUCTION QUALITY ASSURANCE OFFICER (CQAO) FOR CONDITIONS ENCOUNTERED. AS APPROPRIATE, ANY ADJUSTMENTS SHALL BE REFLECTED IN THE RECORD DRAWINGS AND/OR CONSTRUCTION VERIFICATION DOCUMENTATION TO BE SUBMITTED TO THE ILLINOIS EPA AND/OR ANY OTHER GOVERNMENT AGENCY WITH AUTHORITY OVER THE FACILITY AND ITS CONSTRUCTION.
10. THE LEACHATE COLLECTION PIPING WILL BE PERFORATED 6 INCH DIAMETER SDR 17 OR STRONGER HDPE SMOOTH WALLED PIPE LAID AT THE SLOPES SHOWN. PIPING OF DIFFERENT MATERIALS OF CONSTRUCTION MAY BE SUBSTITUTED FOR THOSE SHOWN ON THESE DRAWINGS PROVIDED IT IS COMPATIBLE WITH THE LIQUIDS TO BE HANDLED, IS OF ADEQUATE STRENGTH, AND MINIMUM FLOW CAPACITIES ARE MAINTAINED.
11. PERIMETER GAS PROBES WILL BE LOCATED AS SHOWN AND TYPICALLY A NOMINAL 100' FROM THE WASTE BOUNDARY OR AT THE PROPERTY LINE, WHICHEVER IS CLOSER. WHERE DICTATED BY FIELD CONDITIONS, GAS PROBES MAY BE LOCATED CLOSER TO THE WASTE BOUNDARY THAN DESCRIBED ABOVE. INSTALLATION OF INDIVIDUAL GAS PROBES WILL BE PRIOR TO, OR IN CONJUNCTION WITH, THE DEVELOPMENT OF THE FILL AREA THEY ADJOIN.
12. WHERE NATURAL BARRIERS ARE NOT PRESENT, 4' (MINIMUM) WOVEN WIRE FENCE OR CHAIN LINK FENCING WITH LOCKABLE GATES WILL BE PROVIDED TO RESTRICT ACCESS TO THE FACILITY AND PREVENT UNAUTHORIZED ENTRY AT ALL TIMES.
13. THE PERIMETER BERMS WILL HAVE A MINIMUM TOP WIDTH OF 16 FEET AND BE CONSTRUCTED AT LEAST 2 FEET ABOVE THE FLOW LINES OF ADJOINING DITCHES.
14. LEACHATE TRANSFER PIPING LOCATED WITHIN THE WASTE WILL BE SINGLE-WALLED. PIPING OUTSIDE THE WASTE WILL BE DOUBLE-WALLED.

NO	DATE	REVISION DESCRIPTION	BY

ANDREWS ENGINEERING
3300 GINGER CREEK DRIVE
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PONTIAC, IL • LOMBARD, IL • INDIANAPOLIS, IN • WARRENTON, MO

APPROVED BY: DWM | DESIGNED BY: DWM | DRAWN BY: MPN

SITE DEVELOPMENT PLAN

SIGNIFICANT MODIFICATION TO PERMIT FOR
LANDFILL 33, LTD.
EFFINGHAM COUNTY, ILLINOIS

DATE: FEBRUARY 2019
PROJECT ID: 180130/0006
SHEET NUMBER: B2-2

Tab: Layout1 Last Saved: February 8, 2019, by Mike Nguyen Plotted: Friday, February 8, 2019 3:15:21 PM
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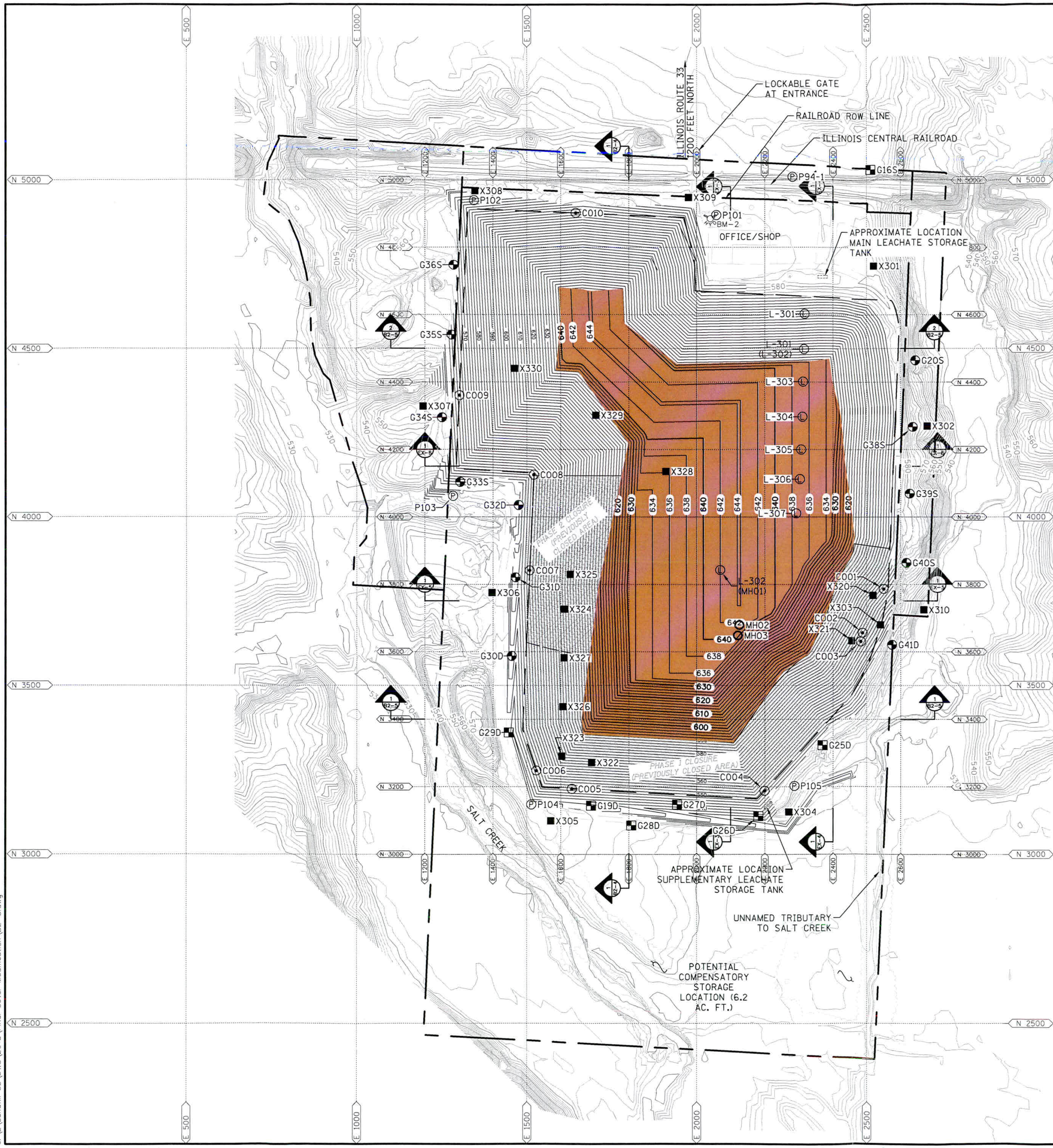

LEGEND

- PROPERTY BOUNDARY (FACILITY BOUNDARY)
- WASTE BOUNDARY
- CELL BOUNDARY
- DITCH, STREAM, OR WATERWAY
- UNPAVED ROAD
- TREE LINE
- EXISTING MONITORING WELL (SS)
- EXISTING MONITORING WELL (PVC)
- EXISTING GROUNDWATER PIEZOMETER
- EXISTING GAS PROBE
- LEACHATE COLLECTION CLEANOUT
- LEACHATE COLLECTION MANHOLE
- FIRE HYDRANT
- AREA OF PROPOSED FINAL COVER MODIFICATION

NOTES

1. THIS DRAWING DEPICTS PROPOSED FINAL GRADE IF FINAL COVER MODIFICATION IS PERMITTED.
2. FOR CLARITY, NOT ALL SITE FEATURES ARE SHOWN.
3. AT LEAST 5 GAS MONITORING PROBES WILL BE LOCATED WITHIN THE WASTE BOUNDARY AS SHOWN. INSTALLATION WILL BE NO LATER THAN 60 DAYS AFTER FINAL COVER IS IN PLACE IN THE AREA WHERE THE PROBES ARE TO BE LOCATED. THE ACTUAL LOCATIONS OF THE GAS MONITORING PROBES WITHIN THE WASTE MAY VARY WITH IEPA APPROVAL.
4. THE SITE'S END USE WILL BE "OPEN SPACE".
5. LEACHATE TRANSFER PIPING LOCATED WITHIN THE WASTE BOUNDARY WILL BE SINGLE-WALLED. PIPING OUTSIDE THE WASTE BOUNDARY WILL BE DOUBLE-WALLED.
6. THE FINAL CONTOURS AND CONDITIONS SHOWN HERE MAY BE REFINED OR UNDERGO MINOR MODIFICATIONS FOR THE IEPA DEVELOPMENTAL PERMIT APPLICATION.

N

0 150 300 600

SCALE: IN FEET

NO.	DATE	REVISION DESCRIPTION	BY

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PROPOSED FINAL CONTOURS

SIGNIFICANT MODIFICATION TO PERMIT FOR
LANDFILL 33, LTD.
EFFINGHAM COUNTY, ILLINOIS

DATE: FEBRUARY 2019
PROJECT ID: 180130/0006
SHEET NUMBER:
B2-3

Tab: Layout1 Last Saved: February 11, 2019, by Mike Nguyen Plotted: Monday, February 11, 2019 9:13:52 AM
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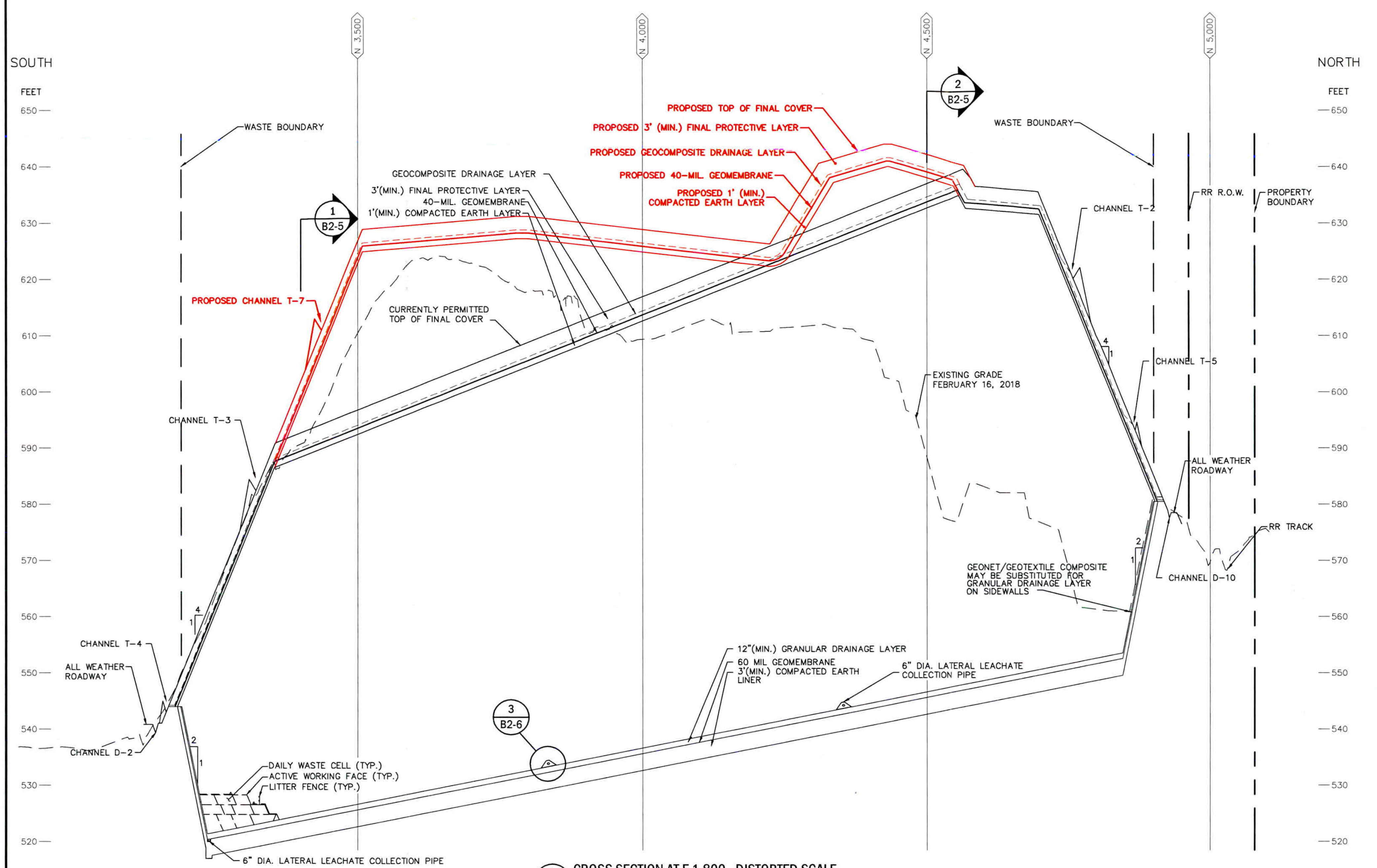
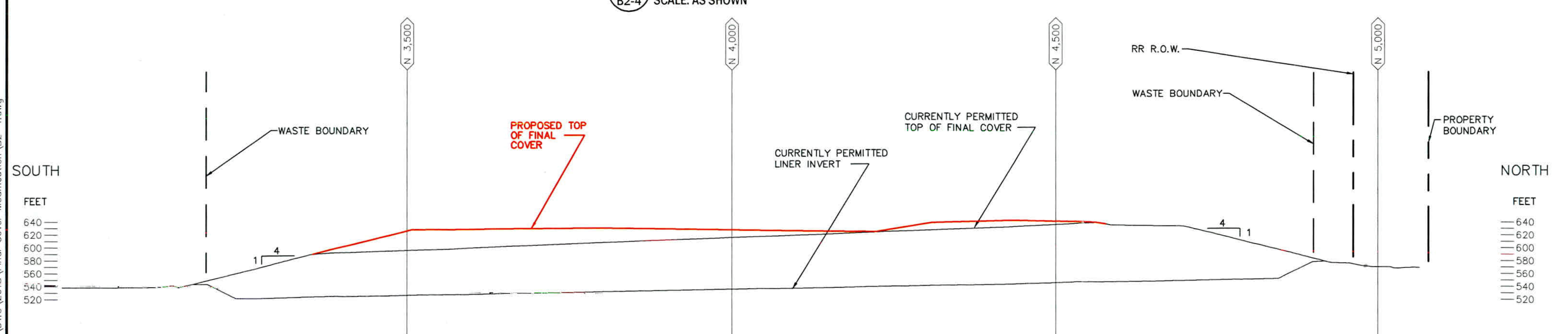
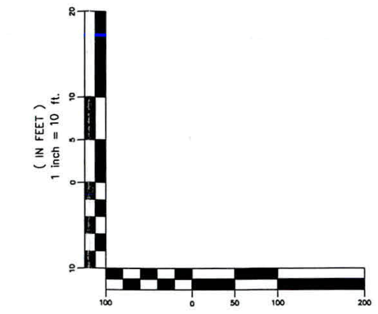


1 B2-4 **CROSS SECTION AT E 1,800 - DISTORTED SCALE**
SCALE: AS SHOWN



2 B2-4 **CROSS SECTION AT E 1,800 - TRUE SCALE**
SCALE: AS SHOWN



GRAPHIC SCALE

NOTES

1. THE EXISTING GRADE WAS DERIVED FROM THE CONTOURS ON SHEET B2-1.
2. FOR CLARITY, NOT ALL SITE FEATURES ARE SHOWN.
3. FOR CLARITY IN DEPICTING THE FEATURES OF THE LANDFILL, SECTIONS HAVE BEEN DISTORTED BY A FACTOR OF 10 IN THE VERTICAL SCALE. THE TRUE PROFILE OF DRAWING 1 IS 1/10 THE PROFILE SHOWN IN THE VERTICAL DIMENSION.
4. AS NECESSARY TO DIVERT ON-SITE SURFACE DRAINAGE AROUND ACTIVE AREAS OR CONSTRUCTION, TEMPORARY DIVERSION BERMS WILL BE UTILIZED.
5. THE PROPOSED LANDFILL LINER SIDESLOPES WILL BE 2H:1V OR FLATTER.
6. DAILY AND INTERMEDIATE SOIL COVER WILL BE PERMEABLE TO THE EXTENT NECESSARY TO PREVENT THE ACCUMULATION OF WATER AND THE FORMATION OF PERCHED WATER TABLES AND GAS BUILDUP WITHIN THE LANDFILL. ALTERNATIVELY, SOIL COVER WILL BE REMOVED AND/OR DISTURBED AS NECESSARY PRIOR TO ADDITIONAL WASTE PLACEMENT TO ACHIEVE THE SAME RESULTS.
7. AREAS OVEREXCAVATED IN EXCESS OF THAT NECESSARY FOR LANDFILL LINER CONSTRUCTION WILL BE BACKFILLED IN ACCORDANCE WITH THE REPORT OF STABILITY ANALYSIS CONDUCTED IN CONJUNCTION WITH THIS PROJECT.
8. THE EXISTING LANDFILL LINER INVERT AND SIDESLOPES WAS DERIVED FROM PERMIT APPLICATIONS PREVIOUSLY SUBMITTED TO THE IEPA.

NO.	DATE	REVISION DESCRIPTION	BY

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CROSS SECTION AT E 1,800

SIGNIFICANT MODIFICATION TO PERMIT FOR
LANDFILL 33, LTD.
EFFINGHAM COUNTY, ILLINOIS

DATE: FEBRUARY 2019
PROJECT ID: 180130/0006
SHEET NUMBER: B2-4

Tab: Layout1 Last Saved: February 11, 2019, by Mike Nguyen Plotted: Monday, February 11, 2019 10:24:05 AM
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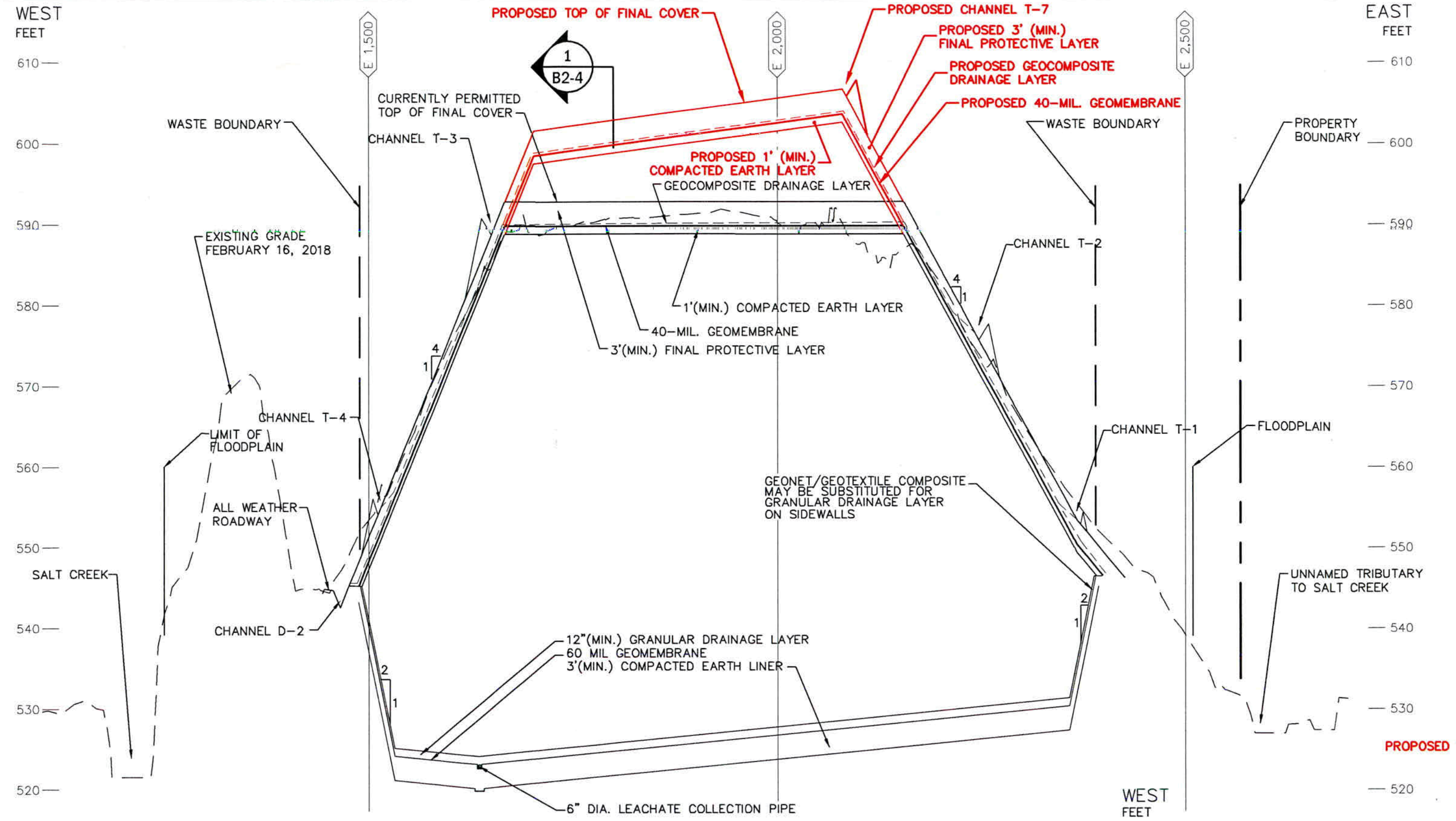
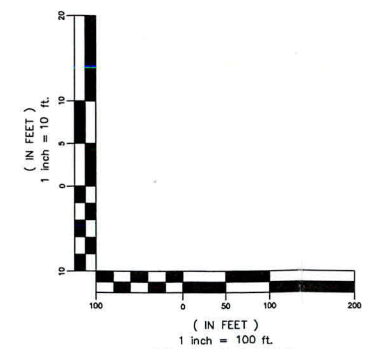
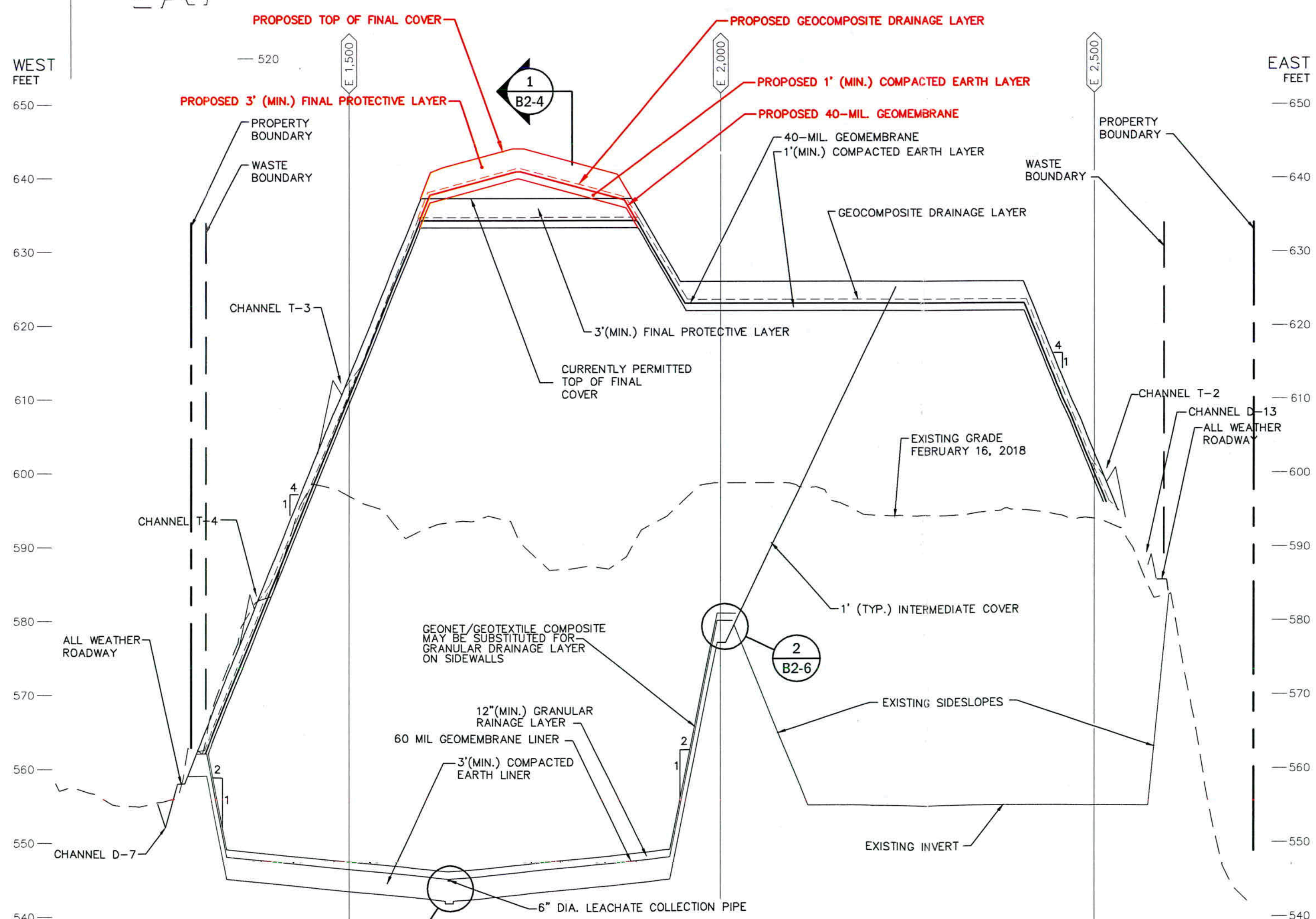


1 CROSS SECTION AT N 3,400
B2-5 SCALE: AS SHOWN





2 CROSS SECTION AT N 4,500
B2-5 SCALE: AS SHOWN

NOTES

1. THE EXISTING GRADE WAS DERIVED FROM THE CONTOURS ON SHEET B2-1.
2. FOR CLARITY, NOT ALL SITE FEATURES ARE SHOWN.
3. FOR CLARITY IN DEPICTING THE FEATURES OF THE LANDFILL, SECTIONS HAVE BEEN DISTORTED BY A FACTOR OF 10 IN THE VERTICAL SCALE. THE TRUE PROFILE OF THE LANDFORM IS 1/10 THE PROFILE SHOWN IN THE VERTICAL DIMENSION.
4. AS NECESSARY TO DIVERT ON-SITE SURFACE DRAINAGE AROUND ACTIVE AREAS OR CONSTRUCTION, TEMPORARY DIVERSION BERMS WILL BE UTILIZED.
5. THE PROPOSED LANDFILL LINER SIDESLOPES WILL BE 2H:1V OR FLATTER.
6. DAILY AND INTERMEDIATE SOIL COVER WILL BE PERMEABLE TO THE EXTENT NECESSARY TO PREVENT THE ACCUMULATION OF WATER AND THE FORMATION OF PERCHED WATER TABLES AND GAS BUILDUP WITHIN THE LANDFILL. ALTERNATIVELY, SOIL COVER WILL BE REMOVED AND/OR DISTURBED AS NECESSARY PRIOR TO ADDITIONAL WASTE PLACEMENT TO ACHIEVE THE SAME RESULTS.
7. AREAS OVEREXCAVATED IN EXCESS OF THAT NECESSARY FOR LANDFILL LINER CONSTRUCTION WILL BE BACKFILLED IN ACCORDANCE WITH THE REPORT OF STABILITY ANALYSIS CONDUCTED IN CONJUNCTION WITH PROJECT PERMITTING.
8. THE EXISTING LANDFILL LINER INVERT AND SIDESLOPES WAS DERIVED FROM PERMIT APPLICATIONS PREVIOUSLY SUBMITTED TO THE IEPA.

Tab: Layout1 Last Saved: February 11, 2019, by Mike Nguyen Plotted: Monday, February 11, 2019 10:25:24 AM
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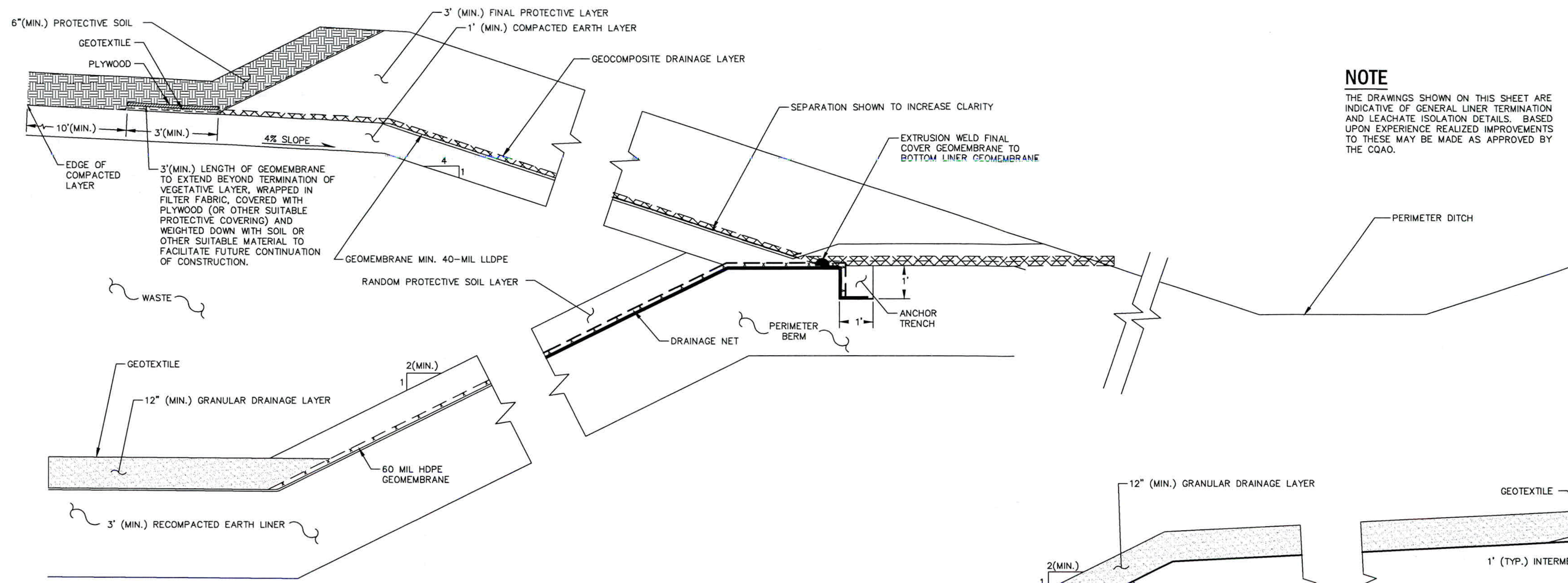
CROSS SECTIONS AT N 3,400 AND N 4,500

SIGNIFICANT MODIFICATION TO PERMIT FOR
LANDFILL 33, LTD.
EFFINGHAM COUNTY, ILLINOIS

DATE: FEBRUARY 2019
PROJECT ID: 180130/0006
SHEET NUMBER:
B2-5



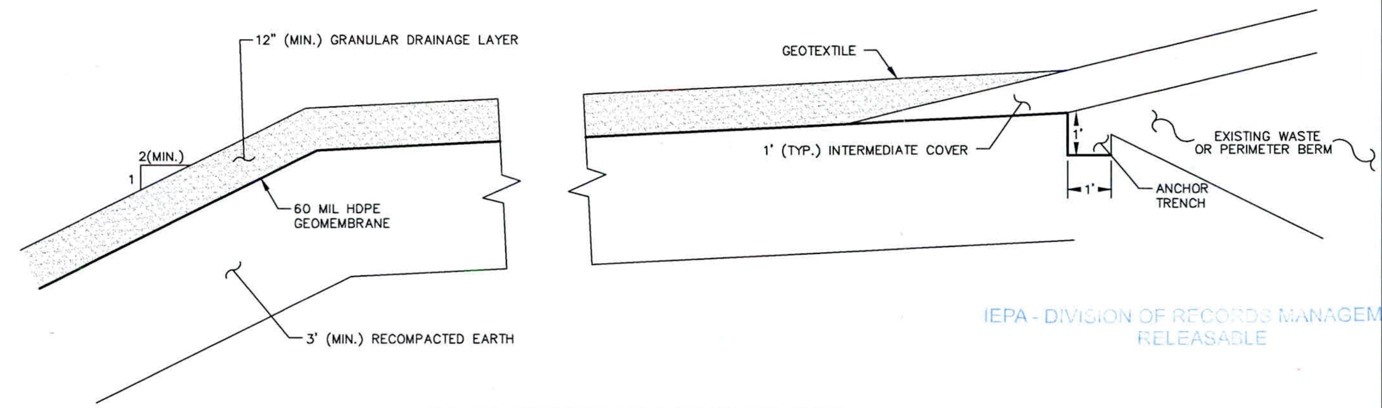
NOTE

THE DRAWINGS SHOWN ON THIS SHEET ARE INDICATIVE OF GENERAL LINER TERMINATION AND LEACHATE ISOLATION DETAILS. BASED UPON EXPERIENCE REALIZED IMPROVEMENTS TO THESE MAY BE MADE AS APPROVED BY THE CQAO.

NOTES

1. THE ANCHOR TRENCHES SHALL BE FILLED WITH COMPACTED CLAY.
2. ALL DIMENSIONS SHOWN REPRESENT MINIMUM VALUES.
3. IF SAND IS PLACED OVER THE SIDEWALL LINER, THE RANDOM PROTECTIVE SOIL LAYER AND DRAINAGE NET MAY BE OMITTED.
4. UNFILLED GAPS OR VENT HOLES IN ANCHOR TRENCH BACKFILL WILL BE PEROIDICALLY LEFT TO FACILITATE AIR ESCAPE UNDER GEOMEMBRANE WHEN PROVIDING SURFACE COVERING.
5. THE RANDOM PROTECTIVE SOIL LAYER WILL BE PLACED IN ±12" LIFTS AND COMPACTED WITH TRACKED EQUIPMENT
6. A SECOND ANCHOR TRENCH WILL BE PROVIDED IF DEPLOYMENT OF DRAINAGE NET AND GEOTEXTILE IS DELAYED BEYOND GEOMEMBRANE INSTALLATION

1 / B2-6 FINAL COVER/ANCHOR TRENCH DETAIL
NOT TO SCALE

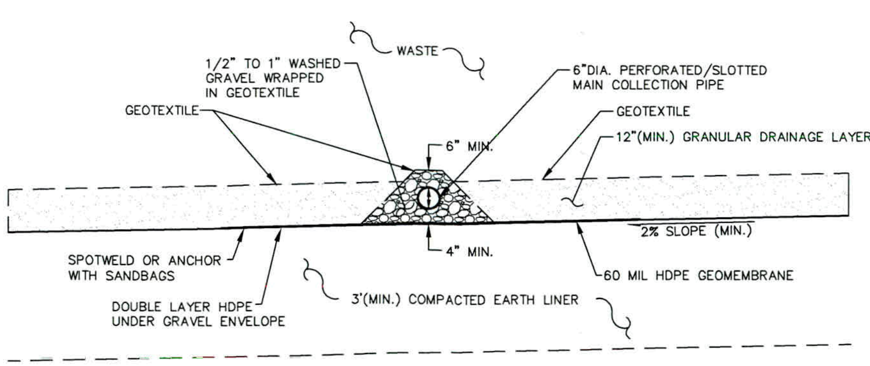


2 / B2-6 LINER SIDEWALL/SEPARATION LAYER DETAIL
NOT TO SCALE

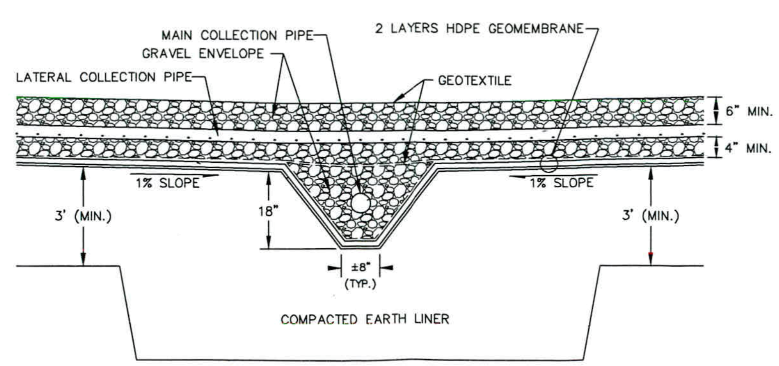
IEPA - DIVISION OF RECORDS MANAGEMENT
RELEASABLE

NOV 05 2019

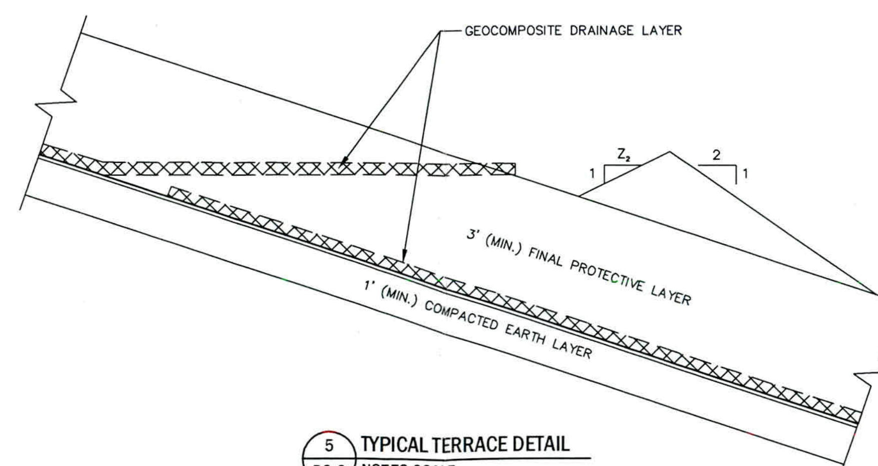
REVIEWER: MED



3 / B2-6 LATERAL COLLECTION PIPE DETAIL
NOT TO SCALE



4 / B2-6 LEACHATE COLLECTION TRENCH DETAIL
NOT TO SCALE



5 / B2-6 TYPICAL TERRACE DETAIL
NOT TO SCALE

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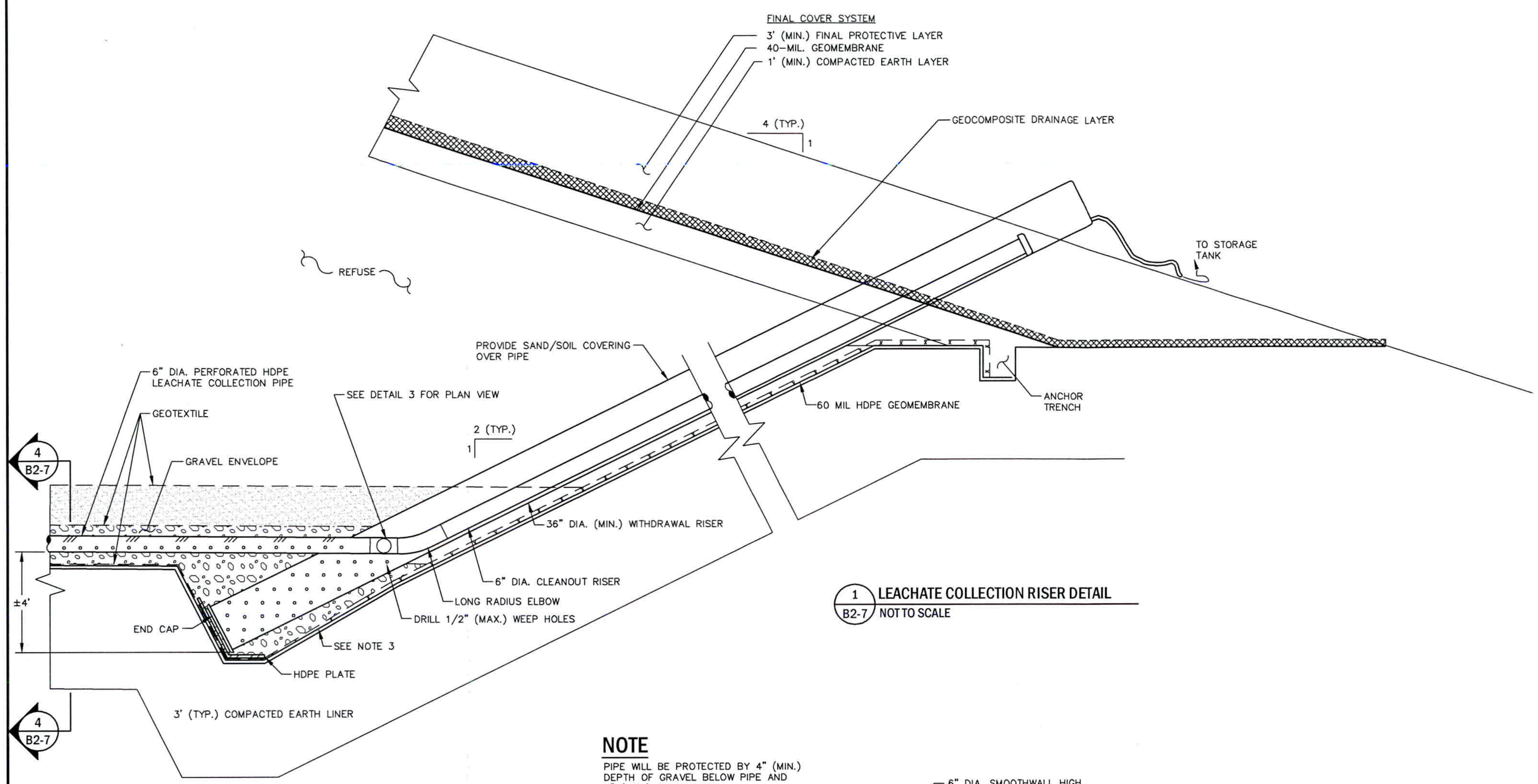
LEACHATE COLLECTION DETAILS 1

SIGNIFICANT MODIFICATION TO PERMIT FOR
LANDFILL 33, LTD.
EFFINGHAM COUNTY, ILLINOIS

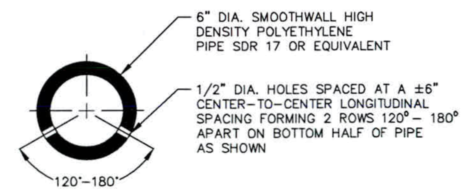
DATE: FEBRUARY 2019
PROJECT ID: 180130/0006
SHEET NUMBER:
B2-6



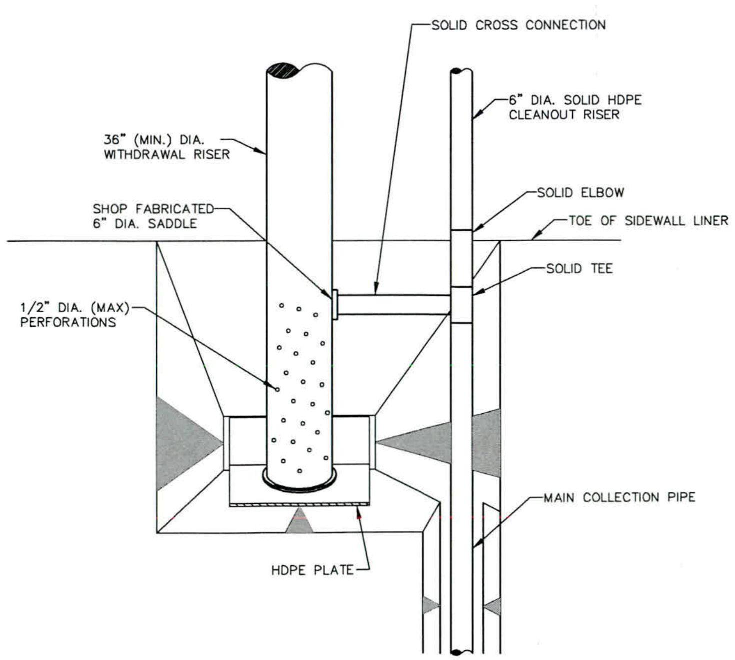
1 B2-7 LEACHATE COLLECTION RISER DETAIL
NOT TO SCALE

NOTE

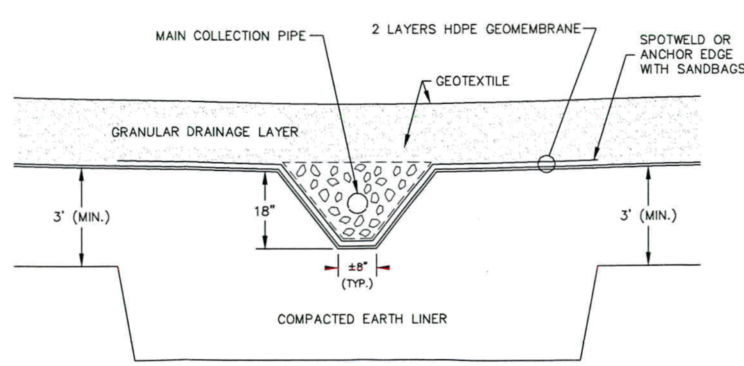
PIPE WILL BE PROTECTED BY 4" (MIN.) DEPTH OF GRAVEL BELOW PIPE AND 6" (TYP.) ABOVE PIPE.



2 B2-7 LEACHATE COLLECTION PIPE DETAIL
NOT TO SCALE



3 B2-7 COLLECTION SUMP PLAN VIEW
NOT TO SCALE



4 B2-7 LEACHATE COLLECTION TRENCH DETAIL
NOT TO SCALE

NOTES

1. TO AVOID DAMAGE TO THE HDPE GEOMEMBRANE, THE CORNERS OF ALL EXCAVATONS SHOULD BE SLIGHTLY ROUNDED.
2. THE FLOW LINE OF THE COLLECTOR PIPE WILL BE APPROXIMATELY 12" BELOW THE TRENCH FLOOR. RECORD DRAWINGS OF THE RISERS WILL BE FURNISHED TO THE IEPA ILLUSTRATING THE ELEVATIONS OF THE RISER COMPONENTS WITH THE ASSOCIATED ACCEPTANCE REPORT.
3. IN THE LOWER AREAS OF THE RISER SUMP, A DOUBLE LAYER OF HDPE GEOMEMBRANE WILL BE USED TO FURTHER SAFEGUARD AGAINST PENETRATION OF THE GEOMEMBRANE. THE TWO LAYERS OF GEOMEMBRANE WILL SURROUND A LAYER OF BENTONITE IMPREGNATED GEOTEXTILE (GCL). THIS CENTER LAYER WILL PROVIDE A CUSHION AND SEPARATION OF THE GEOMEMBRANES TO PREVENT POSSIBLE DAMAGE DURING COMPACTION OF THE MATERIALS ABOVE.
4. THE COLLECTOR PIPE WILL BE PLACED IN A TRENCH AND BACKFILLED WITH GRAVEL. THIS GRAVEL WILL BE 3/4" TO 1 1/4" DIAMETER UNCRUSHED WEATHERED GRAVEL DEVOID OF FINES. A LAYER OF GEOTEXTILE WILL BE PLACED AROUND THE GRAVEL ENVELOPE TO PROTECT THE UNDERLYING LINER AND PROVIDE A FILTER FROM THE SAND DRAINAGE LAYER ABOVE IT.
5. EACH LIFT OF GRAVEL BACKFILL AROUND THE COLLECTOR PIPE WILL BE COMPACTED TO PREVENT BRIDGING OF THE GRAVEL.
6. THE WITHDRAWAL AND CLEANOUT RISER PIPE WILL REST DIRECTLY ON THE GEOTEXTILE COVERED SIDESLOPE. A SPACE IS SHOWN FOR CLARITY.
7. LEACHATE STORAGE WILL BE PROVIDED ON-SITE TO ACCOMMODATE AT LEAST FIVE DAYS OF LEACHATE ACCUMULATION IN ACCORDANCE WITH 35 IAC 811.309(d)(1). THIS STORAGE CAPACITY MAY BE PROVIDED USING ONE OR MORE TANKS AND MAY BE PROVIDED IN STAGES AS LANDFILL DEVELOPMENT PROGRESSES. ALSO, TANKAGE MAY BE PROVIDED FOR EACH INDIVIDUAL UNIT WHICH MEETS THE INDIVIDUAL UNIT'S STORAGE REQUIREMENT, OR THROUGH CENTRALIZED TANKAGE WHICH MEETS THE CUMULATIVE CAPACITY REQUIRED FOR THE AREAS SERVED.
8. ALL TANKS, PUMPS AND OTHER EQUIPMENT/APPURTENANCES WHICH WILL BE IN CONTACT WITH LEACHATE WILL BE CONSTRUCTED OF CORROSION RESISTANT MATERIALS. THE MANUFACTURER/FABRICATOR OR HIS REPRESENTATIVE WILL CONFIRM IN WRITING PRIOR TO PURCHASE THAT THE MATERIALS OF CONSTRUCTION ARE COMPATIBLE WITH THE LEACHATE EXPECTED TO BE GENERATED AND RESISTANT TO THE ANTICIPATED TEMPERATURE EXTREMES.
9. LEACHATE TRANSFER PIPING WITHIN THE LANDFILL COVER AND ABOVE LANDFILLED WASTE MAY BE SINGLE-WALLED.
10. FLEXIBLE CONNECTORS WILL BE PROVIDED AT ALL PIPE CONNECTIONS TO STRUCTURES WHERE THE STRUCTURES OR PIPING ARE SUBJECT TO SETTLING DUE TO PLACEMENT ON REFUSE.
11. ALL PIPING/HOSING WILL BE FREE DRAINING OR PROTECTED FROM FREEZING BY BURIAL, HEAT-TRACING, INSULATION AND/OR OTHER APPROPRIATE MEANS.

NO.	DATE	REVISION DESCRIPTION	BY

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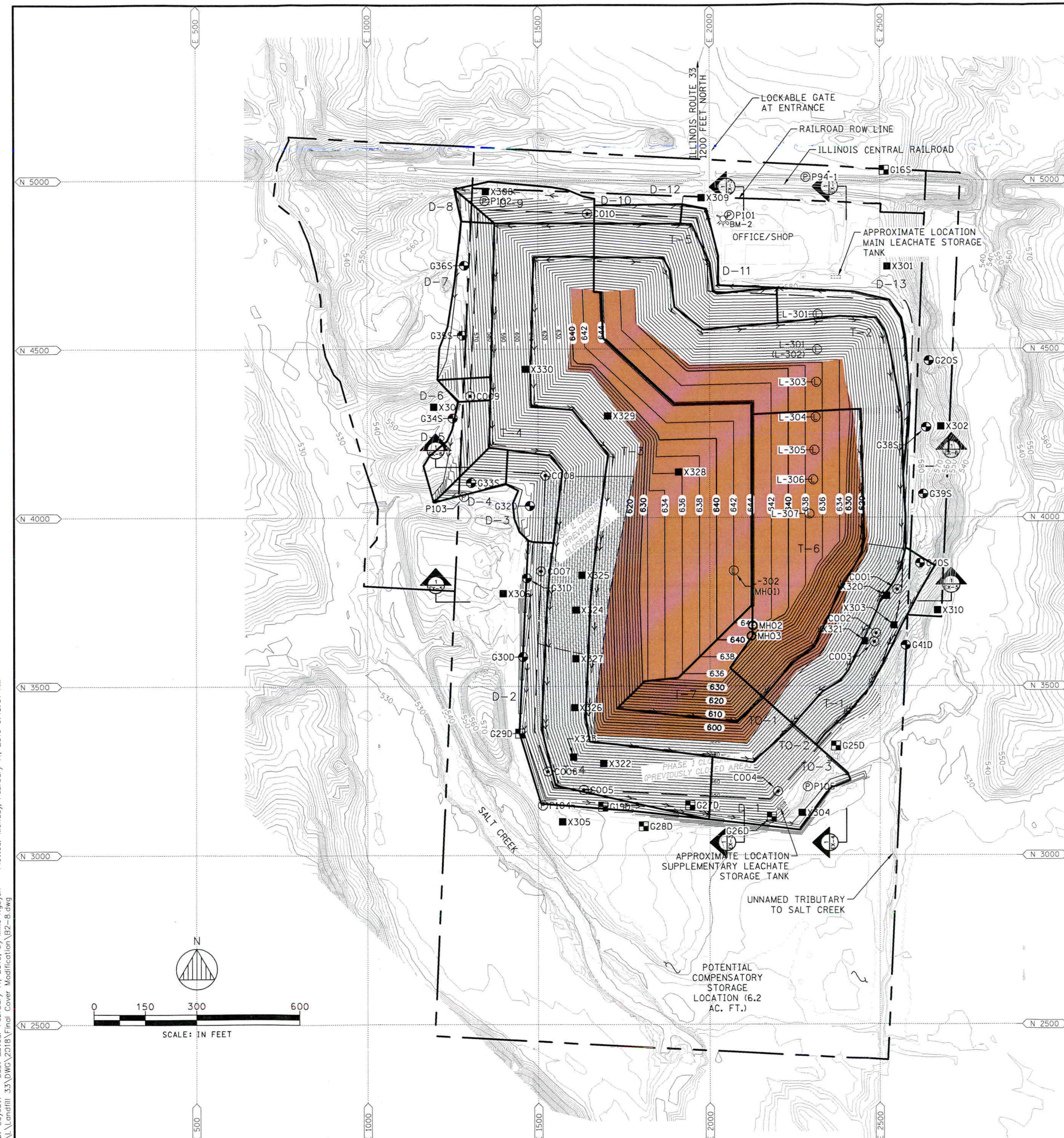
APPROVED BY: DWM | DESIGNED BY: DWM | DRAWN BY: MPN

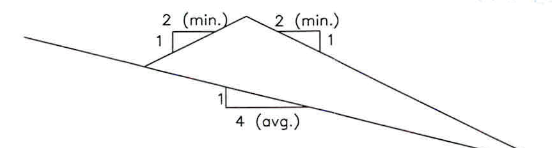
LEACHATE COLLECTION DETAILS 2
SIGNIFICANT MODIFICATION TO PERMIT FOR
LANDFILL 33, LTD.
EFFINGHAM COUNTY, ILLINOIS

DATE: FEBRUARY 2019
PROJECT ID: 180130/0006
SHEET NUMBER: B2-7

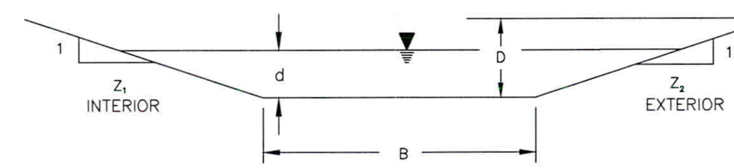


LEGEND

- PROPERTY BOUNDARY (FACILITY BOUNDARY)
- WASTE BOUNDARY
- CELL BOUNDARY
- DITCH, STREAM, OR WATERWAY
- UNPAVED ROAD
- TREE LINE
- DRAINAGE CHANNEL
- WATERSHED BOUNDARY
- EXISTING MONITORING WELL (SS)
- EXISTING MONITORING WELL (PVC)
- EXISTING GROUNDWATER PIEZOMETER
- EXISTING GAS PROBE
- LEACHATE COLLECTION CLEANOUT
- LEACHATE COLLECTION MANHOLE
- FIRE HYDRANT
- AREA OF PROPOSED FINAL COVER MODIFICATION



TYPICAL TERRACE DETAIL



CHANNEL ID	Q (cfs)	V (fps)	d (feet)	D (feet)	B (feet)	Z_1 (min.)	Z_2 (min.)	SLOPE (%)
D–1	59.6	4.9	2.1	2.5	0	4	3	1.7
D–2	8.3	2.1	1.3	1.5	0	4	3	1.1
D–3	6.0	3.4	1.0	1.5	0	3	3	3.9
D–4	3.0	3.0	0.7	1.0	0	3	3	7.4
D–5	5.3	4.2	0.8	1.0	0	3	3	8.5
D–6	1.5	3.2	0.5	1.0	0	3	3	18.6
D–7	9.8	4.4	1.0	1.5	0	3	3	5.7
D–8	0.8	1.5	0.7	1.0	0	3	3	4.9
D–9	6.8	3.9	1.0	1.5	0	3	3	4.7
D–10	2.3	1.6	0.9	1.0	0	4	3	2.4
D–11	20.0	3.0	1.6	2.0	0	4	3	1.2
D–12	22.0	3.0	1.7	2.0	0	3	3	1.2
D–13	6.6	1.6	1.3	1.5	0	4	3	0.9
T–1	9.4	2.8	1.3	1.5	0	4	2	2.0
T–2	65.7	4.9	1.8	2.0	0	4	6	2.0
T–3	102.2	4.9	1.8	2.0	0	4	6	2.0
T–4	41.9	4.8	1.8	2.0	0	4	3	2.0
T–5	12.3	3.1	1.4	1.5	0	4	2	2.0
T–6	12.3	3.1	1.4	1.5	0	4	2	2.0
T–7	12.3	3.1	1.4	1.5	0	4	2	2.0
TO–1	165.9	18.2	0.9	1.0	10	2	2	25.0
TO–2	175.3	18.2	0.9	1.0	10	2	2	25.0
TO–3	175.3	18.2	0.9	1.0	10	2	2	25.0

NOTES

1. AS DETERMINED BY AN ILLINOIS REGISTERED PROFESSIONAL ENGINEER, THE CHANNEL DIMENSIONS AND GRADES MAY BE VARIED FROM THAT SHOWN IF THE DESIGN CAPACITY IS MAINTAINED AND SUITABLE MINIMUM CHANNEL LINING IS PROVIDED.
2. THE DESIGN CAPACITIES FOR THE DRAINAGE CHANNELS ARE BASED UPON THE 25-YEAR, 24-HOUR STORM WITH THE SITE ACTIVE (DISTURBED AREAS PRESENT) OR THE 100-YEAR, 24-HOUR STORM WITH THE SITE CLOSED (COMPLETELY VEGETATED) WHICHEVER YIELDED THE GREATER FLOW.
3. ALL DRAINAGE DITCHES AND TERRACES ARE DESIGNED TO BE VEGETATED CHANNELS AND SHALL BE SEEDED AND/OR STABILIZED AS SOON AS PRACTICABLE AFTER CONSTRUCTION. TERRACE AND DITCH OUTLETS SHALL BE CONSTRUCTED WITH RIPRAP OR SUITABLE CHANNEL LININGS.

NO.	DATE	REVISION DESCRIPTION	BY

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APPROVED BY: DWM DESIGNED BY: DWM DRAWN BY: MPN

SITE DRAINAGE PLAN

SIGNIFICANT MODIFICATION TO PERMIT FOR

LANDFILL 33, LTD.

EFFINGHAM COUNTY, ILLINOIS

DATE: FEBRUARY 2019

PROJECT ID: 180130/0006

SHEET NUMBER: B2-8

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7

Attachment 7

Groundwater Impact Assessment

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TABLES

FIGURES

APPENDICES

1. INTRODUCTION

Under the current Illinois Environmental Protection Agency (IEPA) and Illinois Pollution Control Board (IPCB) Regulations, a groundwater impact assessment is required pursuant to 35 IAC 811.317. This assessment includes an overview of the site geology, a determination of the transport processes at the site, the conversion of the transport processes into a mathematical framework, the formulation of a conceptual model, and an analysis of contaminant transport processes.

2. GENERAL SETTING

The best approach to modeling the Landfill 33, Ltd. existing and lateral expansion area can be determined by reviewing the Report of Hydrogeologic Investigation (RHI) and engineering design specifications. This review determined that three distinct assessments are necessary to evaluate the entire site appropriately and to satisfy the 35 IAC 811.317 regulation. The three phases of the modeling assessment were previously modeled separately as the Existing Landfill Unit, South Unit, and Northwest Unit. These areas are technically not individual "units" as defined by 35 Ill. Adm. Code 810.103, but together comprise the main landfill unit at the Landfill 33 facility. These "units" are identified as such only to emphasize the distinct hydrologic, geologic, and engineering design characteristics of each area.

General facility layout is depicted on the cross-sectional schematics of each modeling scenario under investigation, which are included within this report. This section provides an overview of the geology and hydrogeology relative to the facility design. An overview may be helpful in understanding the conceptual models used, and to elaborate on some of the model specific data needed. A thorough discussion of the site geology may be found in the RHI (see Log No. 1995-231, Volume 2, Attachment 7 - Report of Hydrogeologic Investigation).

As depicted in Figure 1 groundwater flow direction at the facility is generally to the south. However, the landfill appears to be constructed upon a groundwater divide, with about two-thirds of the flow diverted to the south, and about one-third of the flow diverted to the southwest and south-southeast. Hydraulic gradients include a mean of 0.03945 with a maximum and minimum observed gradient of 0.04902 and 0.02817, respectively (see Figure 1 and Figure 2). The following paragraphs provide brief summaries outlining the different scenarios.

2.1 Existing Landfill Unit Geology and Design Overview

The Existing Unit is located in an upland overlooking low-lying areas to the east and south. The overburden deposits consist primarily of silty clay till with some interbedded silt, sand, and gravel of Illinoisan Age. The general stratigraphic relationship includes a) brown silty clay, b) a sand interval which may consist of clayey sand, sand, and/or sand and gravel, and c) gray silty clay. Several silts and clayey silt layers/lenses are also present.

The interval that represents the majority of the uppermost aquifer at the site is a sand that ranges from clayey fine-grained sand to sand and gravel. Hydraulic conductivities range from 4.83×10^{-5} cm/s to 6.71×10^{-2} cm/s with a mean of 6.22×10^{-4} cm/s (see Appendix A). Wells located along the downgradient side of the site (G-104, G-105, and G-119) produce a mean value of 2.31×10^{-2} cm/s.

The Existing Landfill Unit overlies thick silty clay deposits. A minimum 10 foot recompacted and/or in situ earthen liner is in place at the base of the existing landfill and along the sidewalls with material possessing a hydraulic conductivity of 1×10^{-7} cm/s or less. Since the uppermost aquifer sand unit has been virtually removed below the bottom invert and the underlying silty clay sediments appear to be relatively impervious, any transport from the landfill would be effectively forced through any permeable sediments located along the liner side slope (i.e. the sand unit). As depicted in Figure 3 and cross-section E-E' (see Appendix B), the base of the liner system is below the sand unit.

The potentiometric surface of the uppermost aquifer in the area of the Existing Landfill Unit indicates a general groundwater flow from north to south with a slight south-southeasterly component (see Figure 1). The surface overlies the bottom of the trenches (see cross-section E-E' in Appendix B). For a specific representation of existing site conditions, see Figure 3.

2.2 South Unit Geology and Design Overview

The South Unit is located south and west of the Existing Landfill Unit and south of the Northwest Unit, and in general topographically lower than the other Units. The overburden deposits and stratigraphic character of the South Unit is similar to the Existing Landfill Unit.

The South Unit area was excavated through the sand unit and to or into a portion of the thick silty clay deposits. A composite liner consisting 60 mil HDPE and 3 foot recompacted earthen liner was installed. Similarly to the Existing Landfill Unit, the uppermost aquifer was removed by trench excavation and any transport from the landfill would be through any permeable sediments which are located along the liner side slope (i.e. the sand unit). Figure 4 illustrates the liner system relative to the existing stratigraphic deposits.

The general groundwater flow direction for the South Unit is towards the south and southwest (see Figure 1). However, the shortest distance from the proposed waste boundary to the zone of attenuation in the direction of flow is in a southerly direction.

2.3 Northwest Unit Geology and Design Overview

The Northwest Unit geology is dissimilar to that in the South Unit and Existing Landfill Unit areas. In the northwest portion of the site, the sand interval appears to be absent or the interval is clayey. Along the northern half of the west boundary, between borings B-4 and MW-3 (G-103), a bedrock ridge consisting of sandstone at the paleo-surface is present (see geologic cross-section A-A' in Appendix B) (This sandstone ridge appears to be near to the same stratigraphic level as the sand unit to the east). Because of the sandstone proximity relative to the sand unit, the sandstone is included in what is considered the uppermost aquifer. Shale, which underlies the sandstone bedrock, is considered the confining unit. Overlying the bedrock ridge is primarily a silty clay. To the east of the bedrock ridge, overburden down cuts into the bedrock such that a much thicker section of silty clay appears to be developed. Geologic cross sections F-F', G-G', and H-H' illustrate the east-west stratigraphic relationship from the thicker overburden deposits to the bedrock ridge (see Appendix B).

Due to the differences in geology between the Northwest Unit and the Existing Landfill and South Units, only the borings/piezometers located in the vicinity were considered in deriving site specific or field tested data. For example, G-103 is the only piezometer or monitoring well screened in the sandstone. Therefore, slug test data from G-103 shall be used to determine a hydraulic conductivity value representative of the sandstone bedrock ridge. By considering G-103 as a representative data point, the sandstone bedrock of the uppermost aquifer has an approximate hydraulic conductivity of 3.35×10^{-5} cm/s. However, modeling sensitivity shall be conducted to account for any variation in sandstone characteristics which may occur.

The Northwest Unit shall be constructed in the same manner as the South Unit. As far as trench design is concerned, the two expansion units are contiguous. However, the difference comes when the sandstone aquifer is considered as the migration pathway. Since the sandstone appears to be below the proposed invert, both vertical and horizontal components of fluid movement must be considered Figure 5 depicts the liner system relative to the existing stratigraphic deposits. The mean potentiometric surface in this area illustrates a southwesterly groundwater flow direction (see Figure 1).

3. TRANSPORT PROCESSES

Using the design and geology presented in Figure 3, Figure 4 and Figure 5 the transport processes within a layer are analyzed with respect to migration of the leachate constituents. For review purposes, this discussion is presented in two parts, transport pathway and transport mechanism.

The primary pathway to be addressed by any impact assessment can be defined as vertical migration through the liner (and/or underlying less-permeable deposits), and lateral migration within the uppermost aquifer. Within the landfill, migration of contaminants is primarily controlled by diffusion. This can best be seen when the value for the coefficient of hydrodynamic dispersion is analyzed. This coefficient consists of two parts $D'_{ij} = D_{ij} + (D_d^*)_{ij}$, where D_{ij} is the coefficient of advective (mechanical) dispersion, and $(D_d^*)_{ij}$ is the coefficient of molecular diffusion. The coefficient of advective dispersion (D_{ij}) is defined as the product of the average linear velocity and the dispersivity ($D_{ij} = \overline{V}\alpha_{ijkl}$) (Bear, 1972). As the velocity becomes smaller, the advective dispersion coefficient value approaches the value of the molecular diffusion coefficient. As this occurs, diffusion becomes the dominant transport mechanism.

With the scenarios outlined coupled with the multi-transport properties of the liner and upper-most aquifers, a one-dimensional analytical model for the scenarios depicted in Figure 6 and Figure 7 should be adequate to properly characterize the impact on groundwater of the Existing Landfill and South Units, respectively. For the Northwest Unit, a one-dimensional model may not be capable of adequately expressing the complexity of vertical migration through the till and lateral migration in the aquifer. In this instance a two-dimensional analytical model shall be utilized.

The model needed for this transport scenario should provide adequate characterization of the processes associated with diffusion and advection driven transport. With the liner/aquifer configuration as shown in Figure 6, a one-dimensional analytical model is adequate to properly characterize the impact of the facility on the groundwater.

4. MATHEMATICAL MODEL

4.1 One-Dimensional Model

An advection/diffusion, one-dimensional model that would adequately represent contaminant transport is POLLUTE (v. 6) by Rowe and Booker. This model provides for:

- mass flux calculations of contaminant entering and leaving the deposit,
- subdividing the deposits into individual layers where each layer may have different parameters,
- a base material which can be either relatively permeable or impermeable, or infinite in extent,
- advective and diffusive transport in porous or fractured media,
- one-dimensional transport in either horizontal or vertical orientation,
- 1-, 2-, or 3-dimensional fracture system with a dual porosity conceptual framework,
- multiple time and depth solutions to the transport equation,
- retardation of non-conservative constituents,
- first-order radioactive and biological decay, and
- a transport solution with no space or time discretization errors (Rowe & Booker, 1990).

The principal assumptions inherent in POLLUTE are:

1) Fick's Law applies to solute dispersion within the deposit.
2) Sorption-desorption of a non-conservative species of contaminant is linearly controlled, such that

$$S = Kc$$

where,
S = solute sorbed per unit weight of soil [MM^{-1}]
K = distribution/partitioning coefficient [L^3M^{-1}]
c = concentration of contaminant in solution [ML^{-3}]

3) Contaminant migration in a given direction is one-dimensional and, for intact material, is governed by

$$n\frac{\partial c}{\partial t} = nD_h\frac{\partial^2 c}{\partial z^2} - n\overline{v}\frac{\partial c}{\partial z} - \rho K_d\frac{\partial c}{\partial t} - \lambda c$$

where,
c = concentration of contaminant at depth z at time t [ML^{-3}],
D_h = coefficient of hydrodynamic dispersion at depth z [L^2T^{-1}]
$\overline{v}$ = groundwater (seepage) velocity at depth z [LT^{-1}]
n = porosity of the soil at depth z [L^3L^{-3}]

ρ = dry density of the soil at depth z [ML^{-3}]
K_d = Distribution/partitioning coefficient at depth z [L^3M^{-1}]
$v_a = n\overline{v}$ = Darcian velocity [LT^{-1}]
λ = decay constant of the contaminant species [T^{-1}]

4) Multiple layers with different properties may be specified. It is assumed that there is continuity of concentration and flux at the boundary between two layers.

Since POLLUTE is a one-dimensional transport model, Schroeder's Hydrologic Evaluation of Landfill Performance (H.E.L.P.) model was used to evaluate leachate buildup within the units. Figure 3, Figure 4 and Figure 5 shows lithologies, distances, sources, and compliance points for the modeling scenarios. Within the model scenarios, POLLUTE has an advantage that permits a variety of top and bottom boundary conditions. For the purposes of this study, the following assumptions have been made:

1) "Top" boundary set to a constant source boundary.

   where, $c(\tau, z = 0) = c_o$ for all t.

   Presuming a constant source over the entire life and post-closure of the facility is a highly conservative assumption. This implies that full leachate concentrations are present from day one, and no elutriation or removal of the contaminants is occurring. Several recent studies (including Farquhar, 1989) show that leachate quality improves dramatically over a relatively short time period.

   To further the conservative aspect of the conceptual model, the impact assessment shall use full leachate concentrations as input to the model. This implies that there is a catastrophic failure of the liner system. However, the site conditions are such that even this extreme approach will have minimal impact on the results of this assessment.

2) "Bottom" boundary set to an infinite bottom layer.

   This assumes the deposits extend to infinity. The properties specified for the bottom-most layer are used for the infinite layer. POLLUTE documentation suggests that an infinite layer be used when addressing lateral transport. Again, the actual boundary layer has been removed some distance from the compliance boundary to ensure that there is no "boundary condition effect" on the model results.

Using the conservative parameters listed in the conceptual model coupled with the cautious assumptions that POLLUTE offers, the model shall produce a conservative representation of leakage from the proposed facility. Andrews Engineering, Inc. has already provided a copy of POLLUTE (version 5) to the Illinois Environmental Protection Agency, Groundwater Assistance Unit, in conjunction with another application (see IEPA-DLPC Log No. 1992-246). The original version of POLLUTE (version 5) has been subsequently updated to version 6 and provided to the Illinois Environmental Protection Agency, Groundwater Assistance Unit (see IEPA-DLPC Log No. 1994-253).

4.2 Two-Dimensional Model

A two-dimensional model, with advection/diffusion transport that would adequately represent contaminant transport at this site is MIGRATE by Rowe and Booker. This model provides for:

- advective as well as diffusive transport,
- two-dimensional transport in a horizontal and vertical orientation,
- multiple time and distance solutions to the transport equation,
- retardation of non-conservative constituents, and
- a transport solution with no space or time discretization errors (Rowe & Booker, 1988).

The principal assumptions inherent in MIGRATE are:

1) Fick's Law applies to solute dispersion within the deposit.
2) Sorption-desorption of a non-conservative species of contaminant is linearly controlled, such that sorption in the advection-dispersion equation is defined as:

$$S = \rho(K_d)\frac{dc}{dt}$$

where,

ρ = dry density of the soil	$[ML^{-3}]$
K_d = distribution/partitioning coefficient	$[L^3M^{-1}]$
$\frac{dc}{dt}$ = derivative of concentration with respect to time	$[ML^{-3}]$

3) Contaminant migration in a given direction is governed by (Rowe & Booker, 1985):

$$(n+\rho K_d)\frac{\partial c}{\partial t} = \frac{\partial}{\partial x}\left(n\mathrm{D}_{xx}\frac{\partial c}{\partial z}\right) + \frac{\partial}{\partial z}\left(n\mathrm{D}_{zz}\frac{\partial c}{\partial z}\right) - \frac{\partial}{\partial x}(n\bar{v}_x c) - \frac{\partial}{\partial z}(n\bar{v}_z c)$$

where,

c = concentration at point (x, z) where c = c(x, z, t)	$[ML^{-3}]$
D_{xx} = coefficient of hydrodynamic dispersion in x direction	$[L^2T^{-1}]$
D_{zz} = coefficient of hydrodynamic dispersion in z direction	$[L^2T^{-1}]$
$\bar{v}_x$ = groundwater (seepage) velocity in x direction	$[LT^{-2}]$
$\bar{v}_z$ = groundwater (seepage) velocity in z direction	$[LT^{-2}]$
n = porosity of the soil	$[L^3L^{-3}]$
ρ = dry density of the soil	$[ML^{-3}]$
K_d = distribution/partitioning coefficient	$[L^3M^{-1}]$

4) Multiple layers with different properties may be specified. It is assumed that there is continuity of concentration and flux at the boundary between two layers. The question of continuity is only a problem when there is insufficient diffusion to adequately "move" the contaminant across the layer boundary (Rowe, personal communication, September, 1993).

MIGRATE may require vertical velocity components. Schroeder's Hydrologic Evaluation of Landfill Performance (H.E.L.P.) model shall be used to determine leachate buildup within the unit, as well as leachate buildup over time. Within a given model scenario, MIGRATE has an advantage that permits a variety of top and bottom boundary conditions. For the purposes of this study, the following assumptions have been made:

1) "Top" boundary is a constant source boundary.

$$c_t = c(x, 0, t) \text{ for } z = 0, \text{ and all } t$$

Presuming a constant source over the entire life and post-closure of the facility is a highly conservative assumption. This implies that full leachate concentrations are present from day one, and no elutriation or removal of the contaminants is occurring. Several recent studies (including Farquhar, 1989) show that leachate quality improves dramatically over a relatively short time period.

2) "Bottom" boundary is a base flow boundary.

$$c_b = c(x,H,t) = \int_0^t \left[\frac{f_z(x,H,\tau)}{hn_b} - \frac{\overline{v}_b}{n_b} \frac{\partial c(x,H,\tau)}{\partial x} + D_H \frac{\partial^2 c(x,H,\tau)}{\partial x^2} \right] \partial\tau$$

where,

$c(x,H,t)$	denotes the concentration in the aquifer at time t	$[ML^{-3}]$
$f_z(x,H,\tau)$	is the mass flux into the aquifer at time τ	$[ML^{-2}T^{-1}]$
n_b	is the porosity of the base aquifer	[–]
h_b	is the thickness of the base aquifer	[L]
$\overline{v}_b$	is the Darcy velocity at the downgradient edge of the landfill	$[LT^{-1}]$
D_H	= coefficient of hydrodynamic dispersion in the aquifer	$[L^2T^{-1}]$
H	is the thickness of the clay layer above	[L]
h	the thickness of the aquifer	[L]

MIGRATE documentation suggests that either an impermeable or an aquifer bottom boundary may be used. The aquifer bottom boundary condition assumes a high vertical dispersion within the base aquifer layer and the concentration at the bottom of the deposit is the concentration at the top of the base aquifer.

Using the conservative parameters listed in the conceptual model coupled with the cautious assumptions that MIGRATE offers, the model shall produce a conservative representation of leakage from the proposed facility. Andrews Environmental Engineering, Inc. has already provided a copy of MIGRATE (version 9) and the accompanying documentation to the Illinois Environmental Protection Agency, Groundwater Assistance Unit.

5. CONCEPTUAL MODEL

5.1 Conversion Assumptions

To adequately express the site geology within the context of a contaminant transport model, but also to provide a conservative approach to the selection of input parameters, some simplifications to the site geology, hydrology, and facility design are necessary (see Figure 6, Figure 7 and Figure 8).

Several assumptions were made in the conversion to these conceptual models. These are:

1) **All geologic units and earthen structures are homogeneous and isotropic with respect to all lithologic and hydrologic parameters.** - Most contaminant transport models are incapable of working with the small-scale changes for these parameters that are seen within many geologic materials. Sensitivity analyses performed over the observed range of values should provide an adequate examination of the effects of this variability.

2) **The uppermost aquifer is of uniform thickness, and is laterally extensive.** - The thicknesses used within the model are more uniform than actually present at the facility. The existing landfill and southern lateral expansion area sand can possess variation in thickness at the site. The northwest lateral expansion area sandstone also appears to possess some variation in thickness at the site. Sensitivity analysis provides a tool to appraise the effects of variability in this parameter.

3) **Geologic and hydrologic parameters used are statistical values for site specific data, or statistical ranges taken from the literature for similar materials. A conservative range of values is taken into consideration for parameter sensitivity.** - The values analyzed provide a conservative analysis of the site conditions. Transport through a geologic unit with a high variability of hydraulic conductivity, transmissivity, porosity, etc., will actually produce an "average" movement through the geologic unit. Sensitivity analysis provides a mechanism for determination of the effects of variability in this parameter.

4) **The recompacted soil liners/sidewalls are 3 feet (0.9144 meters) thick in the South and Northwest Units, and 10 feet (3.048 meters) thick in the Existing Landfill Unit.** - This is the minimum thicknesses cited in the application and regulations. The assessments of the existing and southern areas address sidewalls, while the northwest area addresses a basal liner.

5) **The composite liner system possesses several "holes" such that it is not a completely impermeable barrier.** - The assessment assumes that the HDPE portion of the composite liner possesses several holes (four, 1 cm^2 hole per acre). This is a conservative assumption that provides for a migration pathway from the inside of the unit through the composite liner system. The rate, or flux through the liner is used in the impact assessment to provide a quantitative value for the amount of leachate entering the aquifer. H.E.L.P. was also used to assess liner design.

6) **The bottom of the uppermost aquifer (sand) is the underlying silty clay throughout the existing landfill and southern lateral expansion areas and within a portion of the northwest lateral expansion area. For some of the northwest expansion area, the bottom of the uppermost aquifer (sandstone) is competent shale.** - Sensitivity analysis shall address variation in aquifer layer thicknesses.

7) **The silty clay below the uppermost aquifer sand unit or the shale below the uppermost sandstone aquifer are impermeable boundaries.** - Laboratory and packer test derived hydraulic conductivity data indicates the underlying silty clay and shale material is relatively impermeable (less than 1×10^{-7} cm/sec) (see Appendix C for actual representative data).

8) **The recompacted and/or in situ soil liners/sidewalls** - consists of overburden material having a hydraulic conductivity of 1×10^{-7} cm/s or less.

9) **Leachate buildup within the modeled units cause an outward gradient** - The H.E.L.P. [Hydrologic Evaluation of Landfill Performance (Schroeder, 1989)] model was used to determine leachate driving head and liner performance for each of the units. The design assessment for the lateral expansion areas included turning off the leachate collection pumps after 30 years of post-closure care, and allowing leachate levels to rise within the unit for the remaining 70 years. The Existing Unit H.E.L.P. assessment addresses the leachate buildup during the initial active-life, during the leachate extraction period, and when the leachate collection pumps are turned-off during the after post-closure care period.

10) **All angles are assumed to be 90°** - Providing right angle corners removes any extra thicknesses from the liner and shortens flow distances.

11) **The sand and/or sandstone are modeled laterally infinite thickness bottom boundaries with flow only in the downgradient direction** - see conceptual models depicted in Figure 6, Figure 7 and Figure 8.

12) **The modeling results were determined at varying distances, depending on direction of flow for each unit scenario.** - For the Existing Unit and Southern Unit 1-D POLLUTE modelling scenarios the length is based on the thickness of the liner and the distance to the downgradient edge of the Zone of Attenuation. For the Northwest Unit, the lengths are based upon the lateral distance from the upgradient edge of the uppermost aquifer (sandstone bedrock) to the downgradient edge of the Zone of Attenuation. The distance to the Zone of Attenuation is based upon the length of the outer edge of the toe of the slope of the liner to the edge of the Zone of Attenuation. See Figure 6, Figure 7and Figure 8 for actual modeling distances for each scenario.

13) **External stresses on the system are constant through time.** - Stresses on the model system over time cannot be accurately modeled for the entire Groundwater Impact Assessment period. Therefore, potential changes in heads due to construction, weather, dewatering, and other flux changes are ignored. The regulations, including 35 IAC 813.304, provide a mechanism to reevaluate the site should any major change occur in the parameters used within the impact assessment.

6. MODEL INPUT AND SENSITIVITY ANALYSIS

Many input parameters were determined from samples collected at the site. These parameters include hydraulic conductivity, gradient, physical soil data, thickness of units, leachate concentrations, and background groundwater concentrations. Parameters that are not site specific are taken from literature values for comparable materials. The literature citations used for the impact assessment may be found in Appendix D.

Due to the complexity of the site geology, separate assessments have been prepared for each of the three distinct modeling scenarios – the Existing Landfill Unit, the South Unit, and Northwest Unit. Each of these assessments are discussed below. The baseline model with time and distance profiles and sensitivity results for the Existing, South and Northwest Units are provided in Appendix E, Appendix F and Appendix G, respectively.

6.1 Existing Landfill Unit Model

6.1.1 Existing Landfill Profile Setup

The Existing Landfill Unit has been accepting waste since the site began operations in late 1981, early 1982. The design, calls for a minimum ten (10) feet thick recompacted and/or in situ liner with material possessing a hydraulic conductivity of 1 x 10^{-7} cm/s or less.

The uppermost aquifer sand unit has been virtually removed below the bottom invert and the underlying silty clay sediments appear to be relatively impervious. Therefore, any transport from the landfill would be effectively forced through any permeable sediments which are located along the liner side slope (i.e. the uppermost aquifer sand unit). Figure 3 and Figure 6 depicts the cross-sectional geology and conceptual configuration that is used for the Existing Landfill Unit.

The modeling period for the Existing Landfill profile scenario is the current operating period (45 years) plus the post-closure care period (30 years) plus the seventy (70) years of additional time required by 35 IAC 811.317. Thus requiring a total of 145 years for the Existing Landfill. The assumed date of commencement of modeling is January 1, 1982.

Early in the assessment, it was determined that the Existing Landfill Unit was incapable of meeting the requirements of 35 IAC 811.317 if the existing leachate driving head was not dealt with in some manner. Therefore, the H.E.L.P. model was utilized to determine leachate buildup within the Existing Landfill Unit if leachate withdrawal was instituted. A series of H.E.L.P. runs were performed to calibrate leachate buildup to present levels, and to simulate leachate pumping and gradual leachate buildup after pumping ceases. These H.E.L.P. runs are given in Appendix H. A graphical representation of these runs is presented in Appendix E. Also presented in Appendix E are the head values used in the POLLUTE runs for the Existing Landfill Unit.

The POLLUTE runs for the Existing Landfill Unit implemented the variable option mode to vary leachate levels (and with it the Darcy velocity) within the landfill over the entire modeling period. For the first five years of the modeling period (1982 through 1986), the leachate within the Existing Unit was assumed to build up to the mean leachate level above the groundwater piezometric surface (12 feet) linearly and within the entire area of the Existing Unit. This assumption is quite conservative, since only a few of the trenches were even filled during that time period.

After an initial 5 year leachate build up, the mean leachate level above the groundwater piezometric surface (12 feet) between L301, L302, L303, L304, and L305 was used from Year 6 through Year 16 (1987 through 1997) (see Table 1 and Appendix E). Similar to the initial five years, this is very conservative. Many of the trenches were just getting developed during this time period. Thus, actual leachate build up in some of the trenches was not present for the entire modeling period.

From Year 17 to 19 (1998 through 2000), pumping of leachate was simulated such that the leachate driving head is drawn down linearly from 12 feet above to at or below the groundwater piezometric surface.

Leachate will be extracted from the unit for the active life of the facility to produce a zero gradient condition within the unit. Thus, the leachate level will be at or below the groundwater table. During modeling years 20 through 45 (2001 through 2027), leachate extraction continues and leachate heads within the existing landfill are maintained below the piezometric surface. Thus a negative (inward) gradient is produced. However, for modeling purposes, a gradient of one (1) foot is assumed. No leachate extraction is assumed after-closure of the entire landfill.

After the site post-closure care, a 200-mil geosynthetic drainage layer and 40-mil geomembrane liner will be installed on the crown of the Existing Landfill Unit, and the head on liner ("driving head") is then allowed to build-up. The H.E.L.P. scenario shows that the cumulative percolation/leakage through the cover (including geomembrane) will be 0 feet at Year 145. To provide a conservative approach to the leachate buildup, the slope of the initial leachate buildup is extrapolated to the one (1)-foot level. Using the time period from Year 46 to Year 145, the driving head (and with it the Darcy velocity) is allowed to linearly increase to one foot above the piezometric surface. Table 1 lists the Existing Unit input parameters for the baseline model and profile sensitivity.

6.1.2 Existing Landfill Profile Sensitivity

6.1.2.1 Density

Values for density were taken from data from Sharp-Hansen et al. (1990). For density calculations in the liner and sand aquifer, values were calculated using values for a till (predominantly gravel or silt), and sand, respectively (Sharp-Hansen et al. 1990). Sensitivity was performed over a range of values ($\overline{x} \pm s$), with the maximum, mean, and minimum respectively being 2.12, 1.91, and 1.61 for the liner, and 1.99, 1.69, and 1.13 for the sand aquifer. Variation in predicted concentrations at the observation points was not observed for all layers and density values. Therefore, POLLUTE is insensitive to this parameter for this model configuration.

6.1.2.2 Diffusion Coefficient

Several studies have been published to determine the coefficient of hydrodynamic dispersion within several lithologies. These studies have primarily focused on clayey liners generally with high clay contents (Quigley *et al.*, 1987; Rowe *et al.*, 1989; Shackelford, 1990). Shackelford (1990) provides a summary of many studies, for several different constituents.

The initial diffusion coefficient for the soil liner and sand aquifer is 0.018 m^2/A, which is close to the mean value (5×10^{-10} m^2/s or 0.01577 m^2/A) found for saturated diffusion coefficients in Shackelford (1990). Sensitivity was performed over a range bounded by a low of 1×10^{-10} m^2/s [.003154 m^2/A] to a maximum of 1×10^{-9} m^2/s [.03154 m^2/A] in Shackelford (1990). Results of this sensitivity show that POLLUTE is not very sensitive to diffusion, with the above variation.

6.1.2.3 Effective Porosity

Values for effective porosity were taken from the saturation water content data from Sharp-Hansen et al. (1990). Bear (1972) defines effective porosity as specific yield or the "drainable water". Saturation water content of a soil, which is the total water drained by gravity from a saturated soil, provides a reasonable approximation of the effective porosity of a soil.

For effective porosity calculations in the liner and sand aquifer, values were calculated using the saturation water content data for a silty clay and loamy sand, respectively (Sharp-Hansen et al. 1990). Sensitivity was performed over a range of values ($\overline{x} \pm s$), with the maximum, mean, and minimum respectively being 42%, 36%, and 29% for the liner, and 50%, 41%, and 32% for the sand aquifer. For the liner and the sand aquifer the mean effective porosity values were used.

Results of this sensitivity show that POLLUTE is not very sensitive to effective porosity, with the above variation.

6.1.2.4 Number of Sublayers

POLLUTE permits a fixed number of sublayers to be entered, or the model will determine the number (if the thickness is large and NSUB = 1). For this study, the number of sublayers was set. A larger number of sublayers produce a more accurate solution (personal communication with regard to POLLUTE; R. K. Rowe, 1993).

Variation in the number of sublayers ranged from 5 to 20 for the liner and 20 to 90 for the aquifer, with minimal variation in predicted concentrations at the observation points. The slight variation may be due to the variable option mode that was implemented for the Existing Landfill Unit scenario.

6.1.2.5 Thickness

Sensitivity was not performed on the layer thicknesses since they represent conservative (minimum) assumptions and design. A minimum liner thickness of 3.048 meters (or 10 feet) is called for in the construction specifications. Also, the distance from the liner sidewall to the Zone of Attenuation is a measurable and conservative value (see Figure 6).

6.1.2.6 Darcy Velocity

The POLLUTE runs for the Existing Landfill Unit used the variable option mode, which included varying the Darcy velocity, depending on leachate levels within the landfill over the entire modeling period. The resultant Darcy velocities were dependent on existing leachate levels and simulated leachate driving head from pumping and post-closure build-up.

For example, the mean leachate level above the groundwater piezometric surface between L301, L302, L303, L304, and L305 is 12 feet (see Figure 1 and Figure 9). Assuming a 1 x 10^{-7} cm/sec [0.0315 m/A] sidewall liner and 12 feet of leachate driving head over the 10 feet of sidewall thickness, the Darcy velocity from the existing landfill is:

$$0.0315\ {}^{m}\!/\!_{A}\left({}^{12ft}\!/\!_{10ft}\right) = 0.0378\ {}^{m}\!/\!_{A}.$$

It is assumed that from modeling year 76 through 145 the leachate head will build up linearly to 1 foot above mean groundwater piezometric surface. Assuming a 1 x 10^{-7} cm/sec [0.0315 m/A] sidewall liner and 1 foot of leachate driving head over the 10 feet of sidewall thickness, the Darcy velocity increases to a value of:

$$0.0315\ {}^{m}\!/\!_{A}\left({}^{1ft}\!/\!_{10ft}\right) = 0.00315\ {}^{m}\!/\!_{A}.$$

The Darcy velocities for modeling years 76 through 145 were linearly stepped up from a velocity of 0.0 m/A to 0.00315 m/A in fourteen 5 year increments of 0.0027.

Since the varying velocity values represent what is believed to be Existing Landfill conditions, additional sensitivity analysis was not performed. A copy of the baseline model run for the Existing Landfill Unit with concentration versus time and concentration versus distance plots may be found in Appendix E includes initial Darcy velocities and the respective change relative to the number of time steps.

6.1.2.7 Dispersivity

Values for dispersivity were not determined from actual field tests. For the variable flow rate option, POLLUTE requires a dispersivity value to be input into the model (otherwise it is included in the coefficient of hydrodynamic dispersion calculation).

Following Illinois EPA guidance (LPC-PA2, Appendix C) acceptable sources for evaluating longitudinal dispersivity, α_L, include: Gelhar, et al (1992) for all distances; Xu and Eckstein (1995) for distances greater than 100 m, and Schulze-Makuch (2005) for distances less than 100 m. For the purposes of the Existing Unit assessment, the scale or length of flow path used to determine the longitudinal dispersivity may conservatively be assumed to be distance from the inside of the liner to the downgradient edge of the Zone of Attenuation, 30.5 m.

Since the flow distance is less than 100 m, the relationship between dispersivity and flow distance given by Schulze-Makuch (2005) is appropriate. Using longitudinal dispersivity data compiled from 109 different authors for different types of geological media, Schulze-Makuch (2005) developed a power law relationship relating the geologic media and study scale to dispersivity.

$$\alpha = c(L)^m$$

where:

α = mechanical dispersivity (m)
L = study scale (m)
c = a parameter characteristic for a geologic medium
m = scaling exponent related to the geologic medium

For unconsolidated sediments, the data was divided into three reliability classes, I being high reliability, II being Intermediate reliability and III being low reliability. Over the entire range of low to high reliability data, the scaling exponent m was found to vary from 0.44 to 0.94 with the higher reliability subset of data (I) at the lower end of the observed range. For purposes of the Existing Unit assessement, the Schulze-Makuch (2005) high reliability values for unconsolidated deposits of c of 0.2 and m of 0.44 were used.

The study scale L is the groundwater flowpath distance for the layer being evaluated. The horizontal flowpath distance is 30.5 m. For the Existing Unit assessment the mechanical dispersivity is calculated as:

$$\alpha = c(L)^m = 0.2(30.5m)^{0.44} = 0.9\,m$$

The sensitivity analysis addressed dispersivities that ranged from one-half to twice the calculated dispersivity, 0.45 meters to 1.8 meters. Results show that the higher dispersivity, 1.8 m, produces the highest predicted concentrations, and that POLLUTE, in this scenario was somewhat sensitive to dispersivity. The calculated dispersivity value of 0.9 meters was used for the Existing Unit dispersivity value.

6.2 South Unit Model

6.2.1 South Unit Profile Setup

The South Unit has been excavated through the sand unit and to or into a portion of the thick silty clay deposits (see Figure 4). Transport from the Unit is depicted on the conceptual drawing in Figure 7, and is restricted to horizontal transport from the Unit into the sand aquifer. The design, calls for a 60 mil HDPE layer and a minimum three (3) feet thick recompacted liner with material possessing a hydraulic conductivity of 1 x 10^{-7} cm/s or less. An outward gradient scenario was addressed in this assessment, even though an inward or zero gradient was a realistic approach to modeling the unit. The outward gradient was utilized to provide a more conservative approach to the impact assessment.

The modeling period for the South Unit consists of the thirty-one (31) years of active life, thirty (30) years of post-closure care, and the remaining seventy (70) years required under 35 IAC 811.317. This totals 131 years required for the assessment of the South Unit.

The H.E.L.P. model was utilized to determine leachate buildup within the South Unit with and without leachate collection. The H.E.L.P. runs are included in Appendix H. A graphical representation of leachate head predicted by these runs is presented in Figure 10. Also presented in Figure 10 is the head value used in the POLLUTE run for the South Unit. Even though the leachate driving head at the end of the modeling period was 1.83 inches (0.153 feet) for poor contact, a more conservative one (1) foot of leachate was considered for the baseline model for the entire modeling period (see Appendix F). Table 2 lists the South Unit input parameters for the baseline model and profile sensitivity.

6.2.2 South Unit Profile Sensitivity

6.2.2.1 Density

The baseline and sensitivity density values for the South Unit clay liner and sand aquifer are similar to the values used for the Existing Unit. These values are based density values for the till and sand as presented in Sharp-Hansen et al. (1990). The maximum, mean, and minimum respectively being 2.12, 1.91, and 1.61 for the clay liner, and 1.99, 1.69, and 1.13 for the sand aquifer. For the 60 mil HDPE, the manufacturer specified density of 0.94 was used.

POLLUTE was determined to be insensitive to this parameter for this model configuration since variation in predicted concentrations at the observation points was not observed for all layers and density values.

6.2.2.2 Diffusion Coefficient

The diffusion coefficients used for the soil liner and till layers in the Existing Landfill assessment were also used for the South Unit assessment. The initial diffusion coefficient for the soil liner and till is 0.018 m^2/A, which is close to the mean value (5 x 10^{-10} m^2/s or 0.0157 m^2/A) found for saturated diffusion coefficients in Shackelford (1990). Sensitivity was performed over a range bounded by a low of 1 x 10^{-10} m^2/s [.00315 m^2/A] to a maximum of 1 x 10^{-9} m^2/s [.0315 m^2/A] in Shackelford (1990). However, additional discussion is necessary concerning the HDPE and sand layers.

With a HDPE layer present in the South Unit, a diffusion value presented by Hughes and Monteleone (1987) was used. This value is 0.00008 m^2/A. Sensitivity was performed over a range of values an order of magnitude less than (0.000008 m^2/A) and greater (0.0008 m^2/A) than the baseline value.

For the sand aquifer, the diffusion coefficient of chloride in water was chosen, since this value represents a conservative approach. Domenico and Schwartz (1990, after Li and Gregory, 1974) reported the diffusion of chloride in water as 20.3 x 10^{-10} m^2/s or 0.064 m^2/A. This is the highest diffusion coefficient for a cation in water. Sensitivity was performed over a large range bounded by a low of 0.003154 m^2/A [1 x 10^{-10} m^2/s] to a maximum 0.173 m^2/A. Results of this sensitivity indicated that POLLUTE is somewhat sensitive to hydrodynamic dispersion, with the above variation. However, resultant concentrations are still effectively zero.

6.2.2.3 Effective Porosity

Similar to the Existing Landfill Unit, values for effective porosity were taken from the saturation water content data from Sharp-Hansen et al. (1990). Baseline and sensitivity liner and sand aquifer effective porosities were the same as the Existing Landfill Unit effective porosities. The maximum, mean, and minimum saturation water content values for silty clay (liner) and loamy sand (uppermost aquifer) are 42%, 36%, and 29%, and 50%, 41%, and 32%, respectively. For the liner and the sand aquifer the mean effective porosity values were used for the baseline scenario. Minimal concentration variation occurred from effective porosity sensitivity evaluation. Values for the HDPE geomembrane are fixed at 100% (or 1.0). Although this implies that the geomembrane is all voids, this is a conservative value as the transport equation uses porosity in the numerator, and smaller numbers for porosity produce correspondingly smaller predicted concentrations. Sensitivity has been performed in the past to confirm this behavior.

6.2.2.4 Number of Sublayers

Under certain circumstances, the number of sublayers can cause a variation in predicted concentrations. However, in this South Unit scenario, the number of sublayers did not affect the predicted concentrations at all. Variation in the number of sublayers ranged from 1 to 9 for the recompacted soil liner and 10 to 20 for the aquifer, with no variation in predicted concentrations at the observation points. The lack of significant variation is likely due to the extremely low predicted concentrations.

6.2.2.5 Thickness

Sensitivity was not performed on the layer thicknesses since they represent conservative (minimum) assumptions and design. For example, 60 mil HDPE and a minimum liner thickness of 0.914 meters (or 3 feet) are called for in the construction specifications. Also, the distance from the liner sidewall to the Zone of Attenuation is a measurable and conservative value (see Figure 7).

6.2.2.6 Darcy Velocity

The South Unit relationship with the groundwater surface indicates that a negative or zero gradient condition would be appropriate for the unit. However, a worst case scenario with one (1) foot head difference between the unit and the aquifer shall be used. A determination of leachate head buildup was completed using H.E.L.P. (Schroeder, 1989) (see Appendix H). H.E.L.P. predicts that with leachate collection, the maximum driving head is 0.0 feet (0.0 meters) with poor geomembrane contact. A comparison of the H.E.L.P. results with the modeled head is presented in Figure 10.

Darcy velocity was calculated using the seepage rate equations found in Giroud et al. (1990). There are two equations, poor or good liner contact. As part of the conservative nature of this study, the poor scenario was used to provide baseline model sensitivity. The seepage equation from Giroud et al. (1990) was used to determine seepage from the unit. Using the poor quality control (QC) equation, one 1 centimeter "defect" hole per acre, a one foot leachate driving head, the minimum liner permeability of 1 x 10^{-9} m/sec, and 4,047 m^2/acre, the liner flux is:

$$Q = 1.15(0.305\,m)^{0.9}(0.0001\,m^2)^{0.1}(1 \times 10^{-9})^{0.74} = 3.44\ \times 10^{-8}\frac{\frac{m^3}{sec}}{acre}$$

The volumetric flow must be divided by the area to produce a seepage velocity and multiplied by four (4) defects per acre:

$$3.44\ \times 10^{-8}\frac{\frac{m^3}{sec}}{acre} \div 4{,}047\frac{acre}{m^3} \times \frac{4\,defects}{acre} \times \frac{31536000\,sec}{1\,A} = 0.00107\frac{m}{A}$$

The baseline scenario used the calculated Darcy velocity of 0.00107 m/A. Sensitivity was performed on Darcy velocity values an order of magnitude lower (0.000107 m/A) and an order of magnitude greater (0.0107 m/A). The maximum value produced the highest predicted concentration. The velocity calculated from the assumed one (1) foot of driving head was used in the baseline model for the entire 131 year model period. A copy of the baseline model run for the South Unit with concentration versus time and concentration versus distance plots may be found in Appendix F.

6.2.2.7 Dispersivity

The flow distance for the South Unit is 100 feet (30.5 m), the same as that for the Existing Landfill Unit assessment. Given that the flow distance is less than 100 meters, the relationship between dispersivity and flow distance given by Schulze-Makuch (2005) is appropriate. For a horizontal flowpath distance of 30.5 m, the dispersivity is calculated as:

$$\alpha = c(L)^m = 0.2(30.5m)^{0.44} = 0.9\,m$$

The sensitivity analysis addressed dispersivities that ranged from one-half to twice the calculated dispersivity, 0.45 meters to 1.8 meters. The sensitivity analysis results indicate higher dispersivity results in the highest predicted concentrations, and that POLLUTE, in this scenario was quite sensitive to dispersivity. The dispersivity value of 0.9 meters was used for the baseline dispersivity value.

6.3 Northwest Unit Model

6.3.1 Northwest Unit Profile Setup

The hydrogeologic conditions of the Northwest Unit is relatively different from the South Unit area and the Existing Landfill Unit. In the northwest portion of the site, the sand interval that comprises the uppermost aquifer for the South Unit and Existing Unit was not encountered, and appears to be absent from this area. However, a sandstone ridge appears to be near to the same stratigraphic level as the sand unit to the east. The sandstone bedrock along the western edge of the Northwest Unit is considered part of the uppermost aquifer system. Thus, the sandstone was modeled as the migration pathway for the Northwest Unit scenario. To the east of the bedrock ridge, overburden appears to be much thicker and the uppermost sandstone bedrock material is absent. Since the sandstone appears to be below the proposed invert, both vertical and horizontal components of fluid movement must be considered.

The Northwest Unit was constructed above the bedrock and within the overburden material (see Figure 5). Transport from the Northwest Unit area is depicted on the conceptual drawing in Figure 8, and includes both vertical and horizontal transport from the Unit into the sandstone aquifer. The unit was constructed with a 60 mil HDPE layer and a minimum three (3) feet thick recompacted liner with material possessing a hydraulic conductivity of 1 x 10^{-7} cm/s or less. A minimum thickness of 18 feet of recompacted soil and/or in situ overburden material was placed or left in place, respectively, above the sandstone aquifer. An outward gradient scenario was addressed in this assessment, even though an inward or zero gradient was a realistic approach to modeling the unit. The outward gradient was utilized to provide a more conservative approach to the impact assessment.

The modeling period for the Northwest Unit consists of sixteen (16) years of life in the Northwest Unit, the thirty (30) years of post-closure care, and the remaining seventy (70) years required under 35 IAC 811.317. This totals 116 years required for the assessment of the Northwest Unit. The H.E.L.P. model was utilized to determine leachate buildup within the Northwest Unit. The H.E.L.P. runs may be found in Appendix H. A graphical representation of the leachate head predicted by these runs is presented in Figure 11. Also presented in Figure 11 is the head value used in the MIGRATE runs for the Northwest Unit assessment. Even though the leachate head at the end of the modeling period was 0.04425 feet (poor contact), a more conservative one (1) foot of leachate was considered for the baseline model for the entire modeling period (see Appendix G). Table 3 list the Northwest Unit input parameters for the baseline model and profile sensitivity.

6.3.2 Northwest Unit Profile Sensitivity

6.3.2.1 Landfill Width

The modeled section for the Northwest Unit, as illustrated on Figure 5, shows a landfill length of approximately 200 feet. Figure 5 was derived from the intersection of geologic cross section A-A' and B95-1 (B-B' and G-G') parallel to groundwater flow. A landfill length of 150 feet can be derived from geologic cross section G-G' (see Appendix B). The measurement from the eastern limits of the sandstone bedrock (near B95-1) to the western landfill toe equals 150 feet. The 200 feet distance; however, is more realistic since Figure 5 was constructed parallel to flow, while the RHI cross section G-G' was constructed perpendicular to the landfill waste/toe boundary. Therefore, the Northwest Unit has been modeled using a landfill distance of 200 feet (see Figure 8). However, for sensitivity purposes, a landfill distance of 250 feet was also modeled. Sensitivity indicates that there was little variation between landfill distances of 150 feet versus 250 feet.

6.3.2.2 Density

The Northwest Unit baseline and sensitivity density values are the same as that used in the South Unit and Existing Landfill Unit assessments. The baseline and sensitivity density values for the Northwest Unit clay liner and in situ clay are the same values used for the Existing Unit Sharp-Hansen et al. (1990). The maximum, mean, and minimum respectively being 2.12, 1.91, and 1.61 for the clay liner and in situ clay. For the 60 mil HDPE, the manufacturer specified density of 0.94 was used.

MIGRATE was determined to be insensitive to this parameter for this model configuration, since variation in predicted concentrations at the observation points was not observed for all layers and density values.

6.3.2.3 Diffusion Coefficient

The Northwest Unit used the same diffusion value for the HDPE layer present as the South Unit (0.00008 m^2/A). Sensitivity was performed over a range of values an order of magnitude less than (0.000008 m^2/A) and greater than (0.0008 m^2/A) the baseline value.

The Northwest Unit diffusion coefficient for the recompacted clay liner and in situ clay layers was the same as the Existing Landfill and South Unit Scenario. The baseline diffusion coefficient for the soil liner and in situ silty clay is 0.018 m^2/A. Sensitivity was performed over a range bounded by a low of 1×10^{-10} m^2/s (0.003154 m^2/A) to a maximum of 1×10^{-9} m^2/s (0.003154 m^2/A) (Shackelford 1990).

Results of this sensitivity show that MIGRATE is somewhat sensitive to diffusion, with the above variation. Apparently, the thicker the material, the wider the variability.

6.3.2.4 Effective Porosity

As with the South Unit, values for the HDPE geomembrane are fixed at 100% (or 1.0).
Similar to the Existing Landfill and South Units, liner and in situ silty clay effective porosity values for both baseline and sensitivity were taken from the saturation water content data from Sharp-Hansen et al. (1990). The maximum, mean, and minimum saturation water content values for recompacted clay liner and in situ silty clay are 42%, 36%, and 29%. For the recompacted clay liner and in situ silty clay the mean effective porosity values were used for the baseline scenario.

For porosity calculations in the sandstone aquifer, values were calculated using the total porosity data for a sandstone (Sharp-Hansen et al. 1990). Sensitivity was performed over a broad range of values, with the maximum, mean, and minimum being 49%, 34% and 14%, respectively. The porosity value used for this baseline scenario was 34%.

Minimal concentration variation occurred from effective porosity sensitivity evaluation. As expected, variation in predicted concentrations within the range of values showed that the lower values for effective porosity produced higher predicted concentrations.

6.3.2.5 Number of Sublayers

Variations in the number of sublayers did not impact the predicted concentrations at all. Variation in the number of sublayers for the Northwest Unit ranged from 1 to 6 for the recompacted soil liner and the in situ silty clay, with no variation in predicted concentrations at the observation points.

6.3.2.6 Thickness

MIGRATE provides for analysis of all layers between the refuse and the lower boundary (a permeable base in this instance). For the purposes of this analysis, the model has been divided into three layers; the HDPE geomembrane, the recompacted clay liner, and a silty clay (till) layer.

The HDPE geomembrane is specified at a 60 mil (0.0015 meters) thickness. Since it is a man-made product, the variation from this thickness is nominal. No sensitivity was performed on this parameter.

The recompacted soil liner is specified at a minimum 3 feet (0.9144 meters) nominal thickness. If more liner is required to meet the minimum 18 feet of recompacted soil liner and/or in situ silty clay, then additional liner shall be constructed to meet the minimum requirements.

The in situ silty clay (i.e. glacial till) provides an additional protection between the unit and the uppermost aquifer. To provide an estimate of the thickness of the remaining silty clay beneath the unit, a geologic cross section was constructed along the western invert toe (see Figure 5). The maximum and minimum thicknesses of in situ silty clay along the western toe are 15 feet (4.57 m) and 5.5 feet (1.68 m), respectively. Sensitivity was performed over this range of maximum and minimum thickness values. The Northwest Unit assessment was somewhat sensitivity to variation of the thickness of the in situ silty clay layer.

The uppermost aquifer beneath the western edge of the Northwest Unit consists of sandstone that rests conformably on shale bedrock. Figure 5 illustrates that the maximum sandstone thickness along and beneath the western invert is 12.5 feet (3.81 m). However, the sandstone layer rapidly decreases in thickness to the east, as seen on Figure 5. Sensitivity was performed on the variation of thickness of the aquifer. The minimum and maximum thickness was 1 foot (0.305 meters) and 12.5 feet (3.81 meters), respectively. Baseline sensitivity used a thickness of 8 feet (2.44 meters). Based on the sensitivity evaluation for this parameter, the Northwest Unit assessment was somewhat sensitive to this parameter.

6.3.2.7 Darcy Velocity

Vertical

For the Northwest Unit assessment the leachate head buildup was determined using H.E.L.P. (Schroeder, 1989) (see Appendix G). H.E.L.P. predicts that with leachate collection, the maximum driving head is 0.044 feet (0.013 meters) for poor contact. A comparison of the H.E.L.P. results with the modeled head is presented in Figure 11. For the Northwest Unit, the gradient condition was calculated using an assume one (1) foot (0.305 m) head for the entire 116 year modeling period. This is a conservative assumption.

Darcy velocity was calculated using the seepage rate equation for poor liner contact as found in Giroud et al. (1990). For a one (1) centimeter hole per acre, a one (1) foot leachate driving head, a minimum liner permeability of 1 x 10^{-9} m/sec, and 4,047 m^2/acre, the liner flux is:

$$Q = 1.15(0.305\,m)^{0.9}(0.0001\,m^2)^{0.1}(1\times10^{-9})^{0.74} = 3.44\times10^{-8}\frac{\frac{m^3}{sec}}{acre}$$

The volumetric flow must be divided by the area to produce a seepage velocity and multiplied for four (4) defects per acre:

$$3.44\times10^{-8}\frac{\frac{m^3}{sec}}{acre} \div 4{,}047\frac{acre}{m^3}\times\frac{4\,holes}{acre}\times\frac{31{,}536{,}000\,sec}{1\,A} = 0.00107\frac{m}{A}$$

The baseline scenario used the calculated Darcy velocity of 0.00107 m/A. Sensitivity was performed on Darcy velocity values an order of magnitude lower (0.000107 m/A) and an order of magnitude greater (0.0107 m/A). Based on the sensitivity evaluation for this parameter, the Northwest Unit assessment was somewhat sensitive to this parameter.

Horizontal

Use of the permeable base, or aquifer bottom boundary condition within MIGRATE requires the calculation of the base Darcy velocity for the aquifer. Hydraulic conductivity data was acquired from G-103 slug test information. G-103 is the only well screened in the sandstone aquifer. Calculation of the Darcy velocity for the uppermost aquifer was completed following the method described in Example 4 on page 126 of the MIGRATE v9 User's Manual (Rowe and others, 1995).

The horizontal Darcy velocity within the base strata is termed the "Base Outflow Velocity." The "Base Outflow Velocity" is the outflow velocity beneath the downgradient edge of the Northwest Unit and corresponds to the horizontal inflow at the upgradient edge (q_{in}) plus the vertical inflow (q_a).

Based on continuity of flow the initial flow in the aquifer, q_{in}, is given by the inflow velocity ($v_{in} = Ki =$ 10.57 m/a x 0.03945 = 0.417 m/a) multiplied by the thickness of the aquifer (h = 2.44 m) and the width of the Northwest Unit perpendicular to the direction of groundwater flow (W = 208 m), thus:

$$q_{in} = v_{in} \cdot h \cdot W = 0.417 \frac{m}{A} \cdot 2.44\, m \cdot 208\, m = 212 \frac{m^3}{A}$$

The flow into the uppermost aquifer, q_a, is the downward Darcy velocity from the HDPE geomembrane, the recompacted clay liner, and a silty clay (till) layer (v_a = 0.00107 m/a) multiplied by the length (L = 60.96 m) and the width (W = 208 m) of the Northwest Unit, thus:

$$q_a = v_a \cdot W \cdot L = 0.00107 \frac{m}{A} \cdot 208\, m \cdot 60.96\, m = 13.6 \frac{m^3}{A}$$

The outflow at the downgradient edge of the Northwest Unit is:

$$q_{out} = q_{in} + q_a = 212 \frac{m^3}{A} + 13.6 \frac{m^3}{A} = 226 \frac{m^3}{A}$$

The "Base Outflow Velocity," $_b$, is the outflow divided by the width of the Northwest Unit ($W = 208$ m) and the thickness of the aquifer ($h = 2.44$ m), therefore:

$$v_b = \frac{q_{out}}{(W \cdot h)} = \frac{226 \frac{m^3}{A}}{(208\, m \cdot 2.44\, m)} = 0.445 \frac{m}{A}$$

The baseline vertical Darcy velocity through the uppermost aquifer is 0.445 m/a. Sensitivity runs were evaluated at an order of magnitude less (0.0445 m/A) and an order of magnitude greater (4.45 m/A) than the value chosen for the baseline evaluation.

Sensitivity runs on the Darcy velocity values show that there is slight variation in predicted concentrations for all velocities. However, the peak concentration occurred at the minimum velocity. The average velocity provide a conservative approach to the model scenario and was utilized for the baseline model for the Northwest Unit.

6.3.2.8 Dispersivity

With a one (1) foot driving head baseline scenario, sensitivity on dispersivity was not performed for transport through the HDPE geomembrane, the recompacted clay liner, and a silty clay (till) layer vertical layers. However, for the horizontal velocity of the permeable base, the mechanical dispersion is an important parameter. For the mean velocity the diffusion coefficient calculation is:

$$D_h = D^* \cdot D_m = 0.018 \frac{m^3}{A} + \frac{1.15\,m \cdot 0.445 \frac{m^2}{A}}{0.34} = 0.018 \frac{m^3}{A} + 1.51 \frac{m^3}{A} = 1.53 \frac{m^2}{A}$$

Sensitivity runs were evaluated at an order of magnitude less (0.153 m^2/A) and an order of magnitude greater (15.3 m^2/A) than the value chosen for the baseline evaluation (1.53 m^2/A). The modeled parameters derived from sensitivity calculations indicate that there was only a slight variation in predicted concentrations.

7. BASELINE MODEL SCENARIOS

Graphical representations of the baseline model results, including input and output hard copy prints, may be found in Appendix E, Appendix F, and Appendix G. Copies of the sensitivity and baseline input and output files are also contained on the diskettes provided with this report.

The baseline model uses a normalized initial leachate concentration of 1 mg/l. This value was selected to provide a mechanism to evaluate all leachate constituents with only one model run. The 1 mg/l value can be assumed to be a multiplier of the initial leachate concentration. Therefore, the values predicted by the model at various points in time and space represent a multiplier of the initial concentration. The value predicted at the edge of the zone of attenuation or Compliance Prediction Factor (CPF) may be used for values that are in the parts per million (ppm) range, or for values in the parts per billion (ppb) range. The actual initial concentration value assigned is not important. It is only necessary that the value is large enough to produce a value within the model, at the point in question within the model framework.

8. SURROGATE MODELING

Since the resulting predicted concentrations for all constituents at the compliance boundary (edge of zone of attenuation) were below the Applicable Groundwater Quality Standards (AGQS) for the Existing and the Southern Units assessments, the baseline scenarios were the only surrogate necessary. However for the Northwest Unit assessment it was necessary to use surrogates for a few leachate parameters. The attenuative properties (retardation and biodegradation) were necessary for the following parameters:

The surrogate distribution coefficients and half-live values are presented in Appendix I. Included in Appendix I are the site-specific fraction organic carbon values.

The distribution coefficients and half-live values used for the surrogate modeling are presented in Table 4. The parameters addressed are leachate species, species concentration, the statistically determined background water quality (at a 95% confidence level), the 35 IAC 620 Class I and II groundwater standards, the site AGQS and each model produced concentration.

8.1 Leachate Characterization

8.1.1 Leachate Species

Compounds listed as leachate species in Leachate Concentration Table 5 are those chemical constituents and/or compounds that had values that were above detection in the leachate analysis.

8.1.2 Leachate Concentration

A comprehensive analysis of the existing landfill leachate was made using the constituents found in the IEPA's Permit Instructions (LPC-PA2) Appendix C, Attachment 1. Compounds listed as leachate species are those chemical constituents and/or compounds with values that were above detection in the leachate analysis. These are the compounds expected to be present in the leachate. Maximum leachate concentrations were used for this assessment.

8.2 Applicable Groundwater Quality Standard (AGQS)

Applicable groundwater quality standard (AGQS) refers to the background water quality at the site. The AGQS values are referred to as prediction limits in the results table. The value is the upper 95% confidence level compiled from the background water quality data collected on site.

8.3 IAC 620 - Class I and II Standards

The values presented from Class I and II groundwater standards are pursuant to 35 IAC 620, as set forth by the Illinois Pollution Control Board. They are included here simply as reference, since the groundwater at the facility has been classified in the Groundwater Monitoring Program, as Class I.

8.4 Surrogate Model Results

Baseline surrogates with no attenuative properties (retardation and biodegradation) for the Existing Unit, Southern Unit and Northwest Units modeling scenarios were used to determine compliance with all leachate parameters. Additional surrogates were necessary for a few leachate parameters. The following are the combinations of parameters for the baseline surrogate modeling scenarios:

1) Existing Unit Assessment (EBASELIN.I/O) – Leachate constituents (all listed parameters)

   Southern Unit Assessment (SBASELIN.I/O) – Leachate constituents (all listed parameters)
   Existing Unit Assessment (BASELINE.I/O) – Leachate constituents (all listed parameters)
   Baseline concentration = 1
   Chloride retardation: $K_d = 0.0\ cm^3/g$
   Half-life: $t_{1/2} = 0$ years
   Model Predicted Concentrations:

   - Existing Landfill Unit = 1.0002e-6

- South Unit = 8.5377e-16
- Northwest Unit = 3.235e-3

As discussed above, additional surrogates were necessary for a select group of parameters for the Northwest Unit assessment. The results of the additional surrogate assessments are as follows:

- Surrogate 1 (SUR001.I/O) = 1.103e-6
- Surrogate 2 (SUR002.I/O) = 0
- Surrogate 3 (SUR003.I/O) = 1.754e-26
- Surrogate 4 (SUR004.I/O) – 0
- Surrogate 5 (SUR005.I/O) – 0
- Surrogate 6 (SUR006.I/O) – 0

Numerical results of the baseline and additional surrogate modeling are presented in Concentration versus Time and Concentration versus Distance profiles are presented in Appendix E, Appendix F, and Appendix G for the baseline and additional surrogate scenarios. The graphs show the breakthrough curves predicted by the model, and show results at various distances in 5 year increments. The modeling results show expected trends, with no unusual results. That is, concentrations are highest near the waste and lowest at the zone of attenuation. The graphs represent the worst case concentrations found within the models.

8.5 Model Predicted Concentration

Predicted concentration values for the constituents listed under the modeling surrogates (see Table 5) were calculated at the down-gradient edge of the zone of attenuation at the end of the assessment periods using the following formula:

$$C_p = C_0 \times MPF$$

where,
C_o = the initial leachate concentration
MPF = the Model Prediction Factor from the transport model at the edge of the zone of attenuation
C_P = the predicted concentration at the desired monitoring point.

The predicted concentrations for the leachate constituents, which are listed in Table 5, do not exceed the background water quality values. Further assessment of surrogates was not necessary.

9. MAXIMUM ALLOWABLE PREDICTED CONCENTRATIONS (MAPC)

MAPCs have been determined for each modeled unit. As stated in 35 IAC 811.318(c), the calculation must be based on the same calculation method, data, and assumptions, used in the impact assessment contaminant transport model.

The baseline run calculated a model prediction factor at several locations at the end of the modeling period. Values at the edge of the zone attenuation are identified as Compliance

Prediction Factors (CPF) and at the well locations as Model Prediction Factors (MPF). These values are used to determine the MAPCs. To calculate the MAPCs the MPF is divided by the CPF resulting in the Well Prediction Factor (WPF). The WPF is then multiplied by the Applicable Groundwater Quality Standard:

$$WPF = MPF / CPF$$
$$MAPC = (WPF)\ AGQS.$$

Once the WPF is known for each well, any MAPC value may be determined for any known AGQS.

Based on the POLLUTE runs for the Existing Landfill and South Units, migration of contaminants are negligible (see Appendix E and Appendix F for graphical representation). Therefore, MAPC values for the down-gradient wells that monitor the Existing Landfill and South Units shall be the AGQS values for all constituents to be monitored. Table 6 contains the MAPC/AGQS values (i.e. groundwater prediction limits) which shall be used for the Existing Landfill and South Units routine parameters, the annual inorganic, and annual organic constituents. This is completely justifiable, as the transport models for the Existing Landfill and South Units predict concentrations that are well below the background standard.

The MIGRATE runs for the Northwest Unit indicate that the predicted concentrations at the compliance boundary were just under several of the AGQS values (see Appendix G). MAPCs for the Northwest Unit were calculated using the CPF and MPF values. The CPF (0.3235e-2) is at the zone of attenuation and the MPF (0.3786e-2) is at the down-gradient monitoring well locations along the Northwest Unit or 40 feet from the waste boundary (the baseline run distance of 200' or 61 m, is equivalent to 40 feet). The calculated WPF (Baseline, MPF/CPF=0.3235e-2/0.3786e-2=1.17; Surrogate 1, ammonia, dissolved as N = 1.13; Surrogate 3, methylene chloride and 1,2-dibromomethane = 1.18) and MAPC values for the Northwest Unit are given in Table 7. For Surrogates 2, 4, 5 and 6 the MAPC and AGQS were equal (1).

10. CONTAMINANT TRANSPORT APPRAISAL

The assumptions inherent in POLLUTE and MIGRATE should be addressed to see if simplifications within the conceptual model, the conversion to mathematical model, or any external parameters have produced a potential problem within the contaminant transport model framework. Model provisions and assumptions shall be addressed one at a time to determine the adequacy of this impact assessment.

10.1 Inherent Assumptions

- **Advective as well as diffusive transport** - POLLUTE and MIGRATE do offer the option of modeling hydrodynamic diffusion. The pure advection of contaminants may be seen within the assessment by observing the horizontal transport within the landfill layers. Even with the gradient (and hence the mechanical dispersion) set to zero, there is still horizontal migration of contaminants. Therefore, this assumption holds true for this impact assessment.
- **Multiple time and distance solutions to the transport equation** - POLLUTE and MIGRATE are analytical models. As such, the advection-dispersion transport equation may be solved exactly for any point in space at any time. The only limitations are noted in the MIGRATE documentation (Booker & Rowe, 1988). These are:

1) maximum number of all sublayers (vertical) = 50 (POLLUTE allows 250)
2) maximum number of lateral distances = 10 (actually only allows 9)
3) maximum number of time periods = 52

- **Retardation of non-conservative constituents** - Retardation is provided within POLLUTE and MIGRATE by applying a distribution coefficient (K_d) along with the density of the soil (ρ). The only real restriction to this assumption is that sorption-desorption is linearly controlled (Booker & Rowe, 1988). Linear control of retardation is not uncommon in transport models. It is probably the more conservative approach to retardation (versus Freundlich or Langmuir sorption), and should be acceptable within the framework of this impact assessment.

  POLLUTE further allows first-order decay to be modeled. This type of retardation includes radioactive decay and biodegredation. This is conservative in its approach if the decay is restricted to outside the landfill mass.

- **A transport solution with no space or time discretization errors** - As stated above, both POLLUTE and MIGRATE produce an analytical solution to the advection-diffusion equation. This implies that there is an exact solution at each point in space for each time that is of interest. Within the framework of a numerical model, the solution to the advection-diffusion equation is an average value for the points that fall within the grid cell. Also within the context of numerical modeling, transient modeling requires some temporal manipulation to produce accurate results. The models have neither of these problems, and hence should produce reasonable and stable results.

10.2 Sensitivity Discussion

Sensitivity was performed to evaluate the values of the critical parameters. With regard to parameter value usage, the hierarchy for the selection were:

> Site specific – values determined from statistical analysis of site specific data were considered representative of the facility.
>
> Literature citation – values taken from literature sources used at conservative values.

A review of the outputs, and specifically the concentration versus time plots, does not show anything that is extremely unusual. The concentration versus distance plots show that there is no impact on the uppermost aquifer at the facility. All scenarios passed the AGQS at the zone of attenuation, except for a few Northwest Unit scenarios (i.e. thickness of recompacted/in situ layers). However, the Northwest Unit thickness scenarios were accounted for by increasing the necessary recompacted/in situ silty clay thickness such that the AGQS at the zone of attenuation passed all constituents. The resultant recompacted/in situ silty clay thickness for the Northwest Unit, which was derived via sensitivity analysis, is 18 feet.

11. CONCLUSIONS

A groundwater impact assessment was performed for the Landfill 33, Ltd. facility near Effingham, Effingham County, Illinois. This impact assessment reviewed the site geology and hydrology to produce conceptual models for the site. The conceptual models were then analyzed to see what type of transport model would best represent each scenario. The models selected were Rowe and Booker's POLLUTE (a 1-dimensional model) and MIGRATE (a 2-dimensional model). Both models provided a best solution to the compound diffusion/dispersion environment at the facility. Sensitivity analysis was performed on the hydrogeologic data used in the models. Baseline model scenarios were developed from the sensitivity analysis to provide a conservative model framework for the impact assessment. Surrogates were developed from the baseline models to express all leachate constituents within the conceptual models framework. Maximum allowable predicted concentrations were also calculated for the leachate constituents utilizing the contaminant transport models. On the basis of this study, this facility does not produce a statistically significant increase over background concentrations over the life, post-closure care, and 100 year assessment periods, pursuant to 35 IAC 811.317 and 811.320.

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TABLES

Deposit Data		R235
No. of Layers		2
Laplace Transform Parameters	Tau	7
	N	20
	Sig	0
	RNU	2
Darcy Velocity	m/A	0
Distance to Zone of Attenuation	m	30.45
Time Period	A	145

Layer Data		Units	BASELINE	MIN	MAX
Layer 1 - In Situ Soil Liner	No. of Sublayer	-	10	5	20
	Thickness	m	3.05	-	-
	Dry Density	g/cm^3	1.91	1.61	2.12
	Porosity	-	0.36	0.29	0.42
	Diffusion Coefficient	m^2/A	0.018	0.00315	0.0315
	Distribution Coefficient	mL/g	0	-	-
Layer 2 - Aquifer	No. of Sublayer	-	40	20	90
	Thickness	m	27.4	-	-
	Dry Density	g/cm^3	1.69	1.13	1.99
	Porosity	-	0.41	0.32	0.5
	Diffusion Coefficient	m^2/A	0.018	0.00315	0.0315
	Distribution Coefficient	mL/g	0	-	-

Boundary Conditions							
Top Boundary Condition	Constant Concentration						
Bottom Boundary Condition	Infinite Thickness						
Variable Properties							
Property Increments within Groups	Yes						
Number of Time Periods	7						
Start Time	0						
Type of Profile	Sublayer						
Time Period	1	2	3	4	5	6	7
End Time	5	15	16	19	20	75	145
No of Increments	5	2	1	3	1	11	14
Beginning Concentration	100	100	100	100	100	100	100
Darcy Velocity	0	0.0378	0.0378	0.0378	0	0	0
Dispersivity	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Concentration Increment	0	0	0	0	0	0	0
Darcy Velocity Increment	0.00756	0	0	-0.0126	0	0	0.0027

Deposit Data		
No. of Layers		2
Laplace Transform Parameters	Tau	7
	N	20
	Sig	0
	RNU	2
Darcy Velocity	m/A	0.00107
Distance to Zone of Attenuation	m	30.45
Time Period	A	131

Layer Data		Units	BASELINE	MIN	MAX
Layer 1 - 60 mil HDPE	No. of Sublayer	-	1	-	-
	Thickness	m	0.00152	-	-
	Dry Density	g/cm^3	0.94	-	-
	Porosity	-	1	-	-
	Diffusion Coefficient	m^2/A	0.00008	0.000008	0.0008
	Distribution Coefficient	mL/g	0	-	-
Layer 2 - Recompacted Clay Liner	No. of Sublayer	-	3	1	9
	Thickness	m	0.914	-	-
	Dry Density	g/cm^3	1.91	1.61	2.12
	Porosity	-	0.36	0.29	0.42
	Diffusion Coefficient	m^2/A	0.018	0.00315	0.0315
	Distribution Coefficient	mL/g	0	-	-
Layer 2 - Aquifer	No. of Sublayer	-	15	10	20
	Thickness	m	38.7	-	-
	Dry Density	g/cm^3	1.69	1.13	1.99
	Porosity	-	0.41	0.32	0.5
	Diffusion Coefficient	m^2/A	0.064	0.00315	0.173
	Distribution Coefficient	mL/g	0	-	-

Boundary Conditions	
Top Boundary Condition	Constant Concentration
Bottom Boundary Condition	Infinite Thickness

General Data	No. of Landfills		1			
	No. of Layers		3			
	Laplace Transform	Tau	7			
		N	11			
		Sig	0			
		RNU	1			
	Gauss Integration	Normal				
Boundary Conditions	Top Boundary	Constant Concentration - Surface				
	Bottom Boundary	Aquifer				
			Units	BASELINE	MIN	MAX
	Top Boundary Condition	Offset Distance	m	0	-	-
		Landfill Base Width	m	61	45.7	76.2
		Landfill Surface Width	m	366	351	381
		Surface Concentration	mg/L	1	-	-
	Bottom Boundary Condition	Base Thickness	m	2.44	0.305	3.81
		Base Half-Life	yrs	0	-	-
		Sink Removal	m/a	0	-	-
		Base Porosity	-	0.34	0.14	0.49
		Outflow Velocity	m/a	0.42	0.042	4.42
		Dispersion Coefficient	m2/a	1.53	0.153	15.3
Layer Data	Layer 1: 60 mil HDPE	Number of Sublayers	-	1	-	-
		Thickness	m	0.00152	-	-
		Dry Density	g/cm3	0.94	-	-
		Porosity	-	1	-	-
		Distribution Coefficient	mL/g	0	-	-
		Vertical Diffusion	m2/a	0.00008	0.000008	0.0008
		Horizontal Diffusion	m2/a	0	-	-
		Vertical Velocity	m/a	0.00107	0.000107	0.0107
		Horizontal Velocity	m/a	0	-	-
		Decay Half-Life	yrs	0	-	-
		Sink Removal	m/a	0	-	-
	Layer 2: Recompacted Clay	Number of Sublayers	-	3	1	6
		Thickness	m	0.914	-	-
		Dry Density	g/cm3	1.91	1.61	2.12
		Porosity	-	0.36	0.29	0.43
		Distribution Coefficient	mL/g	0	-	-
		Vertical Diffusion	m2/a	0.018	0.00315	0.0315
		Horizontal Diffusion	m2/a	0.018	0.00315	0.0315
		Vertical Velocity	m/a	0.00107	0.000107	0.0107
		Horizontal Velocity	m/a	0	-	-
		Decay Half-Life	yrs	0	-	-
		Sink Removal	m/a	0	-	-
	Layer 3: In situ Clay	Number of Sublayers	-	15	1	30
		Thickness	m	2.44	1.52	4.57
		Dry Density	g/cm3	1.91	1.61	2.12
		Porosity		0.36	0.29	0.43
		Distribution Coefficient	mL/g	0	-	-
		Vertical Diffusion	m2/a	0.018	0.00315	0.0315
		Horizontal Diffusion	m2/a	0.018	0.00315	0.0315
		Vertical Velocity	m/a	0.00107	0.000107	0.0107
		Horizontal Velocity	m/a	0	-	-
		Decay Half-Life	yrs	0	-	-
		Sink Removal	m/a	0	-	-
Number of Distances	8	30.48, 45.72, 49.53, 53.34, 57.15, 60.96, 64.77, 83.82				
Number of Times	25	years 5 through 115 at 5 year increments and year 116				

Table 4: Northwest [illegible] Surrogate Parameters

Parameter	K_{oc}, Oct.-Water Part. Coef.				f_{oc}, Frac. of Org. C (%)	K_d, Dist. Coef (mL/g)	$t_{1/2}$, Half-Life (years)				
	Min		Max				Min		Max		
	log K_{oc}	K_{oc} (mL/g)	log K_{oc}	K_{oc} (mL/g)			$t_{1/2}$ (hrs)	$t_{1/2}$ (yrs)	$t_{1/2}$ (hrs)	$t_{1/2}$ (yrs)	$t_{1/2}$ (yrs)
Surrogate 1 (SUR001) - Pnictogen Hydride											
Ammonia as N, total	0.199	1.58	1.58	14.3		**0.0213**	8760	1	52560	6	6
Surrogate 2 (SUR002) - Polynuclear Aromatic Hydrocarbon											
Benzo(a)anthracene	4.52	33113	7.3	19952623		**75.9**	4896	0.559	32640	3.73	**11.7**
Benzo(b)fluoranthene	5.45	281838	8.02	1.05E+08			17280	1.97	29280	3.34	
Benzo(k)fluoranthene	5.47	295121	8.02	1.05E+08			42680	4.87	102720	11.7	
Dibenzo(a,h)anthracene	3.75	5623	8.5	3.16E+08			17328	1.98	45120	5.15	
Surrogate 3 (SUR003) - Halogenated Aliphatic Hydrocarbon											
Methylene Chloride	0.944	8.79	1.44	27.5	0.0135	**0.119**	336	0.0384	1344	0.153	**0.329**
1,2-Dibromoethane	1.556	36	1.699	50			470	0.0537	2880	0.329	
Surrogate 4 (SUR004) - Aliphatic Ether											
Tetrahydrofuran	1.26	18.2	1.37	23.4		**0.246**	1.6	0.000183	1.6	0.000183	**0.000183**
Surrogate 5 (SUR005) - Ketone											
Acetone	-0.586	0.259	-0.523	0.3		**0.0035**	48	0.00548	336	0.0384	**0.0384**
2-Butanone (MEK)	-0.03	0.933	2.41	257			48	0.00548	336	0.0384	
Surrogate 6 (SUR006) - Phenolics											
Phenolics	1.15	14.1	3.49	3090		**0.302**	12	0.00137	168	0.0192	**0.0192**

Parameter	Units	List	Max	AGQS	Existing Unit MPF = 1.0002E-06		South Unit MPF = 8.5377E-16		Northwest Unit MPF = 3.215E-03	
1,1,1,2-Tetrachloroethane	ug/L	L1	50	2.5	5.00E-05	PASS	4.27E-14	PASS	0.16075	PASS
1,1,1-Trichloroethane	ug/L	L1	50	2.5	5.00E-05	PASS	4.27E-14	PASS	0.16075	PASS
1,1,2,2-Tetrachloroethane	ug/L	L1	50	2.5	5.00E-05	PASS	4.27E-14	PASS	0.16075	PASS
1,1,2-Trichloroethane	ug/L	L1	50	2.5	5.00E-05	PASS	4.27E-14	PASS	0.16075	PASS
1,1-Dichloroethane	ug/L	L1	50	2.5	5.00E-05	PASS	4.27E-14	PASS	0.16075	PASS
1,1-Dichloroethene	ug/L	L1	50	2.5	5.00E-05	PASS	4.27E-14	PASS	0.16075	PASS
1,1-Dichloropropene	ug/L	L1	50	2.5	5.00E-05	PASS	4.27E-14	PASS	0.16075	PASS
1,2,3-Trichlorobenzene	ug/L	L1	50	2.5	5.00E-05	PASS	4.27E-14	PASS	0.16075	PASS
1,2,3-Trichloropropane	ug/L	L1	50	2.5	5.00E-05	PASS	4.27E-14	PASS	0.16075	PASS
1,2,4-Trichlorobenzene	ug/L	L1	50	2.5	5.00E-05	PASS	4.27E-14	PASS	0.16075	PASS
1,2,4-Trimethylbenzene	ug/L	L1	130	2.5	1.30E-04	PASS	1.11E-13	PASS	0.41795	PASS
1,2-Dibromo-3-chloropropane	ug/L	L1	50	2.5	5.00E-05	PASS	4.27E-14	PASS	0.16075	PASS
1,2-Dibromoethane	ug/L	L1	50	0.05	5.00E-05	PASS	4.27E-14	PASS	8.77E-25[3]	PASS
1,2-Dichlorobenzene	ug/L	L1	50	2.5	5.00E-05	PASS	4.27E-14	PASS	0.16075	PASS
1,2-Dichloroethane	ug/L	L1	50	2.5	5.00E-05	PASS	4.27E-14	PASS	0.16075	PASS
1,2-Dichloropropane	ug/L	L1	50	2.5	5.00E-05	PASS	4.27E-14	PASS	0.16075	PASS
1,3,5-Trimethylbenzene	ug/L	L1	50	2.5	5.00E-05	PASS	4.27E-14	PASS	0.16075	PASS
1,3-Dichlorobenzene	ug/L	L1	50	2.5	5.00E-05	PASS	4.27E-14	PASS	0.16075	PASS
1,3-Dichloropropane	ug/L	L1	50	2.5	5.00E-05	PASS	4.27E-14	PASS	0.16075	PASS
1,3-Dichloropropene	ug/L	L1	150	2.5	1.50E-04	PASS	1.28E-13	PASS	0.48225	PASS
1,4-Dichlorobenzene	ug/L	L1	50	2.5	5.00E-05	PASS	4.27E-14	PASS	0.16075	PASS
1-Propanol	ug/L	L1	20000	na	-	-	-	-	-	-
2,2-Dichloropropane	ug/L	L1	50	2.5	5.00E-05	PASS	4.27E-14	PASS	0.16075	PASS
2,4,5-TP (Silvex)	ug/L	L1	1	1	1.00E-06	PASS	8.54E-16	PASS	0.003215	PASS
2,4,6-Trichlorophenol	ug/L	L1	500	na	-	-	-	-	-	-
2,4-D	ug/L	L1	190	5	1.90E-04	PASS	1.62E-13	PASS	0.61085	PASS
2,4-Dichlorophenol	ug/L	L1	100	na	-	-	-	-	-	-
2,4-Dimethylphenol	ug/L	L1	100	na	-	-	-	-	-	-
2,4-Dinitrophenol	ug/L	L1	500	na	-	-	-	-	-	-
2,4-Dinitrotoluene	ug/L	L1	100	na	-	-	-	-	-	-
2,6-Dinitrotoluene	ug/L	L1	100	na	-	-	-	-	-	-
2-Butanone (MEK)	ug/L	L1	8000	5	8.00E-03	PASS	6.83E-12	PASS	0[5]	PASS
2-Chloroethyl vinyl ether	ug/L	L1	50	na	-	-	-	-	-	-
2-Chloronaphthalene	ug/L	L1	100	na	-	-	-	-	-	-
2-Chlorophenol	ug/L	L1	100	na	-	-	-	-	-	-
2-Chlorotoluene	ug/L	L1	50	2.5	5.00E-05	PASS	4.27E-14	PASS	0.16075	PASS
2-Hexanone (MBK)	ug/L	L1	100	5	1.00E-04	PASS	8.54E-14	PASS	0.3215	PASS
2-Nitrophenol	ug/L	L1	500	na	-	-	-	-	-	-
2-Propanol	ug/L	L1	12000	na	-	-	-	-	-	-
3,3'-Dichlorobenzidine	ug/L	L1	200	na	-	-	-	-	-	-
4,4'-DDD	ug/L	L1	1	na	-	-	-	-	-	-
4,4'-DDE	ug/L	L1	1	na	-	-	-	-	-	-
4,6-Dinitro-2-methylphenol	ug/L	L1	500	na	-	-	-	-	-	-
4-Bromophenyl-phenylether	ug/L	L1	100	na	-	-	-	-	-	-
4-Chlorophenyl-phenylether	ug/L	L1	100	na	-	-	-	-	-	-
4-Chlorotoluene	ug/L	L1	50	2.5	5.00E-05	PASS	4.27E-14	PASS	0.16075	PASS
4-Methyl-2-pentanone (MIBK)	ug/L	L1	170	5	1.70E-04	PASS	1.45E-13	PASS	0.54655	PASS
4-Methylphenol	ug/L	L1	1500	5	1.50E-03	PASS	1.28E-12	PASS	4.8225	PASS
4-Nitrophenol	ug/L	L1	500	na	-	-	-	-	-	-
Acenaphthene	ug/L	L1	100	1	1.00E-04	PASS	8.54E-14	PASS	0.3215	PASS
Acetone	ug/L	L1	2800	5	2.80E-03	PASS	2.39E-12	PASS	0[5]	PASS
Alachlor	ug/L	L1	4	0.0445	4.00E-06	PASS	3.42E-15	PASS	0.01286	PASS
Aldicarb	ug/L	L1	17	1.725	1.70E-05	PASS	1.45E-14	PASS	0.054655	PASS
Aldrin	ug/L	L1	0.5	0.025	5.00E-07	PASS	4.27E-16	PASS	0.0016075	PASS
Alkalinity, bicarbonate	mg/L	L1	5400	na	-	-	-	-	-	-
alpha-BHC	ug/L	L1	0.5	0.05	5.00E-07	PASS	4.27E-16	PASS	0.0016075	PASS
Aluminum, total	ug/L	L1	24000	968966	2.40E-02	PASS	2.05E-11	PASS	77.16	PASS
Ammonia as N, total	mg/L	L1	850	0.346	8.50E-04	PASS	7.26E-13	PASS	0.0009376[1]	PASS
Anthracene	ug/L	L1	100	1	1.00E-04	PASS	8.54E-14	PASS	0.3215	PASS
Antimony, total	ug/L	L1	60	30	6.00E-05	PASS	5.12E-14	PASS	0.1929	PASS
Arsenic, total	ug/L	L1	540	7.1	5.40E-04	PASS	4.61E-13	PASS	1.7361	PASS
Atrazine	ug/L	L1	9.7	0.151	9.70E-06	PASS	8.28E-15	PASS	0.0311855	PASS
Barium, total	ug/L	L1	1400	222	1.40E-03	PASS	1.20E-12	PASS	4.501	PASS
Benzene	ug/L	L1	50	2.5	5.00E-05	PASS	4.27E-14	PASS	0.16075	PASS
Benzo(a)anthracene	ug/L	L1	100	0.13	1.00E-04	PASS	8.54E-14	PASS	0[2]	PASS
Benzo(a)pyrene	ug/L	L1	100	5	1.00E-04	PASS	8.54E-14	PASS	0.3215	PASS
Benzo(b)fluoranthene	ug/L	L1	100	0.18	1.00E-04	PASS	8.54E-14	PASS	0[2]	PASS
Benzo(g,h,i)perylene	ug/L	L1	100	na	-	-	-	-	-	-
Benzo(k)fluoranthene	ug/L	L1	100	0.17	1.00E-04	PASS	8.54E-14	PASS	0[2]	PASS

Parameter	Units	List	Max	AGQS	Existing Unit MPF = 1.0002E-06		South Unit MPF = 8.5377E-16		Northwest Unit MPF = 3.215E-03	
Beryllium, total	ug/L	L1	20	5	2.00E-05	PASS	1.71E-14	PASS	0.0643	PASS
beta-BHC	ug/L	L1	0.5	na	-	-	-	-	-	-
Biochemical Oxygen Demand	mg/L	L1	29700	6.5	-	-	-	-	-	-
bis(2-chloroethoxy)methane	ug/L	L1	100	na	-	-	-	-	-	-
bis(2-chloroethyl)ether	ug/L	L1	100	na	-	-	-	-	-	-
bis(2-chloroisopropyl)ether	ug/L	L1	100	na	-	-	-	-	-	-
bis(2-ethylhexyl)phthalate	ug/L	L1	100	1	1.00E-04	PASS	8.54E-14	PASS	0.3215	PASS
bis(chloromethyl)ether	ug/L	L1	100000	na	-	-	-	-	-	-
Boron, total	ug/L	L1	9700	504	9.70E-03	PASS	8.28E-12	PASS	31.1855	PASS
Bromobenzene	ug/L	L1	50	2.5	5.00E-05	PASS	4.27E-14	PASS	0.16075	PASS
Bromochloromethane	ug/L	L1	50	2.5	5.00E-05	PASS	4.27E-14	PASS	0.16075	PASS
Bromodichloromethane	ug/L	L1	50	2.5	5.00E-05	PASS	4.27E-14	PASS	0.16075	PASS
Bromoform	ug/L	L1	50	2.5	5.00E-05	PASS	4.27E-14	PASS	0.16075	PASS
Bromomethane	ug/L	L1	50	2.5	5.00E-05	PASS	4.27E-14	PASS	0.16075	PASS
Butanol	ug/L	L1	10000	na	-	-	-	-	-	-
Butylbenzylphthalate	ug/L	L1	100	na	-	-	-	-	-	-
Cadmium, total	ug/L	L1	4.5	3.1	4.50E-06	PASS	3.84E-15	PASS	0.0144675	PASS
Calcium, total	mg/L	L1	690	295.81	6.90E-04	PASS	5.89E-13	PASS	2.21835	PASS
Carbofuran	ug/L	L1	15	2.03	1.50E-05	PASS	1.28E-14	PASS	0.048225	PASS
Carbon Disulfide	ug/L	L1	50	5	5.00E-05	PASS	4.27E-14	PASS	0.16075	PASS
Carbon Tetrachloride	ug/L	L1	50	2.5	5.00E-05	PASS	4.27E-14	PASS	0.16075	PASS
Chemical Oxygen Demand	mg/L	L1	37400	28	-	-	-	-	-	-
Chlordane	ug/L	L1	10	0.05	1.00E-05	PASS	8.54E-15	PASS	0.03215	PASS
Chloride, total	mg/L	L1	3700	211.53	3.70E-03	PASS	3.16E-12	PASS	11.8955	PASS
Chlorobenzene	ug/L	L1	50	2.5	5.00E-05	PASS	4.27E-14	PASS	0.16075	PASS
Chloroethane	ug/L	L1	50	2.5	5.00E-05	PASS	4.27E-14	PASS	0.16075	PASS
Chloroform	ug/L	L1	50	2.5	5.00E-05	PASS	4.27E-14	PASS	0.16075	PASS
Chloromethane	ug/L	L1	50	5	5.00E-05	PASS	4.27E-14	PASS	0.16075	PASS
Chromium, total	ug/L	L1	99	64.5	9.90E-05	PASS	8.45E-14	PASS	0.318285	PASS
Chrysene	ug/L	L1	100	1	1.00E-04	PASS	8.54E-14	PASS	0.3215	PASS
cis-1,2-Dichloroethene	ug/L	L1	200	2.5	2.00E-04	PASS	1.71E-13	PASS	0.643	PASS
Cobalt, total	ug/L	L1	42	48.1	4.20E-05	PASS	3.59E-14	PASS	0.13503	PASS
Copper, total	ug/L	L1	53	97.5	5.30E-05	PASS	4.52E-14	PASS	0.170395	PASS
Cyanide, total	mg/L	L1	0.0091	0.0066	9.10E-09	PASS	7.77E-18	PASS	2.9257E-05	PASS
DDT	ug/L	L1	1	0.05	1.00E-06	PASS	8.54E-16	PASS	0.003215	PASS
delta-BHC	ug/L	L1	1.1	na	-	-	-	-	-	-
Dibenzo(a,h)anthracene	ug/L	L1	100	0.3	1.00E-04	PASS	8.54E-14	PASS	0^2	PASS
Dibromochloromethane	ug/L	L1	50	5	5.00E-05	PASS	4.27E-14	PASS	0.16075	PASS
Dibromomethane	ug/L	L1	50	5	5.00E-05	PASS	4.27E-14	PASS	0.16075	PASS
Dichlorodifluoromethane	ug/L	L1	50	2.5	5.00E-05	PASS	4.27E-14	PASS	0.16075	PASS
Dieldrin	ug/L	L1	1	0.025	1.00E-06	PASS	8.54E-16	PASS	0.003215	PASS
Diethylphthalate	ug/L	L1	100	5	1.00E-04	PASS	8.54E-14	PASS	0.3215	PASS
Dimethylphthalate	ug/L	L1	100	5	1.00E-04	PASS	8.54E-14	PASS	0.3215	PASS
Di-n-butylphthalate	ug/L	L1	100	5	1.00E-04	PASS	8.54E-14	PASS	0.3215	PASS
Di-n-octylphthalate	ug/L	L1	100	na	-	-	-	-	-	-
Endosulfan I	ug/L	L1	1	na	-	-	-	-	-	-
Endosulfan II	ug/L	L1	1	na	-	-	-	-	-	-
Endosulfan Sulfate	ug/L	L1	1	na	-	-	-	-	-	-
Endrin	ug/L	L1	1	0.05	1.00E-06	PASS	8.54E-16	PASS	0.003215	PASS
Endrin Aldehyde	ug/L	L1	1	na	-	-	-	-	-	-
Ethyl Acetate	ug/L	L1	540	na	-	-	-	-	-	-
Ethylbenzene	ug/L	L1	50	2.5	5.00E-05	PASS	4.27E-14	PASS	0.16075	PASS
Fecal Coliform Bacteria	/100 mL	L1	60000	na	-	-	-	-	-	-
Fluoranthene	ug/L	L1	100	1	1.00E-04	PASS	8.54E-14	PASS	0.3215	PASS
Fluorene	ug/L	L1	100	1	1.00E-04	PASS	8.54E-14	PASS	0.3215	PASS
Fluoride, total	mg/L	L1	2.5	0.4485	2.50E-06	PASS	2.13E-15	PASS	0.0080375	PASS
gamma-BHC (Lindane)	ug/L	L1	0.5	0.025	5.00E-07	PASS	4.27E-16	PASS	0.0016075	PASS
Heptachlor	ug/L	L1	0.5	0.025	5.00E-07	PASS	4.27E-16	PASS	0.0016075	PASS
Heptachlor Epoxide	ug/L	L1	0.5	0.5	5.00E-07	PASS	4.27E-16	PASS	0.0016075	PASS
Hexachlorobenzene	ug/L	L1	100	na	-	-	-	-	-	-
Hexachlorobutadiene	ug/L	L1	100	2.5	1.00E-04	PASS	8.54E-14	PASS	0.3215	PASS
Hexachlorocyclopentadiene	ug/L	L1	100	0.5	1.00E-04	PASS	8.54E-14	PASS	0.3215	PASS
Hexachloroethane	ug/L	L1	100	na	-	-	-	-	-	-
Indeno(1,2,3-cd)pyrene	ug/L	L1	100	0.4	1.00E-04	PASS	8.54E-14	PASS	0.3215	PASS
Iodomethane	ug/L	L1	50	5	5.00E-05	PASS	4.27E-14	PASS	0.16075	PASS
Iron, total	ug/L	L1	1400000	29727.6	1.40E+00	PASS	1.20E-09	PASS	4501	PASS
Isopropylbenzene	ug/L	L1	50	2.5	5.00E-05	PASS	4.27E-14	PASS	0.16075	PASS
Lead, total	ug/L	L1	14	31	1.40E-05	PASS	1.20E-14	PASS	0.04501	PASS
m&p-Xylene	ug/L	L1	100	2.5	1.00E-04	PASS	8.54E-14	PASS	0.3215	PASS

Parameter	Units	List	Max	AGQS	Existing Unit MPF = 1.0002E-06		South Unit MPF = 8.5377E-16		Northwest Unit MPF = 3.215E-03	
Magnesium, total	mg/L	L1	170	204.58	1.70E-04	PASS	1.45E-13	PASS	0.54655	PASS
Manganese, total	ug/L	L1	48000	4849	4.80E-02	PASS	4.10E-11	PASS	154.32	PASS
Mercury, total	ug/L	L1	0.9	0.1	9.00E-07	PASS	7.68E-16	PASS	0.0028935	PASS
Methoxychlor	ug/L	L1	5	1	5.00E-06	PASS	4.27E-15	PASS	0.016075	PASS
Methylene Chloride	ug/L	L1	1900	2.5	1.90E-03	PASS	1.62E-12	PASS	3.33E-23[3]	PASS
Naphthalene	ug/L	L1	100	5	1.00E-04	PASS	8.54E-14	PASS	0.3215	PASS
n-Butylbenzene	ug/L	L1	50	2.5	5.00E-05	PASS	4.27E-14	PASS	0.16075	PASS
Nickel, total	ug/L	L1	240	41.5	2.40E-04	PASS	2.05E-13	PASS	0.7716	PASS
Nitrate as N, total	mg/L	L1	3.7	4.474	3.70E-06	PASS	3.16E-15	PASS	0.0118955	PASS
Nitrobenzene	ug/L	L1	100	na	-	-	-	-	-	-
N-Nitrosodimethylamine	ug/L	L1	100	na	-	-	-	-	-	-
N-Nitroso-di-n-propylamine	ug/L	L1	100	na	-	-	-	-	-	-
N-Nitrosodiphenylamine	ug/L	L1	100	na	-	-	-	-	-	-
n-Propylbenzene	ug/L	L1	50	2.5	5.00E-05	PASS	4.27E-14	PASS	0.16075	PASS
Oil (Hexane Soluble)	mg/L	L1	912	5	9.12E-04	PASS	7.79E-13	PASS	2.93208	PASS
o-Xylene	ug/L	L1	50	2.5	5.00E-05	PASS	4.27E-14	PASS	0.16075	PASS
Parathion	ug/L	L1	50	5	5.00E-05	PASS	4.27E-14	PASS	0.16075	PASS
Pentachlorophenol	ug/L	L1	50	25	5.00E-05	PASS	4.27E-14	PASS	0.16075	PASS
pH (field)	s.u.	L1	7.76	6.39 - 7.87	-	-	-	-	-	-
Phenanthrene	ug/L	L1	100	na	-	-	-	-	-	-
Phenolics	ug/L	L1	6700	12.2	6.70E-03	PASS	5.72E-12	PASS	0[6]	PASS
Phosphorus, total	mg/L	L1	1200	na	-	-	-	-	-	-
p-Isopropyltoluene	ug/L	L1	50	2.5	5.00E-05	PASS	4.27E-14	PASS	0.16075	PASS
Polychlorinated Biphenyls(PCBs)	ug/L	L1	10	25	1.00E-05	PASS	8.54E-15	PASS	0.03215	PASS
Potassium, total	mg/L	L1	600	5.796	6.00E-04	PASS	5.12E-13	PASS	1.929	PASS
Pyrene	ug/L	L1	100	1	1.00E-04	PASS	8.54E-14	PASS	0.3215	PASS
sec-Butylbenzene	ug/L	L1	500	2.5	5.00E-04	PASS	4.27E-13	PASS	1.6075	PASS
Selenium, total	ug/L	L1	99	2.7	9.90E-05	PASS	8.45E-14	PASS	0.318285	PASS
Silver, total	ug/L	L1	50	5	5.00E-05	PASS	4.27E-14	PASS	0.16075	PASS
Sodium, total	mg/L	L1	2700	212.69	2.70E-03	PASS	2.31E-12	PASS	8.6805	PASS
Specific Conductance (field)	umhos/cm	L1	24000	5600	-	-	-	-	-	-
Styrene	ug/L	L1	50	2.5	5.00E-05	PASS	4.27E-14	PASS	0.16075	PASS
Sulfate, total	mg/L	L1	1100	720.25	1.10E-03	PASS	9.39E-13	PASS	3.5365	PASS
tert-Butylbenzene	ug/L	L1	50	2.5	5.00E-05	PASS	4.27E-14	PASS	0.16075	PASS
Tetrachlorodibenzo-p-Dioxins	ug/L	L1	500	na	-	-	-	-	-	-
Tetrachloroethene	ug/L	L1	50	2.5	5.00E-05	PASS	4.27E-14	PASS	0.16075	PASS
Tetrahydrofuran	ug/L	L1	1200	2.5	1.20E-03	PASS	1.02E-12	PASS	0[4]	PASS
Thallium, total	ug/L	L1	4.5	5	4.50E-06	PASS	3.84E-15	PASS	0.0144675	PASS
Tin, total	ug/L	L1	270	na	-	-	-	-	-	-
Toluene	ug/L	L1	110	2.5	1.10E-04	PASS	9.39E-14	PASS	0.35365	PASS
Total Dissolved Solids	mg/L	L1	34000	2237.9	-	-	-	-	-	-
Total Organic Carbon	mg/L	L1	1800	10.27	-	-	-	-	-	-
Total Suspended Solids	mg/L	L1	390	na	-	-	-	-	-	-
Toxaphene	ug/L	L1	10	1	1.00E-05	PASS	8.54E-15	PASS	0.03215	PASS
trans-1,2-Dichloroethene	ug/L	L1	200	2.5	2.00E-04	PASS	1.71E-13	PASS	0.643	PASS
trans-1,3-Dichloropropene	ug/L	L1	50	5	5.00E-05	PASS	4.27E-14	PASS	0.16075	PASS
trans-1,4-Dichloro-2-Butene	ug/L	L1	50	1	5.00E-05	PASS	4.27E-14	PASS	0.16075	PASS
Trichloroethene	ug/L	L1	50	2.5	5.00E-05	PASS	4.27E-14	PASS	0.16075	PASS
Trichlorofluoromethane	ug/L	L1	50	2.5	5.00E-05	PASS	4.27E-14	PASS	0.16075	PASS
Vinyl Acetate	ug/L	L1	50	2.5	5.00E-05	PASS	4.27E-14	PASS	0.16075	PASS
Vinyl Chloride	ug/L	L1	50	2.5	5.00E-05	PASS	4.27E-14	PASS	0.16075	PASS
Xylenes (Total)	ug/L	L1	150	2.5	1.50E-04	PASS	1.28E-13	PASS	0.48225	PASS
Zinc, total	ug/L	L1	2400	297.8	2.40E-03	PASS	2.05E-12	PASS	7.716	PASS

NOTES:

1 - Surrogate 1, MPF = 1.103e-6
2 - Surrogate 2, MPF = 0
3 - Surrogate 3, MPF = 1.754e-26
4 - Surrogate 4, MPF = 0
5 - Surrogate 5, MPF = 0
6 - Surrogate 6, MPF = 0

Parameter	Units	AGQS	MAPC
1,1,1,2-Tetrachloroethane	ug/L	2.5	2.5
1,1,1-Trichloroethane	ug/L	2.5	2.5
1,1,2,2-Tetrachloroethane	ug/L	2.5	2.5
1,1,2-Trichloroethane	ug/L	2.5	2.5
1,1-Dichloroethane	ug/L	2.5	2.5
1,1-Dichloroethene	ug/L	2.5	2.5
1,1-Dichloropropene	ug/L	2.5	2.5
1,2,3-Trichlorobenzene	ug/L	2.5	2.5
1,2,3-Trichloropropane	ug/L	2.5	2.5
1,2,4-Trichlorobenzene	ug/L	2.5	2.5
1,2,4-Trimethylbenzene	ug/L	2.5	2.5
1,2-Dibromo-3-chloropropane	ug/L	2.5	2.5
1,2-Dibromoethane	ug/L	0.05	0.05
1,2-Dichlorobenzene	ug/L	2.5	2.5
1,2-Dichloroethane	ug/L	2.5	2.5
1,2-Dichloropropane	ug/L	2.5	2.5
1,3,5-Trimethylbenzene	ug/L	2.5	2.5
1,3-Dichlorobenzene	ug/L	2.5	2.5
1,3-Dichloropropane	ug/L	2.5	2.5
1,3-Dichloropropene	ug/L	2.5	2.5
1,4-Dichlorobenzene	ug/L	2.5	2.5
1-Propanol	ug/L	na	na
2,2-Dichloropropane	ug/L	2.5	2.5
2,4,5-TP (Silvex)	ug/L	1	1
2,4,6-Trichlorophenol	ug/L	na	na
2,4-D	ug/L	5	5
2,4-Dichlorophenol	ug/L	na	na
2,4-Dimethylphenol	ug/L	na	na
2,4-Dinitrophenol	ug/L	na	na
2,4-Dinitrotoluene	ug/L	na	na
2,6-Dinitrotoluene	ug/L	na	na
2-Butanone (MEK)	ug/L	5	5
2-Chloroethyl vinyl ether	ug/L	na	na
2-Chloronaphthalene	ug/L	na	na
2-Chlorophenol	ug/L	na	na
2-Chlorotoluene	ug/L	2.5	2.5
2-Hexanone (MBK)	ug/L	5	5
2-Nitrophenol	ug/L	na	na
2-Propanol	ug/L	na	na
3,3'-Dichlorobenzidine	ug/L	na	na
4,4'-DDD	ug/L	na	na
4,4'-DDE	ug/L	na	na
4,6-Dinitro-2-methylphenol	ug/L	na	na
4-Bromophenyl-phenylether	ug/L	na	na
4-Chlorophenyl-phenylether	ug/L	na	na
4-Chlorotoluene	ug/L	2.5	2.5
4-Methyl-2-pentanone (MIBK)	ug/L	5	5
4-Methylphenol	ug/L	5	5
4-Nitrophenol	ug/L	na	na
Acenaphthene	ug/L	1	1
Acetone	ug/L	5	5
Alachlor	ug/L	0.0445	0.0445
Aldicarb	ug/L	1.725	1.725
Aldrin	ug/L	0.025	0.025
Alkalinity, bicarbonate	mg/L	na	na
alpha-BHC	ug/L	0.05	0.05
Aluminum, total	ug/L	968966	968966
Ammonia as N, total	mg/L	0.346	0.346
Anthracene	ug/L	1	1
Antimony, total	ug/L	30	30
Arsenic, total	ug/L	7.1	7.1
Atrazine	ug/L	0.151	0.151
Barium, total	ug/L	222	222
Benzene	ug/L	2.5	2.5
Benzo(a)anthracene	ug/L	0.13	0.13
Benzo(a)pyrene	ug/L	5	5

Parameter	Units	AGQS	MAPC
Benzo(b)fluoranthene	ug/L	0.18	0.18
Benzo(g,h,i)perylene	ug/L	na	na
Benzo(k)fluoranthene	ug/L	0.17	0.17
Beryllium, total	ug/L	5	5
beta-BHC	ug/L	na	na
Biochemical Oxygen Demand	mg/L	6.5	6.5
bis(2-chloroethoxy)methane	ug/L	na	na
bis(2-chloroethyl)ether	ug/L	na	na
bis(2-chloroisopropyl)ether	ug/L	na	na
bis(2-ethylhexyl)phthalate	ug/L	1	1
bis(chloromethyl)ether	ug/L	na	na
Boron, total	ug/L	504	504
Bromobenzene	ug/L	2.5	2.5
Bromochloromethane	ug/L	2.5	2.5
Bromodichloromethane	ug/L	2.5	2.5
Bromoform	ug/L	2.5	2.5
Bromomethane	ug/L	2.5	2.5
Butanol	ug/L	na	na
Butylbenzylphthalate	ug/L	na	na
Cadmium, total	ug/L	3.1	3.1
Calcium, total	mg/L	295.81	295.81
Carbofuran	ug/L	2.03	2.03
Carbon Disulfide	ug/L	5	5
Carbon Tetrachloride	ug/L	2.5	2.5
Chemical Oxygen Demand	mg/L	28	28
Chlordane	ug/L	0.05	0.05
Chloride, total	mg/L	211.53	211.53
Chlorobenzene	ug/L	2.5	2.5
Chloroethane	ug/L	2.5	2.5
Chloroform	ug/L	2.5	2.5
Chloromethane	ug/L	5	5
Chromium, total	ug/L	64.5	64.5
Chrysene	ug/L	1	1
cis-1,2-Dichloroethene	ug/L	2.5	2.5
Cobalt, total	ug/L	48.1	48.1
Copper, total	ug/L	97.5	97.5
Cyanide, total	mg/L	0.0066	0.0066
DDT	ug/L	0.05	0.05
delta-BHC	ug/L	na	na
Dibenzo(a,h)anthracene	ug/L	0.3	0.3
Dibromochloromethane	ug/L	5	5
Dibromomethane	ug/L	5	5
Dichlorodifluoromethane	ug/L	2.5	2.5
Dieldrin	ug/L	0.025	0.025
Diethylphthalate	ug/L	5	5
Dimethylphthalate	ug/L	5	5
Di-n-butylphthalate	ug/L	5	5
Di-n-octylphthalate	ug/L	na	na
Endosulfan I	ug/L	na	na
Endosulfan II	ug/L	na	na
Endosulfan Sulfate	ug/L	na	na
Endrin	ug/L	0.05	0.05
Endrin Aldehyde	ug/L	na	na
Ethyl Acetate	ug/L	na	na
Ethylbenzene	ug/L	2.5	2.5
Fecal Coliform Bacteria	/100 mL	na	na
Fluoranthene	ug/L	1	1
Fluorene	ug/L	1	1
Fluoride, total	mg/L	0.4485	0.4485
gamma-BHC (Lindane)	ug/L	0.025	0.025
Heptachlor	ug/L	0.025	0.025
Heptachlor Epoxide	ug/L	0.5	0.5
Hexachlorobenzene	ug/L	na	na
Hexachlorobutadiene	ug/L	2.5	2.5
Hexachlorocyclopentadiene	ug/L	0.5	0.5
Hexachloroethane	ug/L	na	na

Parameter	Units	AGQS	MAPC
Indeno(1,2,3-cd)pyrene	ug/L	0.4	0.4
Iodomethane	ug/L	5	5
Iron, total	ug/L	29727.6	29727.6
Isopropylbenzene	ug/L	2.5	2.5
Lead, total	ug/L	31	31
m&p-Xylene	ug/L	2.5	2.5
Magnesium, total	mg/L	204.58	204.58
Manganese, total	ug/L	4849	4849
Mercury, total	ug/L	0.1	0.1
Methoxychlor	ug/L	1	1
Methylene Chloride	ug/L	2.5	2.5
Naphthalene	ug/L	5	5
n-Butylbenzene	ug/L	2.5	2.5
Nickel, total	ug/L	41.5	41.5
Nitrate as N, total	mg/L	4.474	4.474
Nitrobenzene	ug/L	na	na
N-Nitrosodimethylamine	ug/L	na	na
N-Nitroso-di-n-propylamine	ug/L	na	na
N-Nitrosodiphenylamine	ug/L	na	na
n-Propylbenzene	ug/L	2.5	2.5
Oil (Hexane Soluble)	mg/L	5	5
o-Xylene	ug/L	2.5	2.5
Parathion	ug/L	5	5
Pentachlorophenol	ug/L	25	25
pH (field)	s.u.	6.39 - 7.87	6.39 - 7.87
Phenanthrene	ug/L	na	na
Phenolics	ug/L	12.2	12.2
Phosphorus, total	mg/L	na	na
p-Isopropyltoluene	ug/L	2.5	2.5
Polychlorinated Biphenyls(PCBs)	ug/L	25	25
Potassium, total	mg/L	5.796	5.796
Pyrene	ug/L	1	1
sec-Butylbenzene	ug/L	2.5	2.5
Selenium, total	ug/L	2.7	2.7
Silver, total	ug/L	5	5
Sodium, total	mg/L	212.69	212.69
Specific Conductance (field)	umhos/cm	5600	5600
Styrene	ug/L	2.5	2.5
Sulfate, total	mg/L	720.25	720.25
tert-Butylbenzene	ug/L	2.5	2.5
Tetrachlorodibenzo-p-Dioxins	ug/L	na	na
Tetrachloroethene	ug/L	2.5	2.5
Tetrahydrofuran	ug/L	2.5	2.5
Thallium, total	ug/L	5	5
Tin, total	ug/L	na	na
Toluene	ug/L	2.5	2.5
Total Dissolved Solids	mg/L	2237.9	2237.9
Total Organic Carbon	mg/L	10.27	10.27
Total Suspended Solids	mg/L	na	na
Toxaphene	ug/L	1	1
trans-1,2-Dichloroethene	ug/L	2.5	2.5
trans-1,3-Dichloropropene	ug/L	5	5
trans-1,4-Dichloro-2-Butene	ug/L	1	1
Trichloroethene	ug/L	2.5	2.5
Trichlorofluoromethane	ug/L	2.5	2.5
Vinyl Acetate	ug/L	2.5	2.5
Vinyl Chloride	ug/L	2.5	2.5
Xylenes (Total)	ug/L	2.5	2.5
Zinc, total	ug/L	297.8	297.8

Parameter	Units	AGQS	MAPC
1,1,1,2-Tetrachloroethane	ug/L	2.5	2.93
1,1,1-Trichloroethane	ug/L	2.5	2.93
1,1,2,2-Tetrachloroethane	ug/L	2.5	2.93
1,1,2-Trichloroethane	ug/L	2.5	2.93
1,1-Dichloroethane	ug/L	2.5	2.93
1,1-Dichloroethene	ug/L	2.5	2.93
1,1-Dichloropropene	ug/L	2.5	2.93
1,2,3-Trichlorobenzene	ug/L	2.5	2.93
1,2,3-Trichloropropane	ug/L	2.5	2.93
1,2,4-Trichlorobenzene	ug/L	2.5	2.93
1,2,4-Trimethylbenzene	ug/L	2.5	2.93
1,2-Dibromo-3-chloropropane	ug/L	2.5	2.93
1,2-Dibromoethane	ug/L	0.05	0.59[2]
1,2-Dichlorobenzene	ug/L	2.5	2.93
1,2-Dichloroethane	ug/L	2.5	2.93
1,2-Dichloropropane	ug/L	2.5	2.93
1,3,5-Trimethylbenzene	ug/L	2.5	2.93
1,3-Dichlorobenzene	ug/L	2.5	2.93
1,3-Dichloropropane	ug/L	2.5	2.93
1,3-Dichloropropene	ug/L	2.5	2.93
1,4-Dichlorobenzene	ug/L	2.5	2.93
1-Propanol	ug/L	na	na
2,2-Dichloropropane	ug/L	2.5	2.93
2,4,5-TP (Silvex)	ug/L	1	1.17
2,4,6-Trichlorophenol	ug/L	na	na
2,4-D	ug/L	5	5.85
2,4-Dichlorophenol	ug/L	na	na
2,4-Dimethylphenol	ug/L	na	na
2,4-Dinitrophenol	ug/L	na	na
2,4-Dinitrotoluene	ug/L	na	na
2,6-Dinitrotoluene	ug/L	na	na
2-Butanone (MEK)	ug/L	5	5[3]
2-Chloroethyl vinyl ether	ug/L	na	na
2-Chloronaphthalene	ug/L	na	na
2-Chlorophenol	ug/L	na	na
2-Chlorotoluene	ug/L	2.5	2.93
2-Hexanone (MBK)	ug/L	5	5.85
2-Nitrophenol	ug/L	na	na
2-Propanol	ug/L	na	na
3,3'-Dichlorobenzidine	ug/L	na	na
4,4'-DDD	ug/L	na	na
4,4'-DDE	ug/L	na	na
4,6-Dinitro-2-methylphenol	ug/L	na	na
4-Bromophenyl-phenylether	ug/L	na	na
4-Chlorophenyl-phenylether	ug/L	na	na
4-Chlorotoluene	ug/L	2.5	2.93
4-Methyl-2-pentanone (MIBK)	ug/L	5	5.85
4-Methylphenol	ug/L	5	5.85
4-Nitrophenol	ug/L	na	na
Acenaphthene	ug/L	1	1.17
Acetone	ug/L	5	5[3]
Alachlor	ug/L	0.0445	0.0521
Aldicarb	ug/L	1.725	2.02
Aldrin	ug/L	0.025	0.0293
Alkalinity, bicarbonate	mg/L	na	na
alpha-BHC	ug/L	0.05	0.0585
Aluminum, total	ug/L	968966	1133690
Ammonia as N, total	mg/L	0.346	0.391[1]
Anthracene	ug/L	1	1.17
Antimony, total	ug/L	30	35.1
Arsenic, total	ug/L	7.1	8.31
Atrazine	ug/L	0.151	0.177
Barium, total	ug/L	222	260
Benzene	ug/L	2.5	2.93
Benzo(a)anthracene	ug/L	0.13	0.13[3]
Benzo(a)pyrene	ug/L	5	5.85
Benzo(b)fluoranthene	ug/L	0.18	0.18[3]

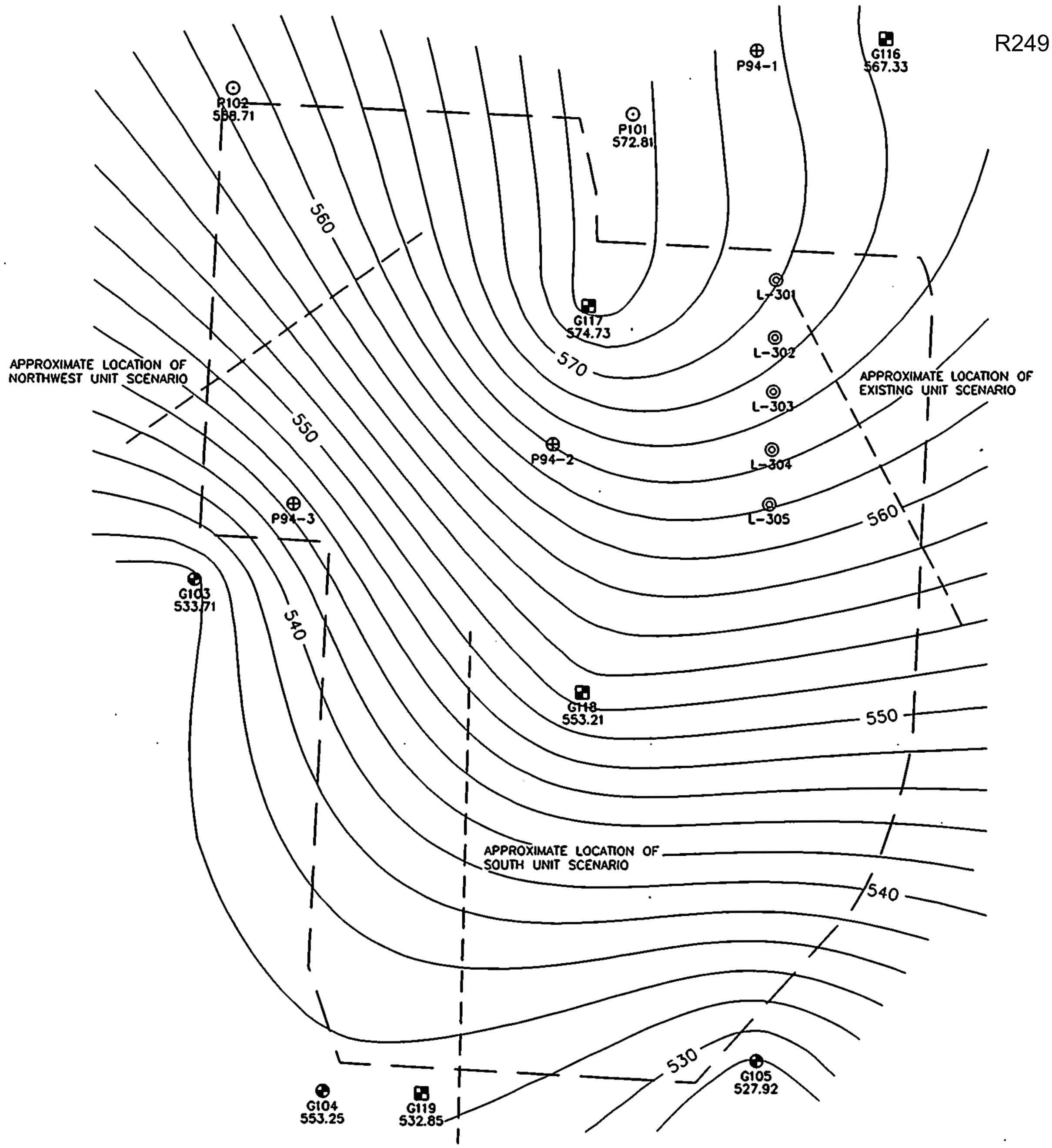
Parameter	Units	AGQS	MAPC
Benzo(g,h,i)perylene	ug/L	na	na
Benzo(k)fluoranthene	ug/L	0.17	0.17[3]
Beryllium, total	ug/L	5	5.85
beta-BHC	ug/L	na	na
Biochemical Oxygen Demand	mg/L	6.5	6.5[4]
bis(2-chloroethoxy)methane	ug/L	na	na
bis(2-chloroethyl)ether	ug/L	na	na
bis(2-chloroisopropyl)ether	ug/L	na	na
bis(2-ethylhexyl)phthalate	ug/L	1	1.17
bis(chloromethyl)ether	ug/L	na	na
Boron, total	ug/L	504	590
Bromobenzene	ug/L	2.5	2.93
Bromochloromethane	ug/L	2.5	2.93
Bromodichloromethane	ug/L	2.5	2.93
Bromoform	ug/L	2.5	2.93
Bromomethane	ug/L	2.5	2.93
Butanol	ug/L	na	na
Butylbenzylphthalate	ug/L	na	na
Cadmium, total	ug/L	3.1	3.63
Calcium, total	mg/L	295.81	346
Carbofuran	ug/L	2.03	2.38
Carbon Disulfide	ug/L	5	5.85
Carbon Tetrachloride	ug/L	2.5	2.93
Chemical Oxygen Demand	mg/L	28	28[4]
Chlordane	ug/L	0.05	0.0585
Chloride, total	mg/L	211.53	247
Chlorobenzene	ug/L	2.5	2.93
Chloroethane	ug/L	2.5	2.93
Chloroform	ug/L	2.5	2.93
Chloromethane	ug/L	5	5.85
Chromium, total	ug/L	64.5	75.5
Chrysene	ug/L	1	1.17
cis-1,2-Dichloroethene	ug/L	2.5	2.93
Cobalt, total	ug/L	48.1	56.3
Copper, total	ug/L	97.5	114
Cyanide, total	mg/L	0.0066	0.00772
DDT	ug/L	0.05	0.0585
delta-BHC	ug/L	na	na
Dibenzo(a,h)anthracene	ug/L	0.3	0.3[3]
Dibromochloromethane	ug/L	5	5.85
Dibromomethane	ug/L	5	5.85
Dichlorodifluoromethane	ug/L	2.5	2.93
Dieldrin	ug/L	0.025	0.0293
Diethylphthalate	ug/L	5	5.85
Dimethylphthalate	ug/L	5	5.85
Di-n-butylphthalate	ug/L	5	5.85
Di-n-octylphthalate	ug/L	na	na
Endosulfan I	ug/L	na	na
Endosulfan II	ug/L	na	na
Endosulfan Sulfate	ug/L	na	na
Endrin	ug/L	0.05	0.0585
Endrin Aldehyde	ug/L	na	na
Ethyl Acetate	ug/L	na	na
Ethylbenzene	ug/L	2.5	2.93
Fecal Coliform Bacteria	/100 mL	na	na
Fluoranthene	ug/L	1	1.17
Fluorene	ug/L	1	1.17
Fluoride, total	mg/L	0.4485	0.525
gamma-BHC (Lindane)	ug/L	0.025	0.0293
Heptachlor	ug/L	0.025	0.0293
Heptachlor Epoxide	ug/L	0.5	0.585
Hexachlorobenzene	ug/L	na	na
Hexachlorobutadiene	ug/L	2.5	2.93
Hexachlorocyclopentadiene	ug/L	0.5	0.585
Hexachloroethane	ug/L	na	na
Indeno(1,2,3-cd)pyrene	ug/L	0.4	0.468
Iodomethane	ug/L	5	5.85

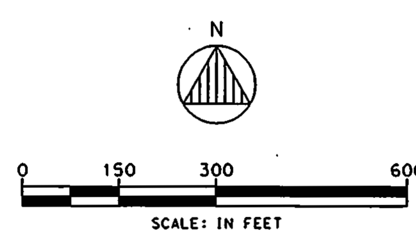
Parameter	Units	AGQS	MAPC
Iron, total	ug/L	29727.6	34781
Isopropylbenzene	ug/L	2.5	2.93
Lead, total	ug/L	31	36.3
m&p-Xylene	ug/L	2.5	2.93
Magnesium, total	mg/L	204.58	239
Manganese, total	ug/L	4849	5,673
Mercury, total	ug/L	0.1	0.117
Methoxychlor	ug/L	1	1.17
Methylene Chloride	ug/L	2.5	2.95[2]
Naphthalene	ug/L	5	5.85
n-Butylbenzene	ug/L	2.5	2.93
Nickel, total	ug/L	41.5	48.6
Nitrate as N, total	mg/L	4.474	5.23
Nitrobenzene	ug/L	na	na
N-Nitrosodimethylamine	ug/L	na	na
N-Nitroso-di-n-propylamine	ug/L	na	na
N-Nitrosodiphenylamine	ug/L	na	na
n-Propylbenzene	ug/L	2.5	2.93
Oil (Hexane Soluble)	mg/L	5	5[4]
o-Xylene	ug/L	2.5	2.93
Parathion	ug/L	5	5.85
Pentachlorophenol	ug/L	25	29.3
pH (field)	s.u.	6.39 - 7.87	6.39 - 7.87[4]
Phenanthrene	ug/L	na	na
Phenolics	ug/L	12.2	12.2[3]
Phosphorus, total	mg/L	na	na
p-Isopropyltoluene	ug/L	2.5	2.93
Polychlorinated Biphenyls(PCBs)	ug/L	25	29.3
Potassium, total	mg/L	5.796	6.78
Pyrene	ug/L	1	1.17
sec-Butylbenzene	ug/L	2.5	2.93
Selenium, total	ug/L	2.7	3.16
Silver, total	ug/L	5	5.85
Sodium, total	mg/L	212.69	249
Specific Conductance (field)	umhos/cm	5600	5600[4]
Styrene	ug/L	2.5	2.93
Sulfate, total	mg/L	720.25	843
tert-Butylbenzene	ug/L	2.5	2.93
Tetrachlorodibenzo-p-Dioxins	ug/L	na	na
Tetrachloroethene	ug/L	2.5	2.93
Tetrahydrofuran	ug/L	2.5	2.5[3]
Thallium, total	ug/L	5	5.85
Tin, total	ug/L	na	na
Toluene	ug/L	2.5	2.93
Total Dissolved Solids	mg/L	2237.9	2237.9[4]
Total Organic Carbon	mg/L	10.27	10.27[4]
Total Suspended Solids	mg/L	na	na
Toxaphene	ug/L	1	1.17
trans-1,2-Dichloroethene	ug/L	2.5	2.93
trans-1,3-Dichloropropene	ug/L	5	5.85
trans-1,4-Dichloro-2-Butene	ug/L	1	1.17
Trichloroethene	ug/L	2.5	2.93
Trichlorofluoromethane	ug/L	2.5	2.93
Vinyl Acetate	ug/L	2.5	2.93
Vinyl Chloride	ug/L	2.5	2.93
Xylenes (Total)	ug/L	2.5	2.93
Zinc, total	ug/L	297.8	348

NOTES:
BASELINE WPF = 1.17
1 - Surrogate 1 WPF = 1.13
2 - Surrogate 3 WPF = 1.18
3 - Surrogates 2, 4, 5 and 6 WPF = 1
4 - Non-Fickian Parameter WPF = 1

FIGURES

R249





WELL #	MEAN LEACHATE HEAD LEVEL	HEAD ABOVE PIEZ. SURFACE	HEAD ABOVE INVERT
L301	583.19'	13.0'	28.2'
L302	584.20'	15.2'	29.2'
L303	581.68'	14.6'	26.6'
L304	573.78'	9.0'	18.6'
L305	570.92'	8.8'	20.9'
AVERAGE	N/A	12.0'	24.8'

ANDREWS
ENGINEERING, INC.
3300 GINGER CREEK DRIVE
SPRINGFIELD, ILLINOIS 62711-7233
PH (217) 787-2334 FAX (217) 787-9495
PONTIAC, IL • LOMBARD, IL • INDIANAPOLIS, IN • WARRENTON, MO
PROFESSIONAL DESIGN ENGINEERING AND LAND SURVEYING FIRM #184-001541

POTENTIOMETRIC SURFACE OF UPPERMOST AQUIFER
SAMPLING DATE: MEAN 5/28/92 - 4/10/95

SIGNIFICANT MODIFICATION TO PERMIT FOR

LANDFILL 33, LTD.

EFFINGHAM COUNTY, ILLINOIS

DATE: AUGUST 2018

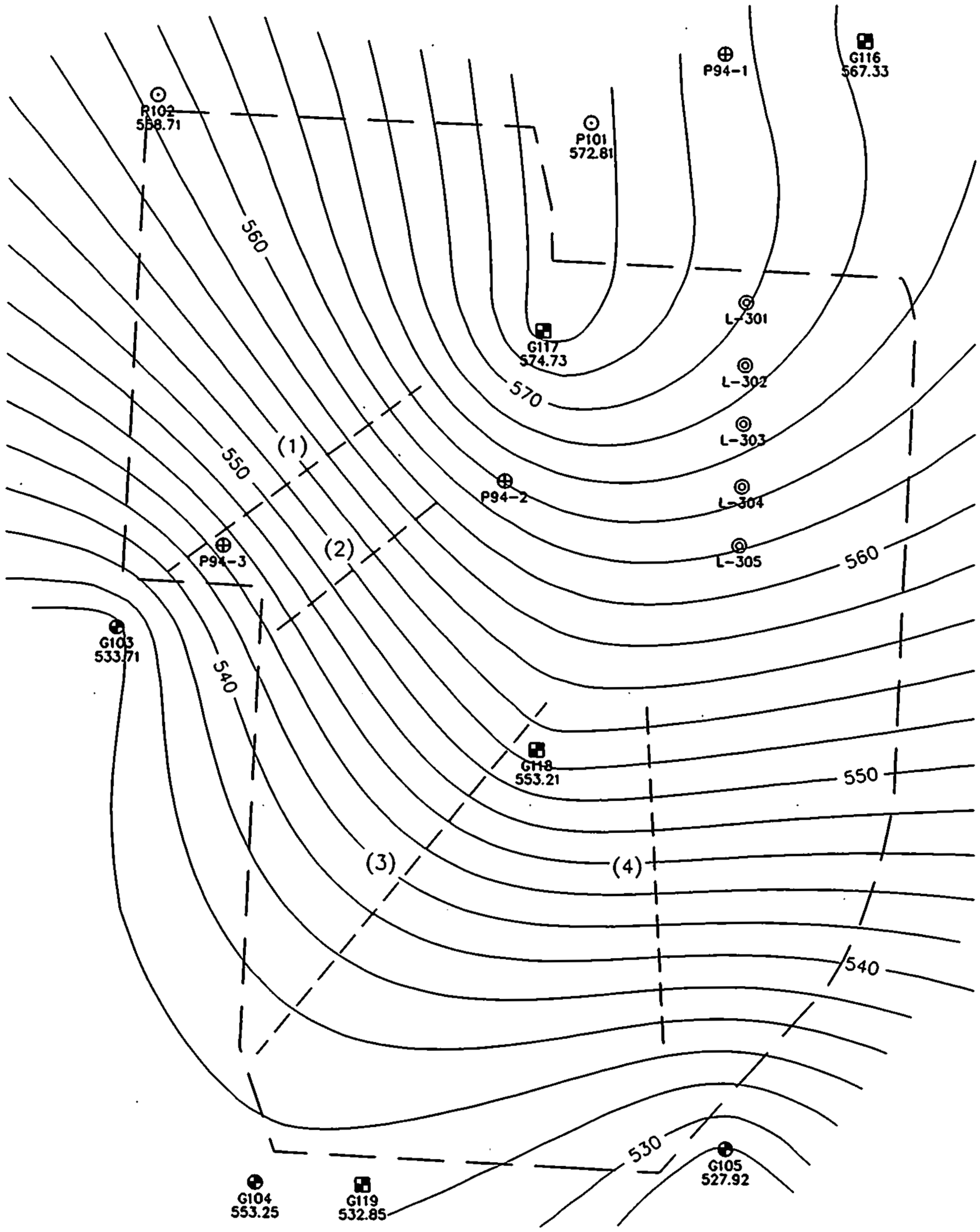
PROJECT ID: 180130/0006

SHEET NUMBER:

FIG. 1

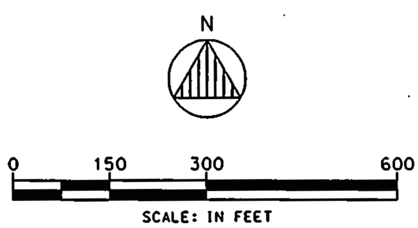
APPROVED BY: MTH | *DESIGNED BY:* TPD | *DRAWN BY:* MPN

R250

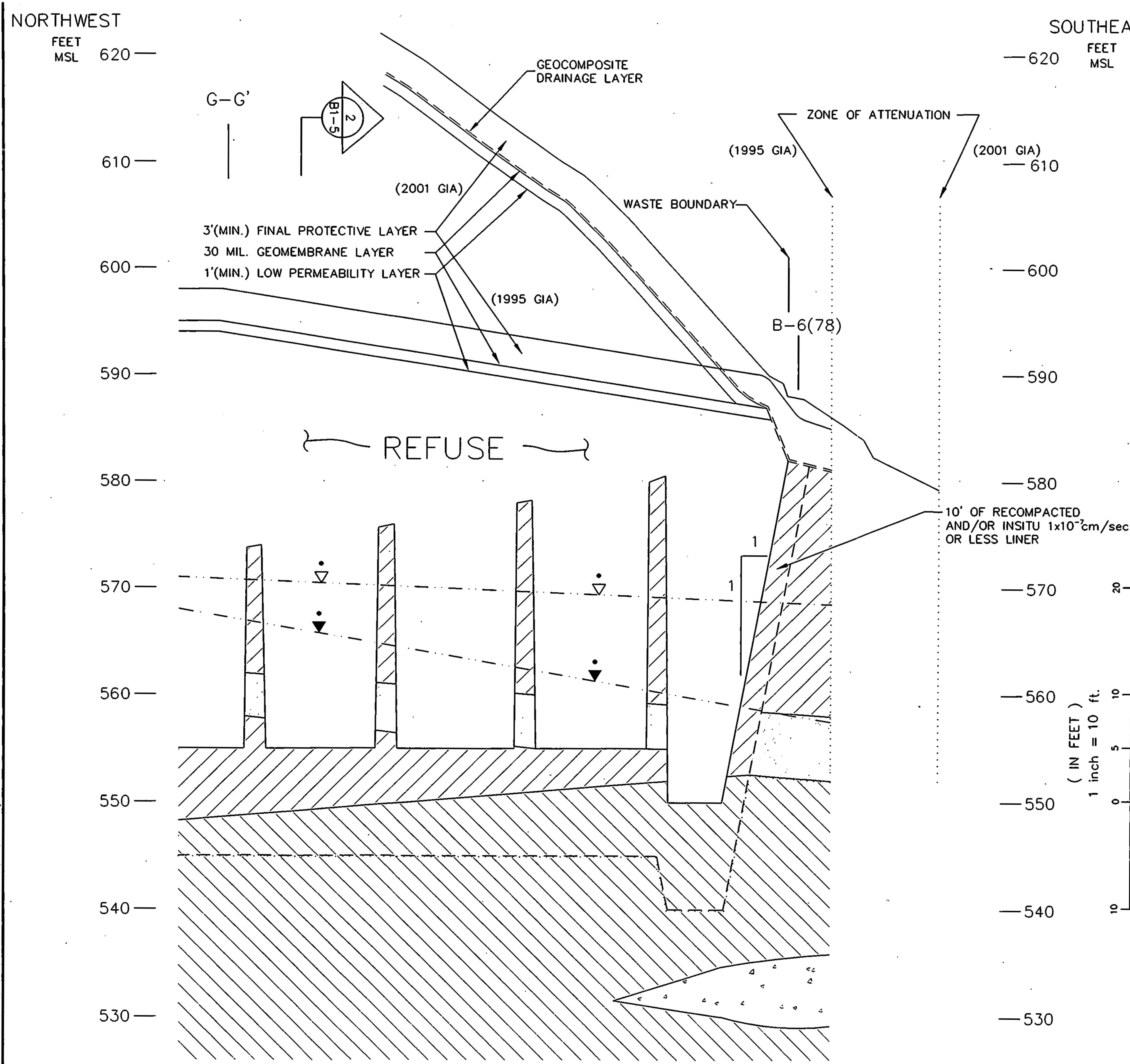


Gradient Calculations i = dh/dl
(1) 25'/510' = 0.04902
(2) 15'/350' = 0.04286
(3) 20'/710' = 0.02817
(4) 20'/530' = 0.03774

Mean = 0.03945



ANDREWS ENGINEERING, INC. 3300 GINGER CREEK DRIVE SPRINGFIELD, ILLINOIS 62711-7233 PH (217) 787-2334 FAX (217) 787-9495 PONTIAC, IL • LOMBARD, IL • INDIANAPOLIS, IN • WARRENTON, MO PROFESSIONAL DESIGN ENGINEERING AND LAND SURVEYING FIRM #184-001541	POTENTIOMETRIC SURFACE OF UPPERMOST AQUIFER SAMPLING DATE: MEAN MAY 92 TO APRIL 95	DATE: AUGUST 2018
	SIGNIFICANT MODIFICATION TO PERMIT FOR LANDFILL 33, LTD. EFFINGHAM COUNTY, ILLINOIS	PROJECT ID: 180130/0006
APPROVED BY: MTH / DESIGNED BY: TPD / DRAWN BY: MPN		SHEET NUMBER: FIG. 2

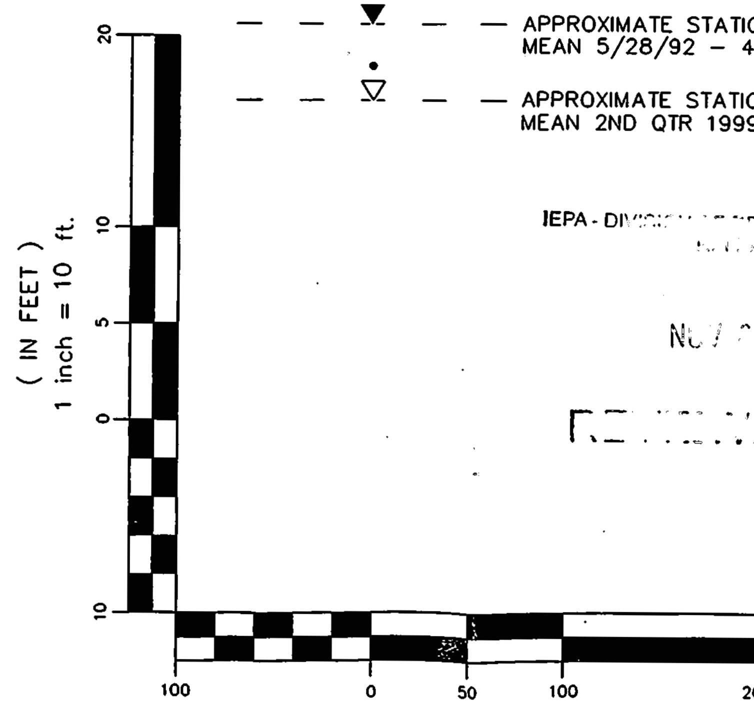


EXPLANATION

- SILTY CLAY SPOIL/FILL
- BROWN SILTY CLAY
- BROWN CLAYEY SILT
- GRAY SILTY CLAY
- GRAY CLAYEY SILT
- BLACK ORGANIC CLAY
- SILT
- CLAYEY SAND
- SAND
- SAND AND GRAVEL
- SHALE
- SANDSTONE
- CALCAREOUS SHALE
- INTERBEDDED SANDSTONE AND SHALE
- SANDSTONE CONGLOMERATE
- COAL

APPROXIMATE STATIC WATER LEVEL MEAN 5/28/92 – 4/10/95 (1995 GIA)

APPROXIMATE STATIC WATER LEVEL MEAN 2ND QTR 1999 – 1ST QTR 2001



(IN FEET)
1 inch = 100 ft.

GRAPHIC SCALE

REVISED 2018

R251

NO	DATE	REVISION DESCRIPTION	BY

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PROFESSIONAL DESIGN ENGINEERING AND LAND SURVEYING FIRM #184-001541

APPROVED BY: MTH DESIGNED BY: TPD DRAWN BY: MPN

REPRESENTATIVE GEOLOGIC CROSS SECTION FOR THE EXISTING UNIT SCENARIO

SIGNIFICANT MODIFICATION TO PERMIT FOR

LANDFILL 33, LTD.

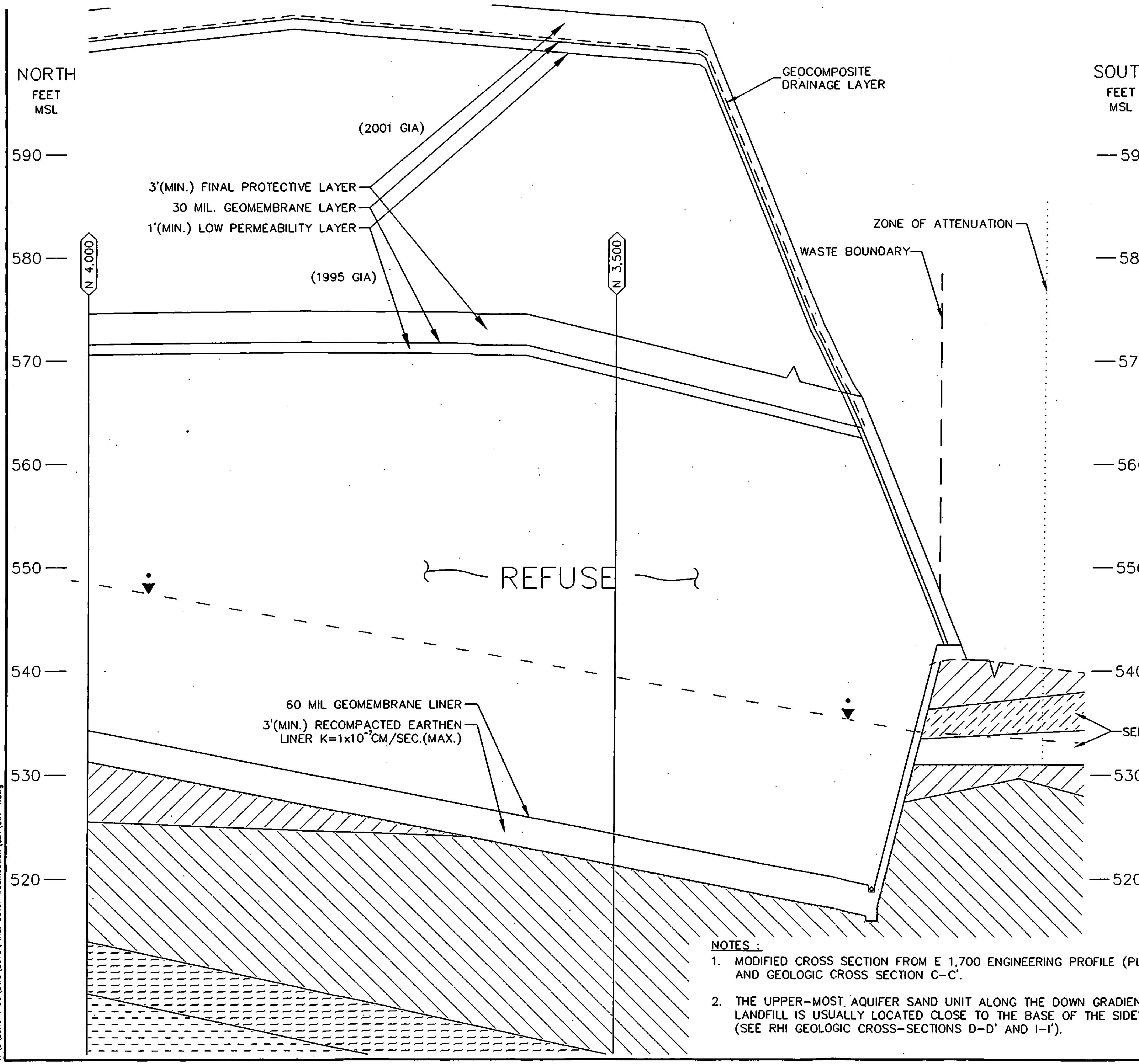
EFFINGHAM COUNTY, ILLINOIS

DATE: AUGUST 2018

PROJECT ID: 180130/0006

SHEET NUMBER:

FIG. 3



EXPLANATION

- SILTY CLAY SPOIL/FILL
- BROWN SILTY CLAY
- BROWN CLAYEY SILT
- GRAY SILTY CLAY
- GRAY CLAYEY SILT
- BLACK ORGANIC CLAY
- SILT
- CLAYEY SAND
- SAND
- SAND AND GRAVEL
- SHALE
- SANDSTONE
- CALCAREOUS SHALE
- INTERBEDDED SANDSTONE AND SHALE
- SANDSTONE CONGLOMERATE
- COAL

APPROXIMATE STATIC WATER LEVEL MEAN 5/28/92-4/10/95 (1995 GIA) AND MEAN 2ND QTR 1999-1ST QTR 2001

(IN FEET)
1 inch = 10 ft.

(IN FEET)
1 inch = 100 ft.

GRAPHIC SCALE

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NOTES :

1. MODIFIED CROSS SECTION FROM E 1,700 ENGINEERING PROFILE (PLAN SHEET B1-5) AND GEOLOGIC CROSS SECTION C-C'.
2. THE UPPER-MOST AQUIFER SAND UNIT ALONG THE DOWN GRADIENT SIDE OF THE LANDFILL IS USUALLY LOCATED CLOSE TO THE BASE OF THE SIDEWALL LINER (SEE RHI GEOLOGIC CROSS-SECTIONS D-D' AND I-I').

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R252

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PROFESSIONAL DESIGN ENGINEERING AND LAND SURVEYING FIRM #184-001541

APPROVED BY: MTH | DESIGNED BY: TPD | DRAWN BY: MPN

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REPRESENTATIVE GEOLOGIC CROSS SECTION FOR THE SOUTH UNIT SCENARIO

SIGNIFICANT MODIFICATION TO PERMIT FOR

LANDFILL 33, LTD.

EFFINGHAM COUNTY, ILLINOIS

DATE: AUGUST 2018

PROJECT ID: 180130/0006

SHEET NUMBER:

FIG. 4

Tab: Layout1 Last Saved: August 30, 2018, by Mike Nguyen Plotted: Thursday, August 30, 2018 8:59:02 AM
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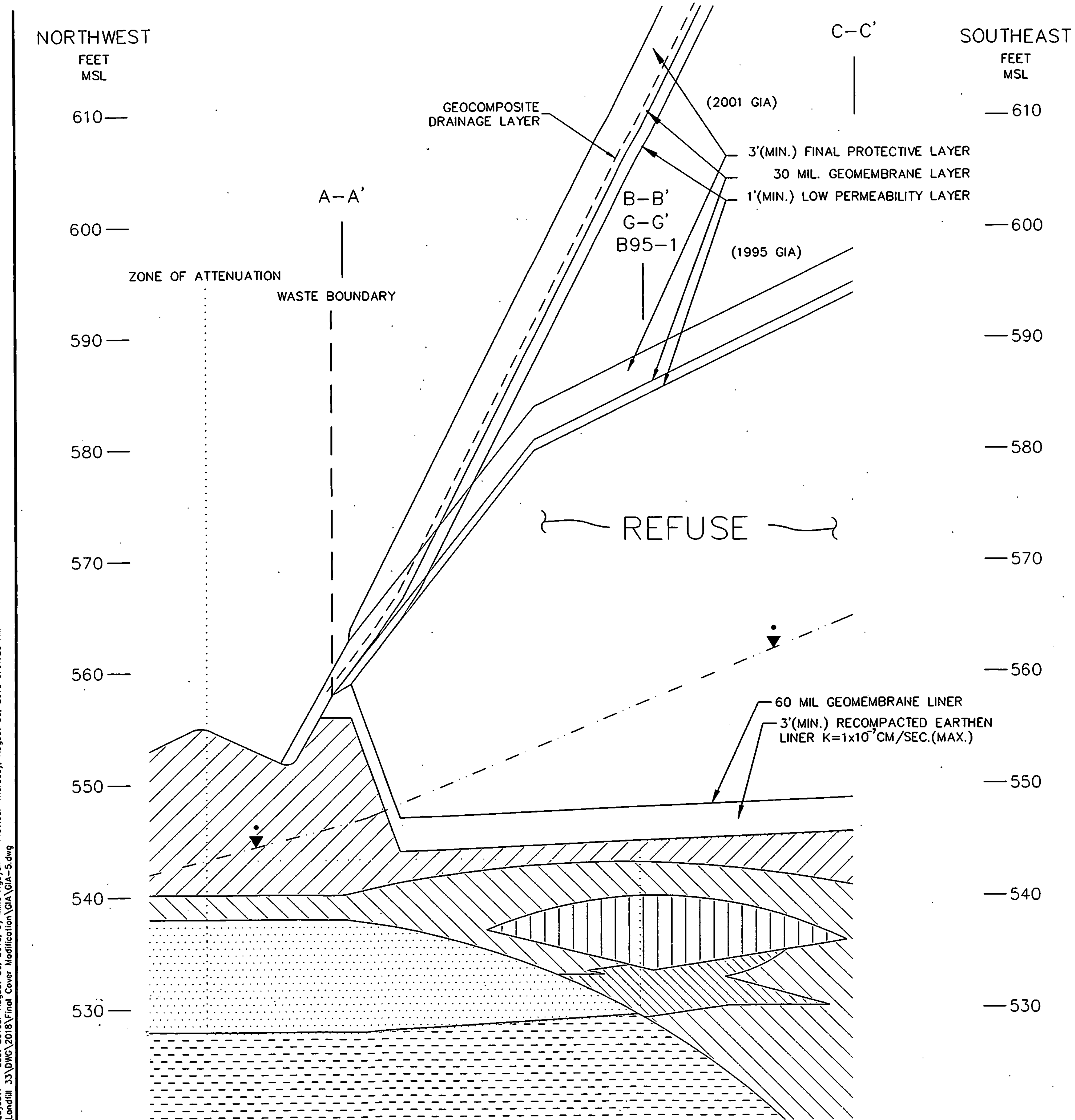
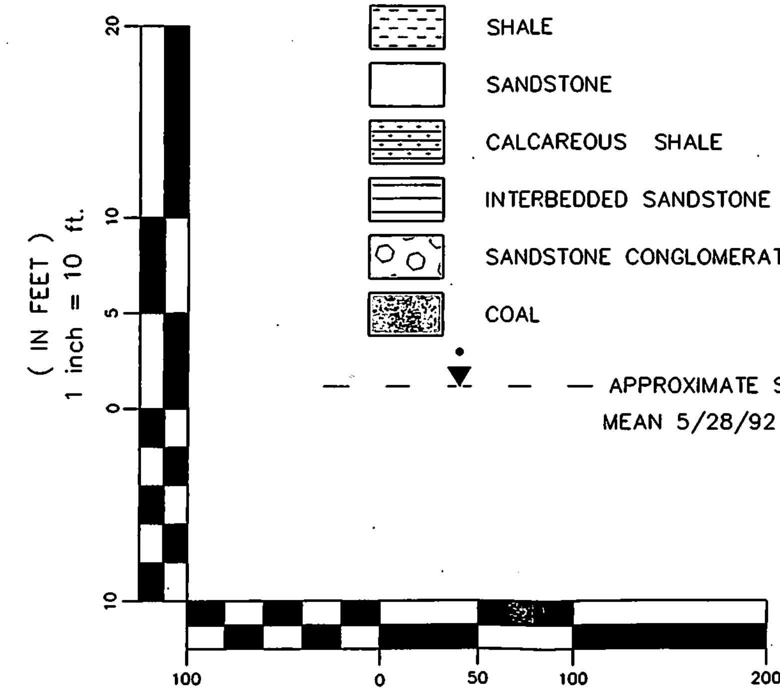
R253



EXPLANATION

- SILTY CLAY SPOIL/FILL
- BROWN SILTY CLAY
- BROWN CLAYEY SILT
- GRAY SILTY CLAY
- GRAY CLAYEY SILT
- BLACK ORGANIC CLAY
- SILT
- CLAYEY SAND
- SAND
- SAND AND GRAVEL
- SHALE
- SANDSTONE
- CALCAREOUS SHALE
- INTERBEDDED SANDSTONE AND SHALE
- SANDSTONE CONGLOMERATE
- COAL
- APPROXIMATE STATIC WATER LEVEL MEAN 5/28/92 – 4/10/95 (1995 GIA)



(IN FEET)
1 inch = 100 ft.

GRAPHIC SCALE

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PROFESSIONAL DESIGN ENGINEERING AND LAND SURVEYING FIRM #184-001541

APPROVED BY: MTH DESIGNED BY: TPD DRAWN BY: MPN

NO.	DATE	REVISION DESCRIPTION	BY

REPRESENTATIVE GEOLOGIC CROSS SECTION FOR THE NORTHWEST UNIT SCENARIO

SIGNIFICANT MODIFICATION TO PERMIT FOR
LANDFILL 33, LTD.
EFFINGHAM COUNTY, ILLINOIS

DATE: AUGUST 2018
PROJECT ID: 180130/0006
SHEET NUMBER:

FIG. 5

Tab: Layout1 Last Saved: August 30, 2018, by Mike Nguyen Plotted: Thursday, August 30, 2018 9:01:28 AM
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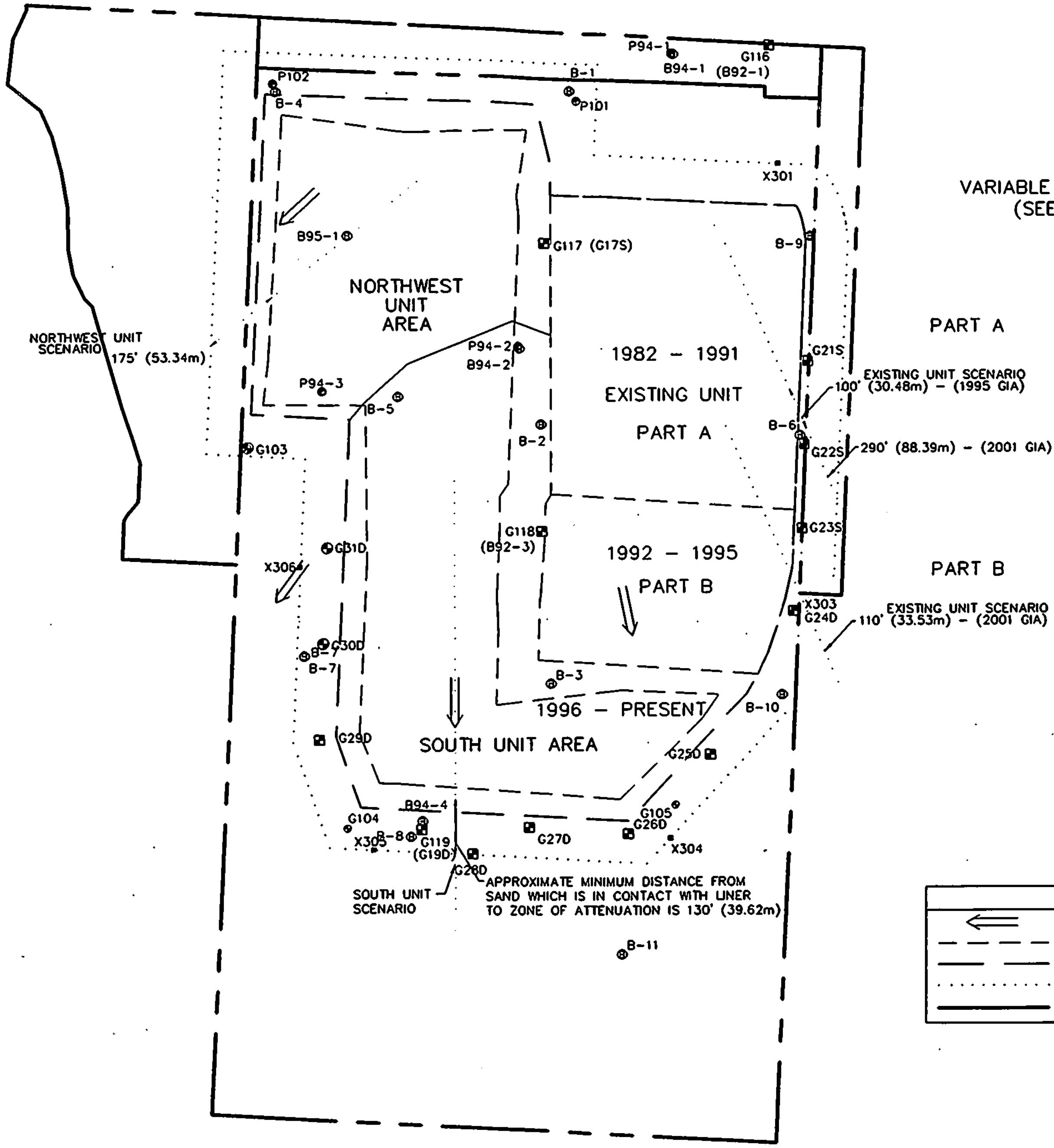
R254

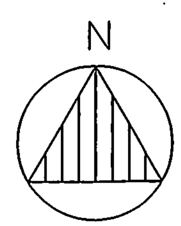


PART A

PART B

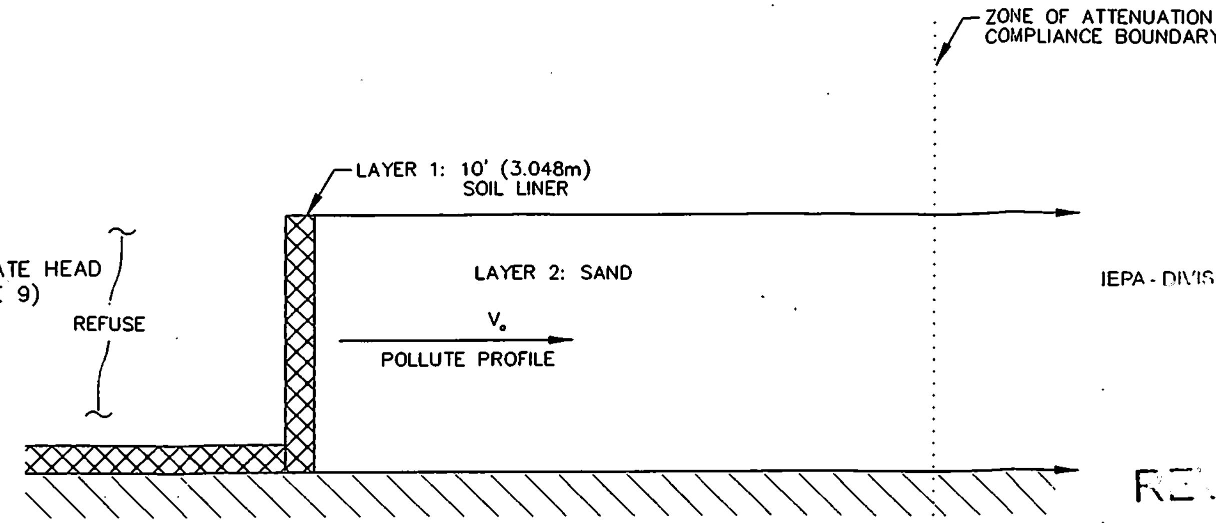
LEGEND	
⇐	GROUNDWATER FLOW
— — —	TRENCH INVERT BOUNDARY
—— ——	WASTE BOUNDARY
· · · · · · ·	ZONE OF ATTENUATION
———	PROPERTY BOUNDARY

FLOW PATHS AND DISTANCES FOR LANDFILL UNITS



GRAPHIC SCALE

(IN FEET)
1 INCH = 400 FT.



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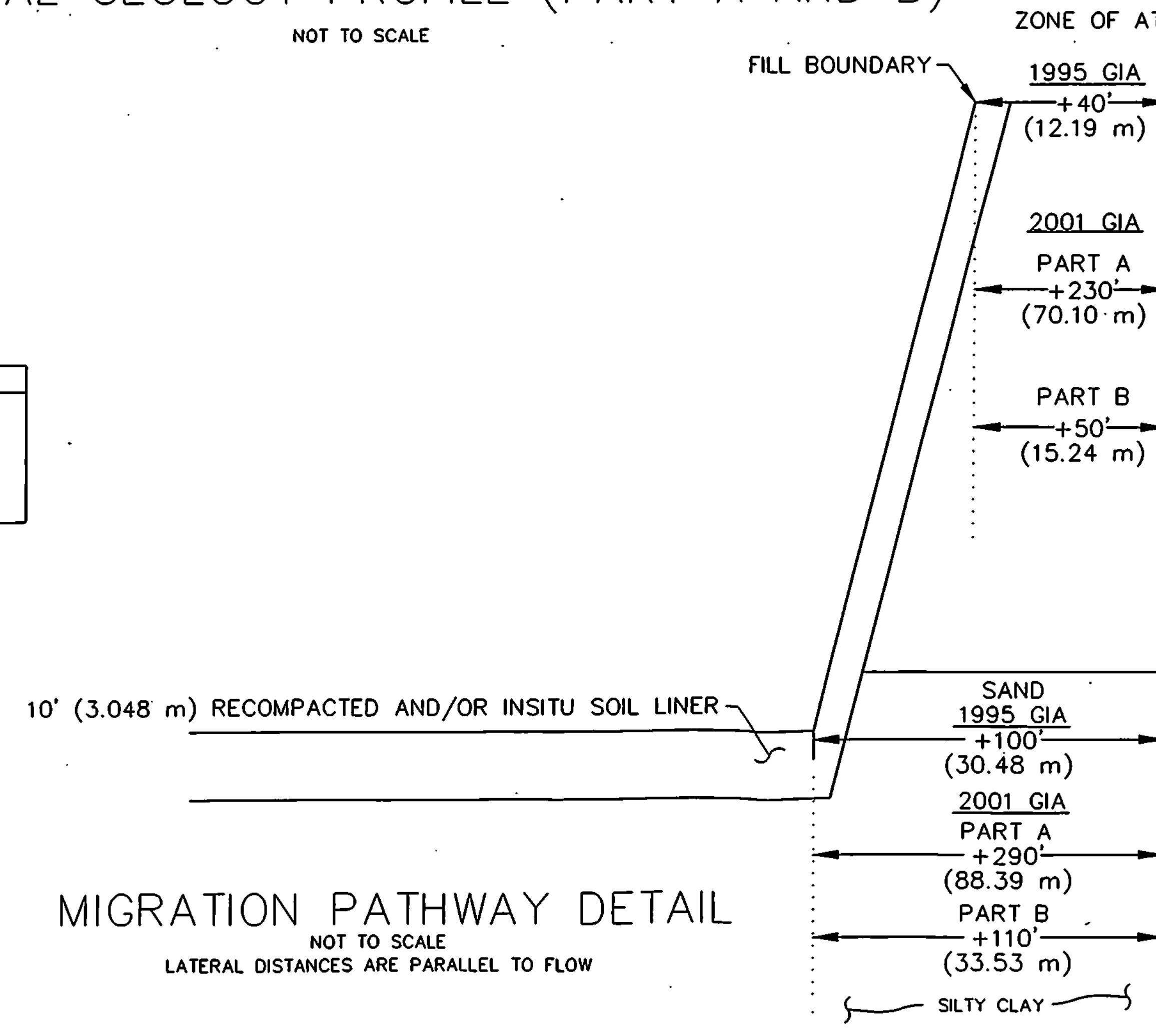
CONCEPTUAL GEOLOGY PROFILE (PART A AND B)

NOT TO SCALE



MIGRATION PATHWAY DETAIL

NOT TO SCALE

LATERAL DISTANCES ARE PARALLEL TO FLOW

REVISED MARCH 1996
JUNE 2001
AUGUST 2018

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PROFESSIONAL DESIGN ENGINEERING AND LAND SURVEYING FIRM #184-001541

APPROVED BY: MTH | DESIGNED BY: TPD | DRAWN BY: MPN

CONCEPTUAL HYDROGEOLOGY FOR EXISTING UNIT SCENARIO

SIGNIFICANT MODIFICATION TO PERMIT FOR
LANDFILL 33, LTD.
EFFINGHAM COUNTY, ILLINOIS

DATE: AUGUST 2018

PROJECT ID: 180130/0006

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FIG. 6

Tab: Layout1 Last Saved: August 30, 2018, by Mike Nguyen Plotted: Thursday, August 30, 2018 9:18:58 AM
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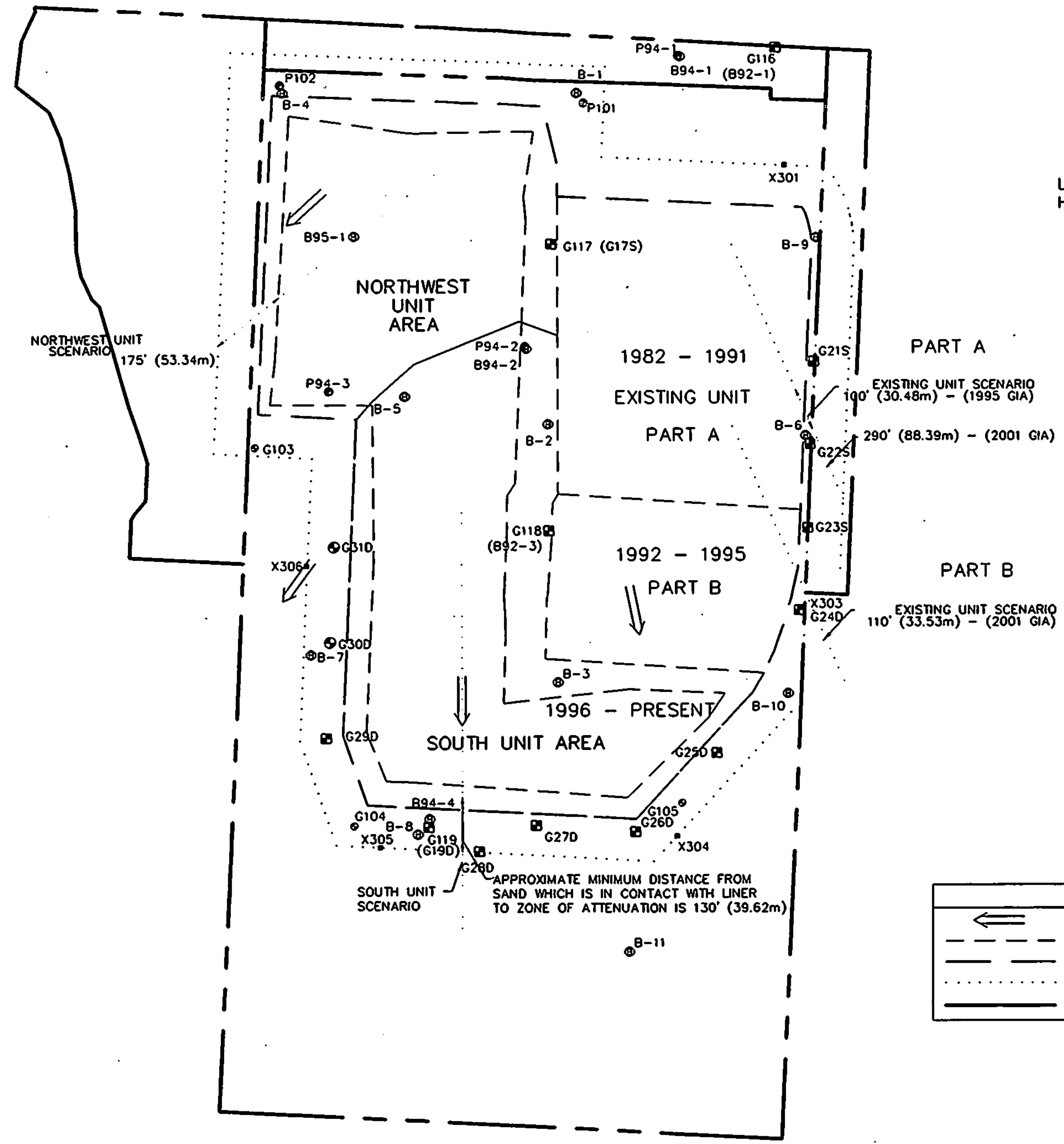
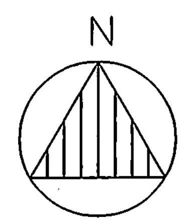


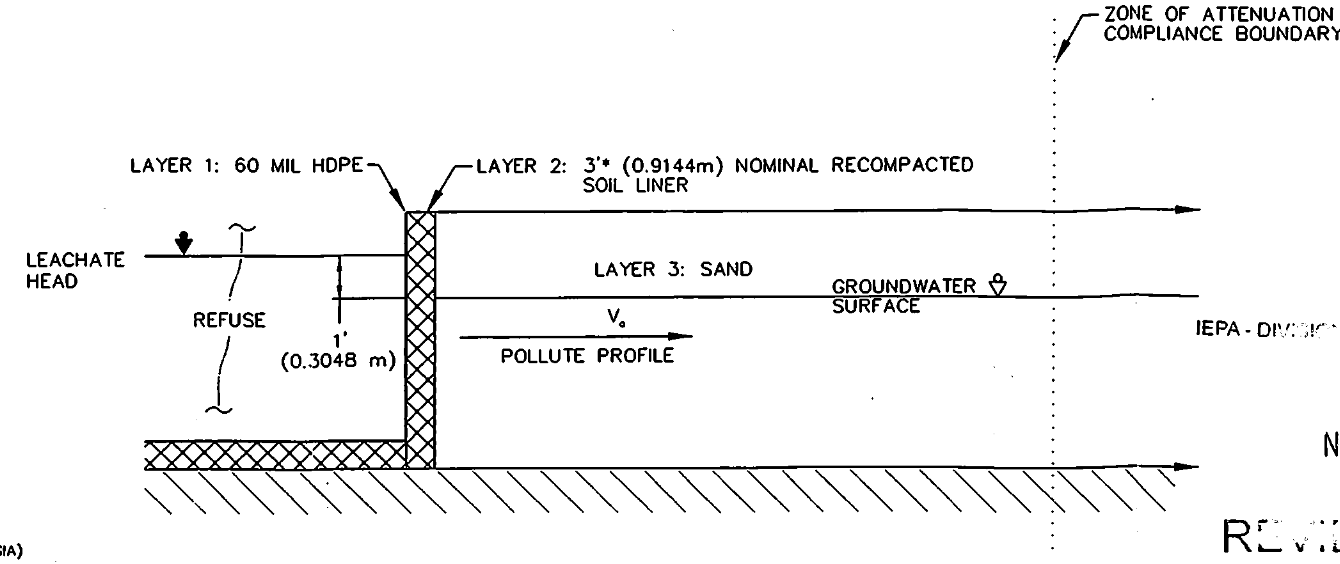
FLOW PATHS AND DISTANCES FOR LANDFILL UNITS

LEGEND	
⟸	GROUNDWATER FLOW
— — —	TRENCH INVERT BOUNDARY
—— ——	WASTE BOUNDARY
....	ZONE OF ATTENUATION
———	PROPERTY BOUNDARY



GRAPHIC SCALE

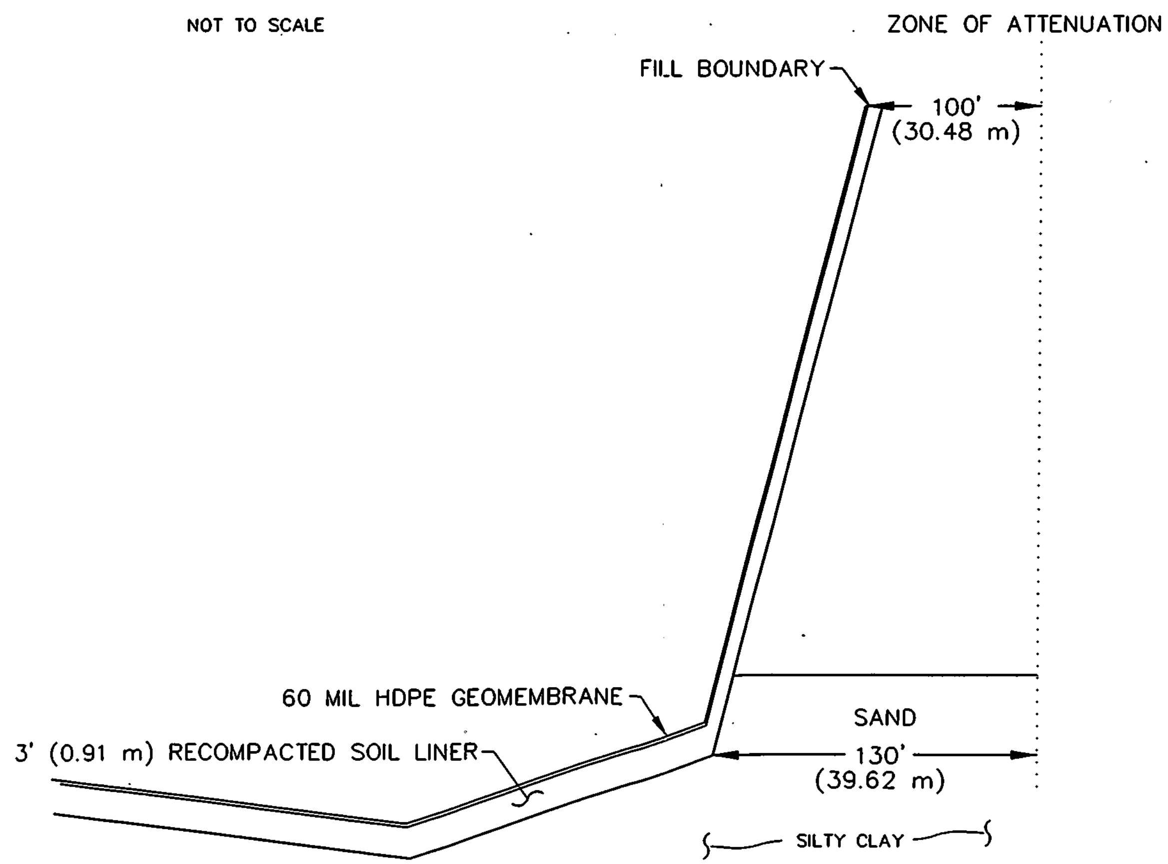
(IN FEET)
1 INCH = 400 FT.



* RECOMPACTED SOIL SIDEWALL INVERT THICKNESS IS NORMAL TO SIDESLOPE

CONCEPTUAL GEOLOGY PROFILE

NOT TO SCALE



MIGRATION PATHWAY DETAIL

NOT TO SCALE

LATERAL DISTANCES ARE PARALLEL TO FLOW

REVISED JUNE 2001
REVISED AUGUST 2018

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PROFESSIONAL DESIGN ENGINEERING AND LAND SURVEYING FIRM #184-001541

APPROVED BY: MTH | DESIGNED BY: TPD | DRAWN BY: MPN

CONCEPTUAL HYDROGEOLOGY FOR SOUTH UNIT SCENARIO

SIGNIFICANT MODIFICATION TO PERMIT FOR
LANDFILL 33, LTD.
EFFINGHAM COUNTY, ILLINOIS

DATE: AUGUST 2018

PROJECT ID: 180130/0006

SHEET NUMBER:

FIG. 7

Tab: Layout1 Last Saved: August 30, 2018, by Mike Nguyen Plotted: Thursday, August 30, 2018 9:18:28 AM
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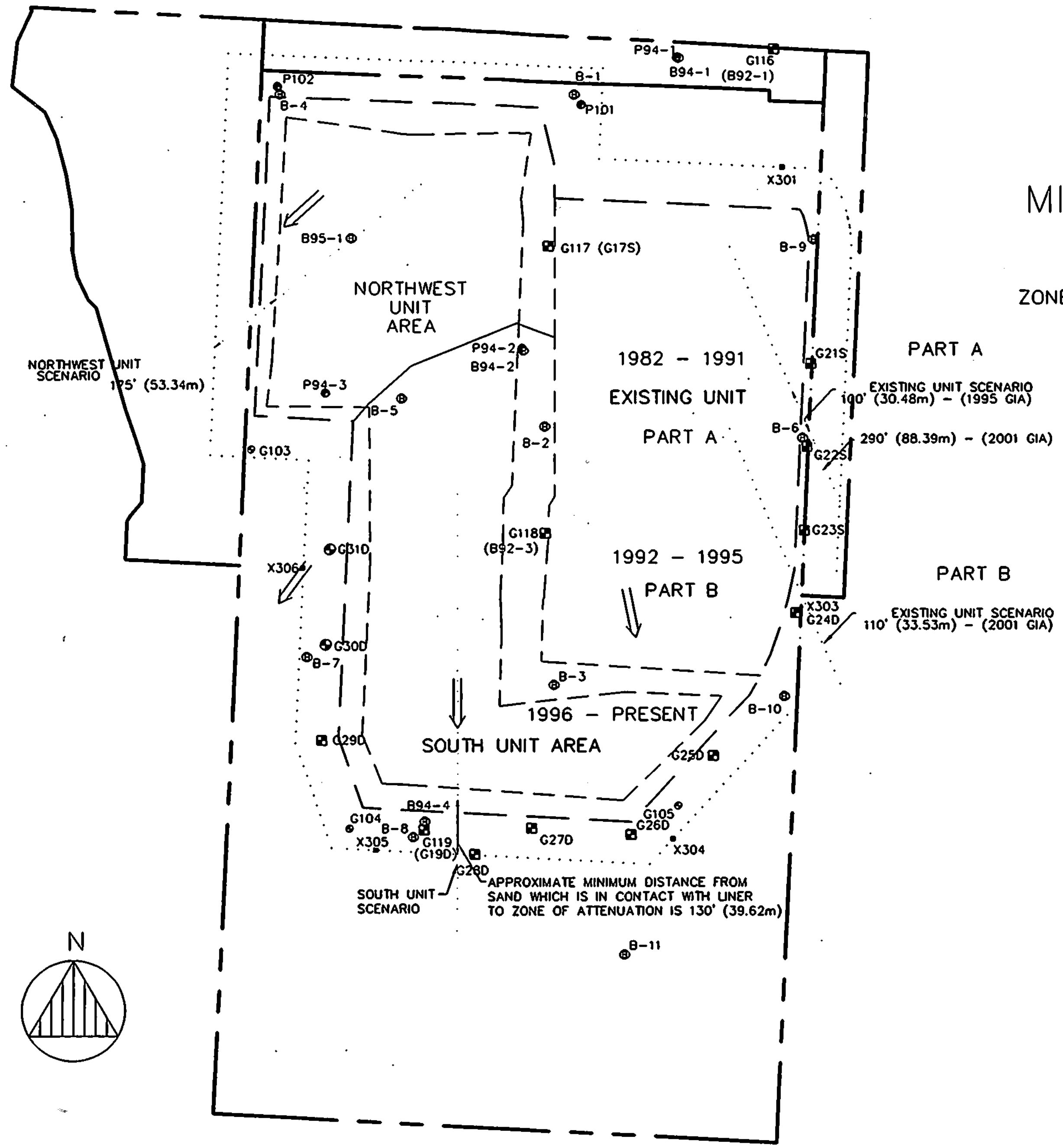
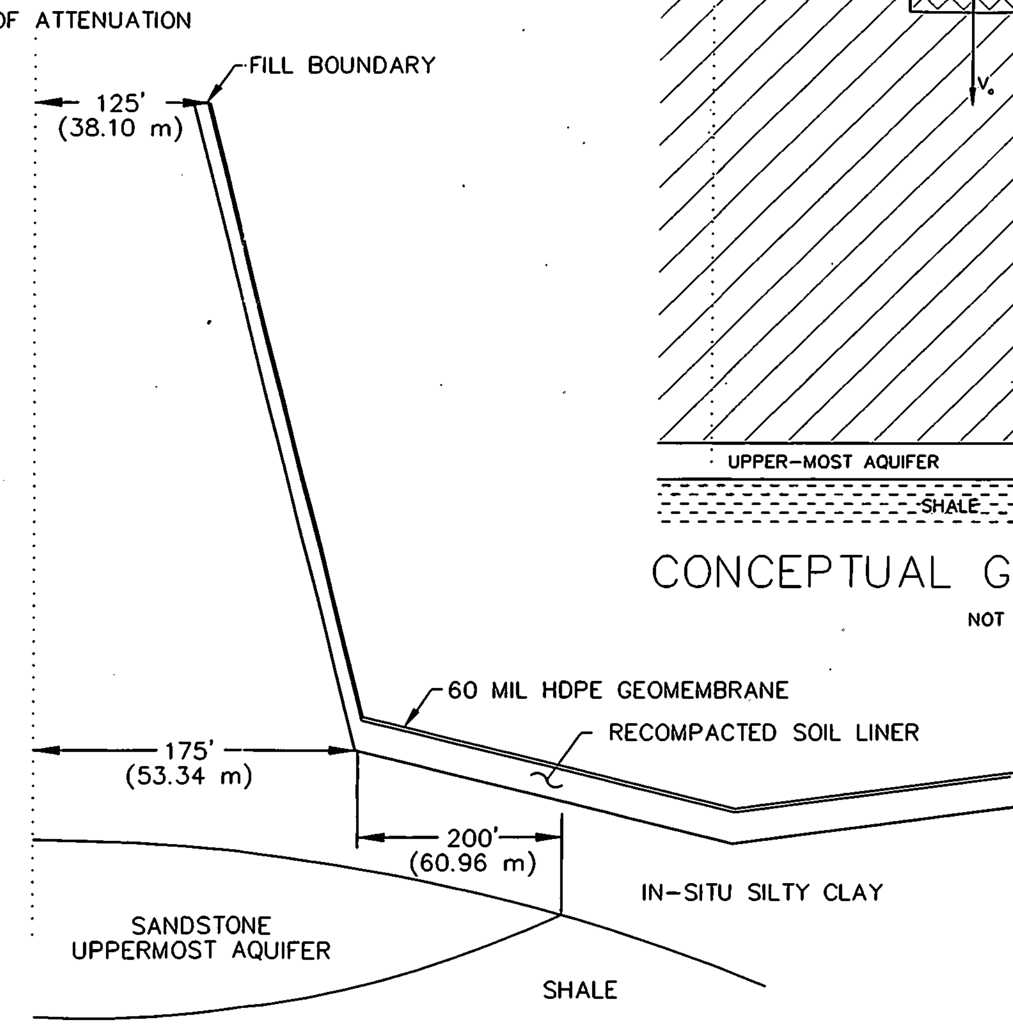


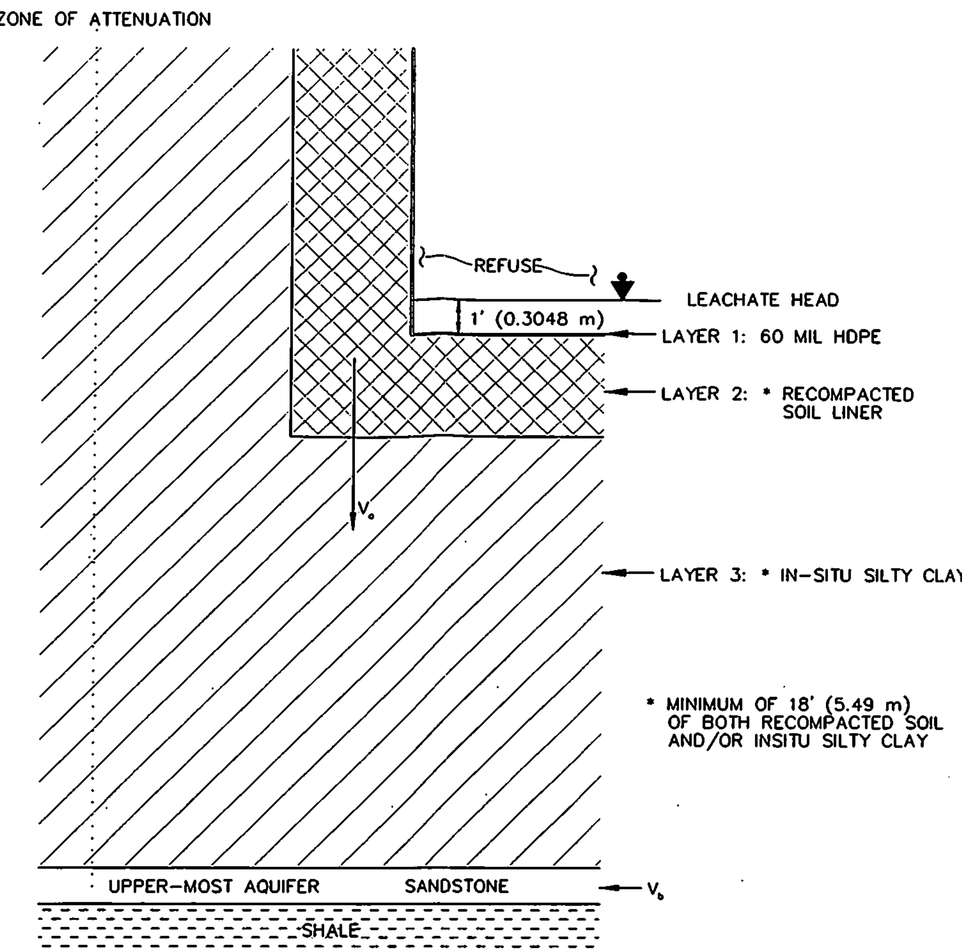
FLOW PATHS AND DISTANCES FOR LANDFILL UNITS

MIGRATION PATHWAY DETAIL

NOT TO SCALE

LATERAL DISTANCES ARE PARALLEL TO FLOW

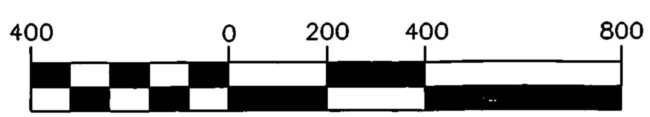




CONCEPTUAL GEOLOGY PROFILE

NOT TO SCALE

GRAPHIC SCALE



(IN FEET)

1 INCH = 400 FT.

LEGEND

⟸	GROUNDWATER FLOW
— — —	TRENCH INVERT BOUNDARY
—— ——	WASTE BOUNDARY
· · · · ·	ZONE OF ATTENUATION
━━━━	PROPERTY BOUNDARY

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NO.	DATE	REVISION DESCRIPTION	BY

APPROVED BY: MTH | DESIGNED BY: TPO | DRAWN BY: MPN

CONCEPTUAL HYDROGEOLOGY FOR NORTHWEST UNIT SCENARIO

SIGNIFICANT MODIFICATON TO PERMIT FOR

LANDFILL 33, LTD.

EFFINGHAM COUNTY, ILLINOIS

DATE: AUGUST 2018

PROJECT ID: 180130/0006

SHEET NUMBER:

FIG. 8

Tab: Layout1 Last Saved: August 30, 2018, by Mike Nguyen Plotted: Thursday, August 30, 2018 9:18:00 AM
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