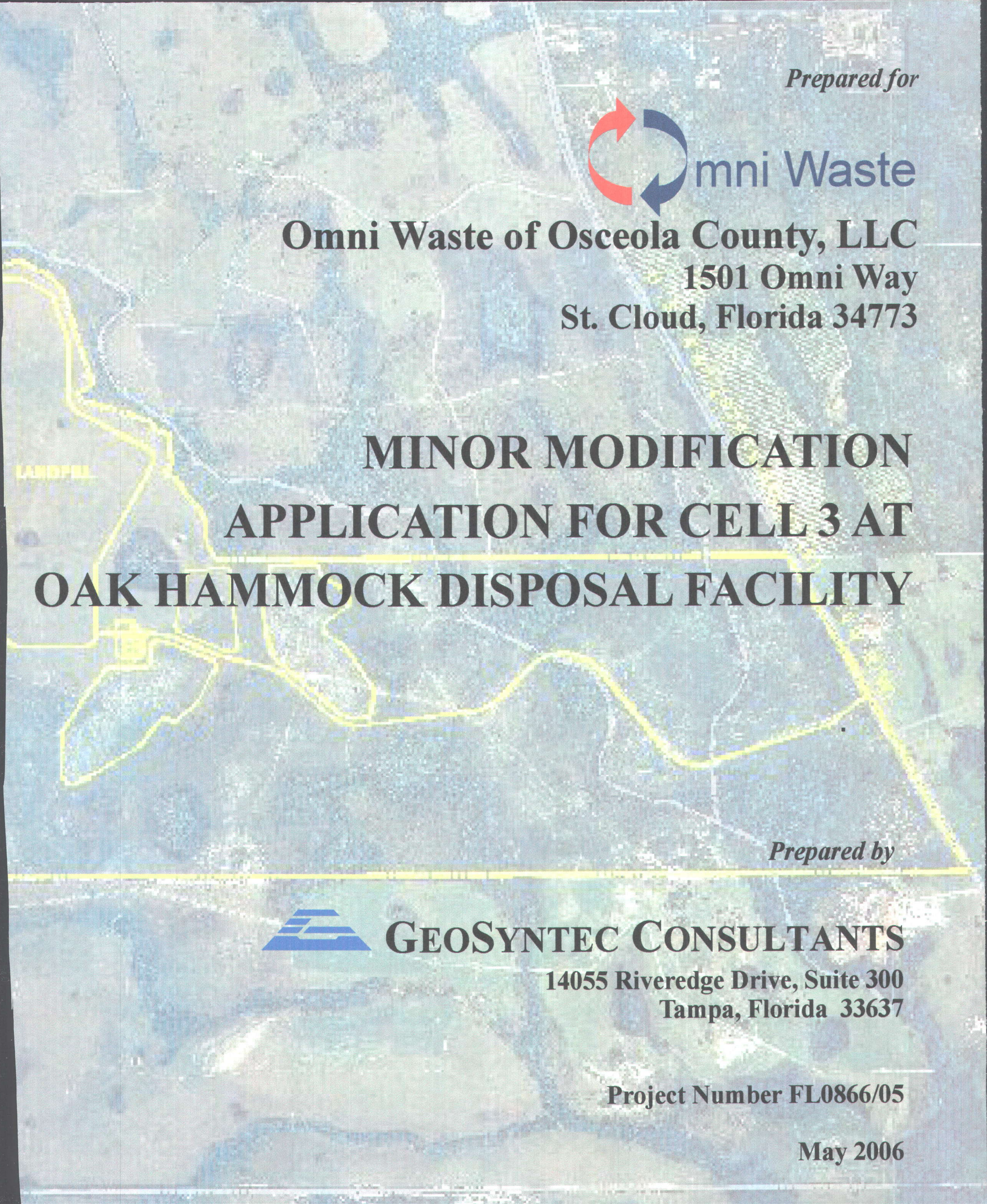

Prepared for

Omni Waste

Omni Waste of Osceola County, LLC
1501 Omni Way
St. Cloud, Florida 34773

MINOR MODIFICATION APPLICATION FOR CELL 3 AT OAK HAMMOCK DISPOSAL FACILITY

Prepared by

GEOSYNTEC CONSULTANTS
14055 Riveredge Drive, Suite 300
Tampa, Florida 33637

Project Number FL0866/05

May 2006

FILE COPY

Prepared for

Omni Waste

Omni Waste of Osceola County, LLC
1501 Omni Way
St. Cloud, Florida 34773

MINOR MODIFICATION APPLICATION FOR CELL 3 AT OAK HAMMOCK DISPOSAL FACILITY

Prepared by

GeoSyntec Consultants
14055 Riveredge Drive, Suite 300
Tampa, Florida 33637

Project Number FL0866/05

May 2006

A. Gupta
22 May 2006

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5.2 Revised Technical Specifications
5.3 Proposed Central Leachate Collection Drain Design
5.4 Differential Settlement Analysis

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3. Currently Permitted Leachate Collection System in Cell 3
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MINOR MODIFICATION APPLICATION FOR CELL 3 LEACHATE COLLECTION SYTEM

1. INTRODUCTION

GeoSyntec Consultants (GeoSyntec) has prepared this minor modification application for Oak Hammock Disposal Facility (OHDF). The OHDF is a 264-acre Class I MSW landfill located in Osceola County, Florida (west of highway U.S. 441, approximately 6.5 miles south of Holopaw). This minor modification application is submitted to the Florida Department of Environmental Protection, Central District (FDEP) on behalf of Omni Waste of Osceola County, LLC (Omni). Omni is a wholly owned subsidiary of Waste Services, Inc. (WSI).

OHDF is currently operating under a construction and operation permit (Permit # SC49-0199726-001 and SO49-0199726-002) issued by FDEP in October 2002. The 5-year construction and operation permit expires in August 2007. The current construction and operation permit was issued based on a solid waste permit application titled "Application of Permit to Construct and Operate a Class I Landfill" prepared by GeoSyntec. The permit application was submitted to FDEP in May 2002 and is hereafter referred to as the *May 2002 Permit Application*. The permit drawings package titled "Oak Hammock Disposal, A Solid Waste Facility, Permit Drawings" was submitted along with the solid waste permit application and is hereafter referred to as the *Permit Drawings*. Additional information requested by FDEP was submitted in a letter report in June 2002. The two reports and the permit drawings are hereafter collectively referred to as the *2002 Permit Documents*.

This minor modification application is being submitted to permit minor design changes to Cell 3 leachate collection system presented in the 2002 Permit Documents. FDEP Form 62-701.900(1), Application for a Permit to Construct, Operate, Modify or Close a Solid Waste Management Facility, has been completed for the proposed minor design modifications and is included as Appendix A to this minor modification application. The minor modification application was prepared by Ayushman Gupta, P.E. and Jay Eun of GeoSyntec and was reviewed by Kwasi Badu-Tweneboah, PhD, P.E., also of GeoSyntec.

2. PROJECT BACKGROUND

The current 5-year construction and operation permit for the OHDF allows development of Phase 1 of the facility. Phase 1 includes four landfill cells (Cells 1 through 4) covering approximately 53 acres as indicated in Figure 1. The first cell at the landfill (Cell 1) was completed and waste acceptance at the OHDF was initiated in January 2004.

Cells 4 and 2 of Phase 1 were completed in 2005 and 2006, respectively, and both are currently under operation. Cell 3 is currently under construction.

The OHDF bottom liner system consists of a double-composite liner system. The liner system, from top to bottom, consists of:

- 2-foot thick liner protective layer;
- primary geocomposite drainage layer;
- 60-mil thick primary HDPE textured geomembrane;
- primary geosynthetic clay liner (GCL);
- secondary geocomposite drainage layer;
- 60-mil thick HDPE secondary textured geomembrane; and
- secondary GCL.

Based on the currently permitted design, the primary leachate collection system for each cell in Phase 1 is located at the toe of the respective cells (see Sheets 11 of 50 of the Permit Drawings). This results in a long drainage path before the leachate collected is conveyed to the leachate collection drain at the toe of the cell. In order to keep the maximum head on the primary geomembrane below 12 inches (maximum head allowed by the regulations), the primary geocomposite drainage layer is required to have relatively high transmissivities (as noted in Table 02740-1 of Section 02740 of the Technical Specifications presented in Appendix P of the May 2002 Permit Application) for the currently permitted primary leachate collection system.

Based on Omni's experience in constructing Cells 1, 2, and 4 at the OHDF, only the triplanar geocomposite Tendrain 7100-2, manufactured by the Tenax Corporation meets the transmissivities required by the current project specifications. The objective of this minor modification application is to permit minor design modifications to the primary leachate collection system in Cell 3 so that other commercially available geocomposite products (such as PermaNet HL and PermaNet UL geocomposites manufactured by GSE) are also suitable for use as the primary geocomposite drainage layer in Cell 3. It is noted that the requested design modifications are only for Cell 3 since Cells 1, 2, and 4 have already been constructed and are currently under operation. Cell 3 is currently under construction and is expected to start accepting waste in the last quarter of 2006.

3. SUITABLE GEOCOMPOSITE PRODUCTS

Commercially available geocomposites with relatively high transmissivity values (even under high stress loading) were identified for use as the primary geocomposite drainage layer in Cell 3. In addition to the triplanar geocomposite Tenax Tendrain (which was used as the primary geocomposite drainage layer in Cells 1, 2, and 4), other commercially available products that may be used as primary geocomposite drainage layer in Cell 3 include GSE Permanet HL or PermaNet UL. The PermaNet geonets have a biplanar structure that is specifically designed to sustain high stresses. A GSE brochure discussing the properties of PermaNet geonets and geocomposites is included in Appendix B. As noted in the GSE brochure, PermaNet geonets have relatively high resistance to creep and as a result these geonets maintain high transmissivities even under high stresses. Appendix B also includes 100-hour transmissivity test results for GSE PermaNet UL geocomposite at 0.02 gradient (corresponding to the initial 2 percent slope of Cell 3 floor); under normal loads of 1,000 psf and 10,000 psf (i.e., stress range applicable to Cell 3); and with the same boundary conditions as in the field (i.e., geocomposite drainage layer sandwiched between sand and texture geomembrane).

A comparison between the primary properties of Tenax Tendrain and GSE Permanet UL geocomposites is presented in Figure 2. As noted, the GSE Permanet UL geocomposite has slightly lower transmissivity as compared to the Tenax Tendrain triplanar geocomposite. However, the GSE Permanet UL geocomposite has higher resistance to creep in comparison to the Tenax Tendrain triplanar geocomposite, especially under high stresses. Since the transmissivity of the GSE PermaNet geocomposites is slightly lower than the transmissivity of the primary drainage geocomposite required by the current technical specifications (see Section 02740, Appendix P of the May 2002 Permit Application), this minor modification application is proposing an additional leachate collection drain in Cell 3 so that the maximum head on the primary geomembrane does not exceed 12 inches (as required by the regulations).

4. PROPOSED DESIGN MODIFICATIONS

The currently permitted leachate collection system in Cell 3 is indicated in Figure 3. As noted, the currently permitted primary leachate collection system includes leachate collection drains along the north and east toe of Cell 3, which are referred to as the *toe leachate collection drains* in this minor modification application. The toe leachate collection drains consist of a 6-inch diameter SDR 11 HDPE perforated pipe surrounded by gravel and geotextile filter fabric as indicated in Figure 4.

The proposed design modification includes providing an additional leachate collection drain in the center of Cell 3 as indicated in Figure 5, which are referred to as the *central leachate collection drain* in this minor modification application. As noted in Figure 5, the central leachate collection drain is located such that the longest drainage path in Cell 3 for the proposed design is approximately half that of the currently permitted design. A reduction in the longest drainage path for Cell 3 leachate collection system will allow use of other commercially available geocomposites (such as GSE PermaNet geocomposites) as the primary geocomposite drainage layer in Cell 3 without exceeding 12 inches of head on the primary geomembrane.

The proposed central leachate collection drain will consist of a 6-inch diameter SDR 11 HDPE perforated pipe surrounded by gravel and geotextile filter fabric as indicated in Figure 6. The size and layout of the perforations for the central leachate collection drain pipe will be same as that for the toe leachate collection drain pipe (see Sheet 19 of 50 of the Permit Drawings). The primary geocomposite drainage layer will be discontinued at the central leachate collection drain to force the leachate collected in west half of Cell 3 into the central leachate collection drain. To protect the ends of primary geocomposite drainage layer on either side of the central leachate collection drain, an additional geotextile will be overlapped and tack welded to the surface of the primary geocomposites as indicated in Figure 6.

The following evaluations are provided in support of the design modifications proposed for the leachate collection system in Cell 3:

- Revised leachate generation rate, leakage, and maximum head computations for Cell 3 taking into consideration the proposed central leachate collection drain;
- Revised technical specifications for the primary geocomposite drainage layer;
- Proposed central leachate collection drain design including pipe flow capacity, perforation sizing, and structural stability; and
- Differential settlement analysis for the proposed central leachate collection drain pipe.

It is noted that the proposed modifications are limited to the primary leachate collection system in Cell 3. No changes are proposed for the secondary leachate collection system, the double composite liner system, cover system, or the grading plans currently permitted for Cell 3 based on the 2002 Permit Documents.

5. EVALUATION IN SUPPORT OF THE PROPOSED DESIGN MODIFICATIONS IN CELL 3

The revised or additional information required in support of the design modifications proposed for the leachate collection system in Cell 3 is included in the sections below.

5.1 Leachate Generation Rates, Leakage, and Maximum Head Computations

The leachate generation rates for the primary and the secondary geocomposite drainage layers, the leakage to subgrade, and the maximum head on the liner systems for the proposed leachate collection system in Cell 3 were evaluated using the HELP model. The HELP model analysis performed for the proposed leachate collection system in Cell 3 is discussed in the calculation package titled *Cell 3 Leachate Management System* included in Appendix C of this minor modification application. The parameters used in the HELP model analysis are presented in Section 4 of Appendix C. The results of the HELP model analysis are presented in Sections 5 and 6 of Appendix C.

5.2 Revised Technical Specifications

The technical specifications for the primary geocomposite were revised based on the HELP model analysis performed (Section 6 of Appendix C) for the proposed design modifications in Cell 3. As noted in Section 6 of Appendix C, Giroud, et. al. (2001) method was used to iteratively estimate the minimum transmissivity for the primary geocomposite drainage layer that results in a maximum head of approximately 12 inches on the primary liner system in Cell 3. The results of this analysis (identified as PDM 2) are summarized in Table C-2 in Appendix C. The spreadsheets presenting the input parameters and the results for this analysis are included as Attachment 4 to the calculation package in Appendix C.

Based on the results of this analysis, the technical specifications for the primary geocomposite were revised and are included in Appendix D. As noted in the revised Table 02740-1 in Appendix D, the minimum transmissivity required for the primary geocomposite in Cell 3 will be 3.0×10^{-3} m^2/sec at 500 psf and 1.0×10^{-3} m^2/sec at 10,000 psf. These transmissivities represent transmissivities measured in a 100-hour test performed at 0.02 gradient with the same boundary conditions as in the field (i.e., geocomposite drainage layer sandwiched between sand and texture geomembrane). It is noted that the maximum vertical stress on the liner system in Cell 3 is approximately 10,000 psf, which corresponds to a maximum waste height of approximately 150 ft after the OHDF is vertically expanded.

5.3 Proposed Central Leachate Collection Drain Design

The design for the central leachate collection drain proposed in Cell 3 is discussed in Section 8 of the calculation package included in Appendix C. Section 8 of Appendix C discusses the pipe flow capacity, perforation sizing, and structural stability for the central leachate collection drain pipe proposed in Cell 3.

5.4 Differential Settlement Analysis

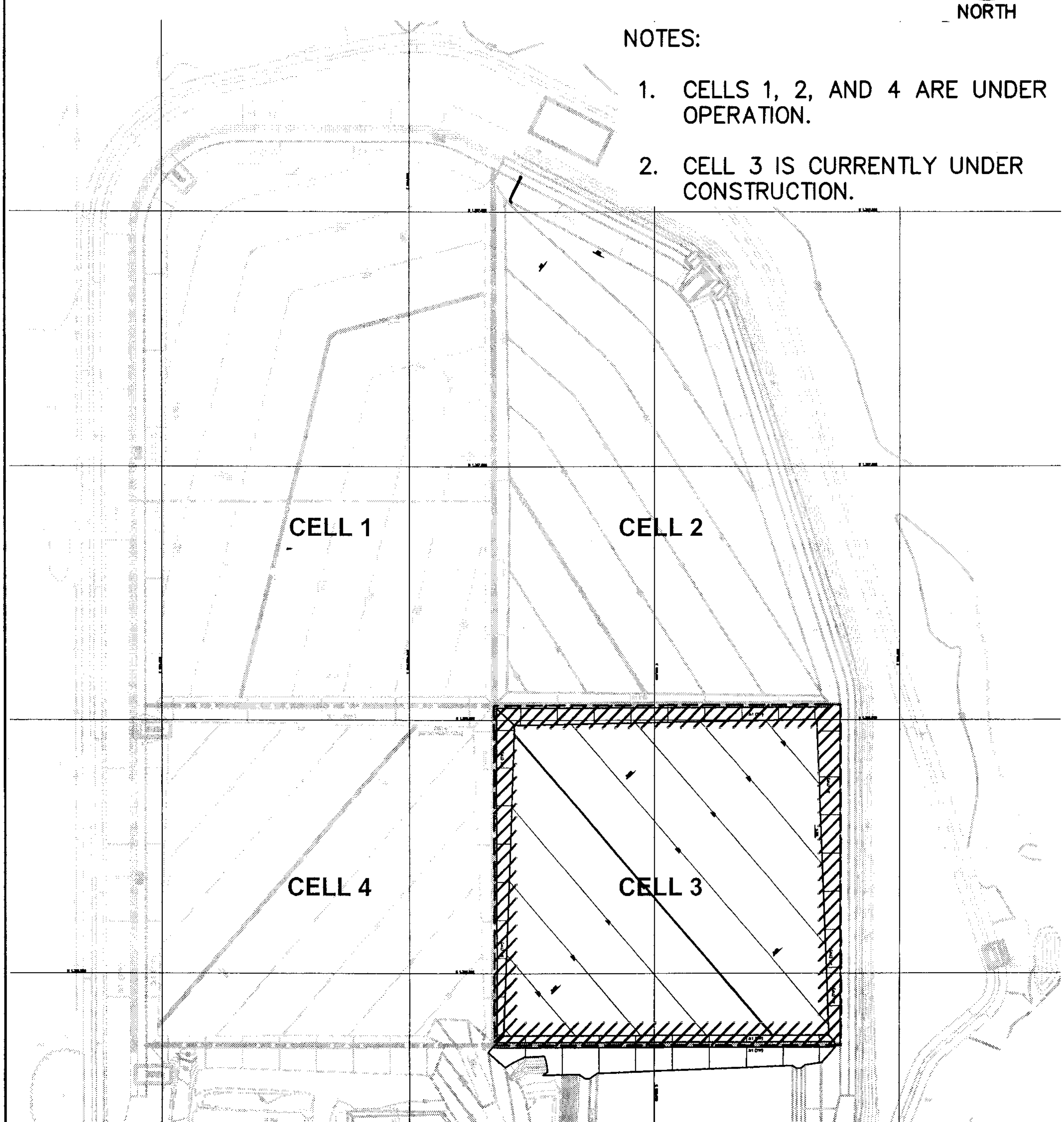
As indicated in Figure 5, the alignment of the proposed central leachate collection system in Cell 3 is approximately parallel to the perimeter dike on east side of Cell 3. This implies that the height of waste overlying the proposed central leachate collection system is nearly the same all along the length of the proposed central drain. Due to the nearly same overburden waste height, the proposed central leachate collection drain is expected to have minimal differential settlement. Based on the pipe flow capacity results presented in Section 8 of Appendix C, the proposed leachate collection drain pipe will have sufficient flow capacity even after the minimal differential settlement expected for the pipe.

OHDF PHASE 1 DEVELOPMENT PLAN
CELLS 1 THROUGH 4

NORTH

NOTES:

1. CELLS 1, 2, AND 4 ARE UNDER OPERATION.
2. CELL 3 IS CURRENTLY UNDER CONSTRUCTION.



0 150' 300' 600'

SCALE: 1" = 300'

A Gupta
22 May 2006
AYUSHMAN GUPTA
LICENSE NUMBER 54023

GEOSYNTEC CONSULTANTS

14055 RIVEREDGE DRIVE, SUITE 300
TAMPA, FLORIDA 33637 USA
TEL: (813) 558-0990 FAX: (813) 558-9726
AUTHORIZATION CERTIFICATE NO. 00004321

PROJECT NO.	FL0957.01	FIGURE NO.	1
DATE.	18 MAY 2006	FILE NO.	FL0957.01F01006

Figure 2

COMPARISON BETWEEN TENAX TENDRAIN AND GSE PERMANET UL

Properties of Tenax Tendrain Geocomposite [1]
(Properties used in May 2002 Permit Application)

Stress	θ	Thickness geonet	
psf	m^2/sec	%	mm
0	N/A [2]	100	7.62
2,000	7.50E-03	97	7.39
15,000	4.20E-03	85	6.48
20,000	2.50E-03	77	5.87

Properties of GSE PermaNet UL Gepcomposite [1]
(Properties used in this application)

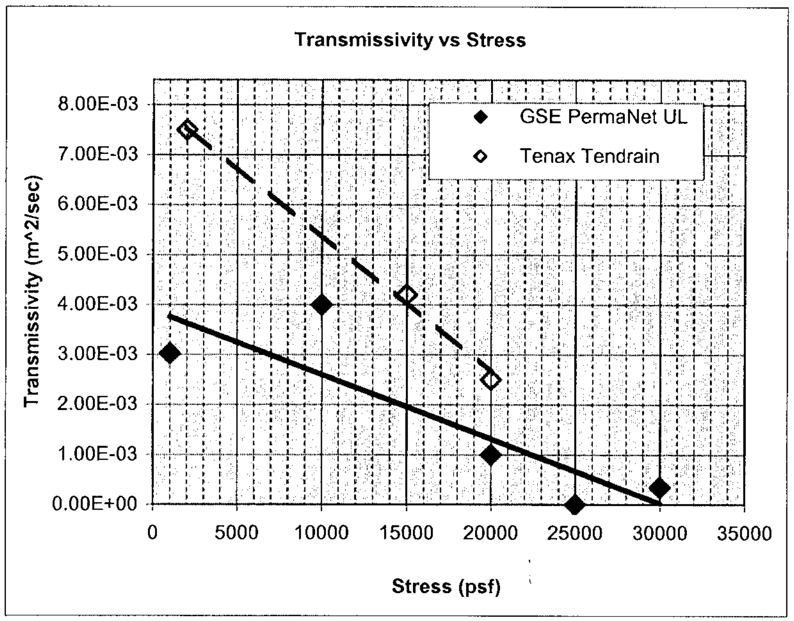
Stress	θ	Thickness geonet [3]	
psf	m^2/sec	%	mm
0	N/A	100	7.62
1000	3.03E-03	N/A	N/A
10000	4.00E-03	91	6.93
20000	1.00E-03	86	6.55
25000	N/A	84	6.40
30000	3.50E-04	N/A	N/A

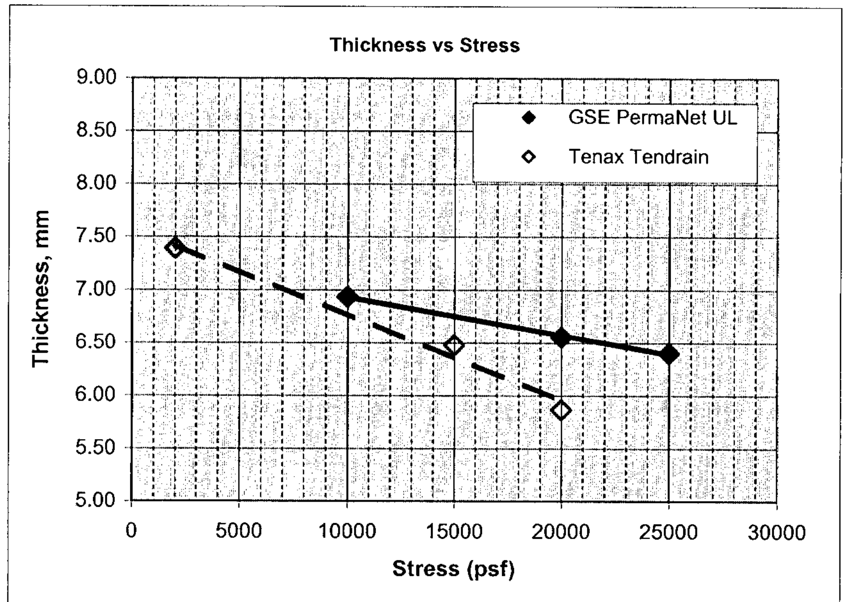
Notes:

[1] Test results are for 0.02 gradient, 100 hours of seating time, and geocomposite sandwiched between sand and textured geomembrane

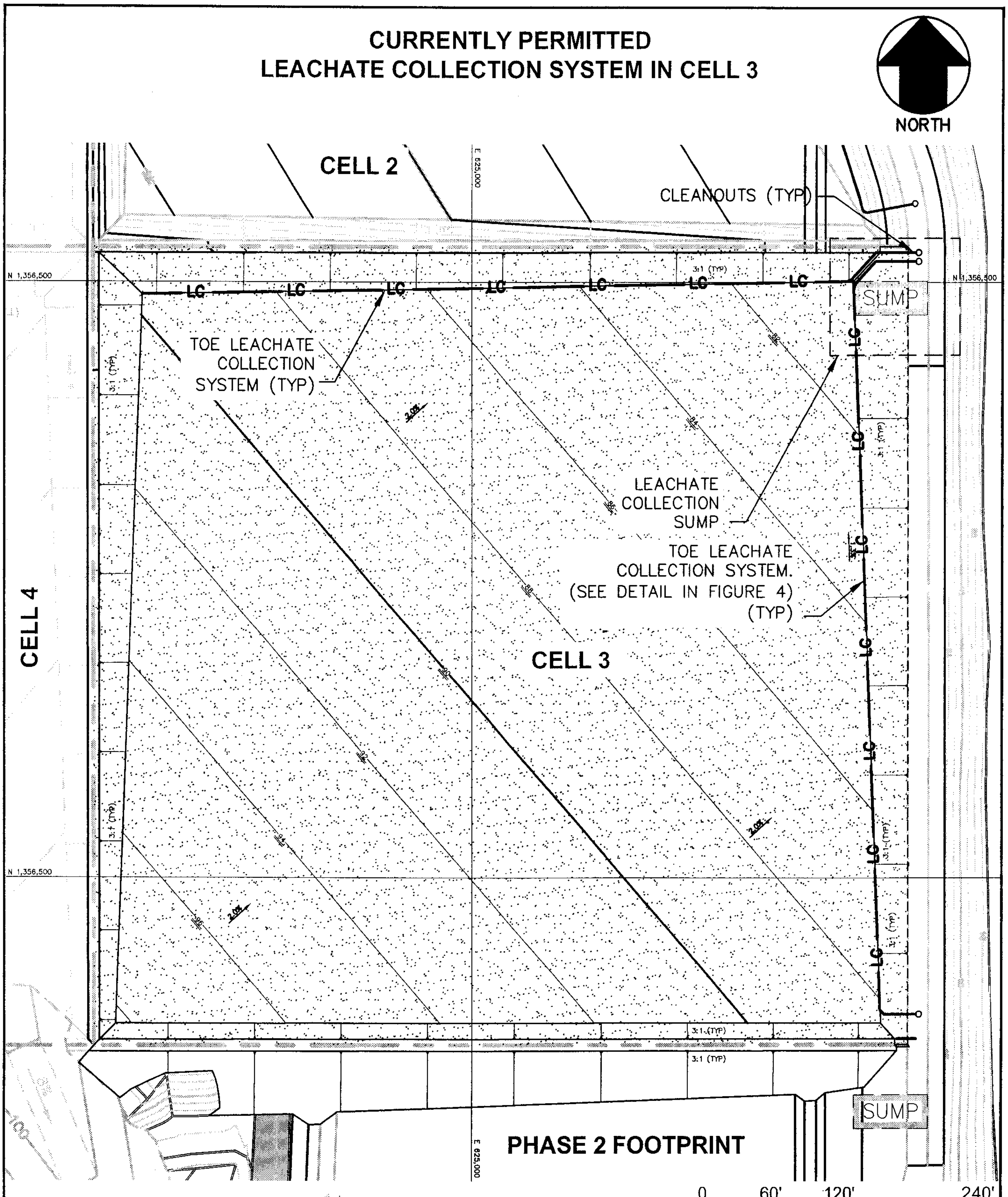
[2] N/A = not available

[3] Thickness after 100,000 hrs of constant stress





CURRENTLY PERMITTED
LEACHATE COLLECTION SYSTEM IN CELL 3



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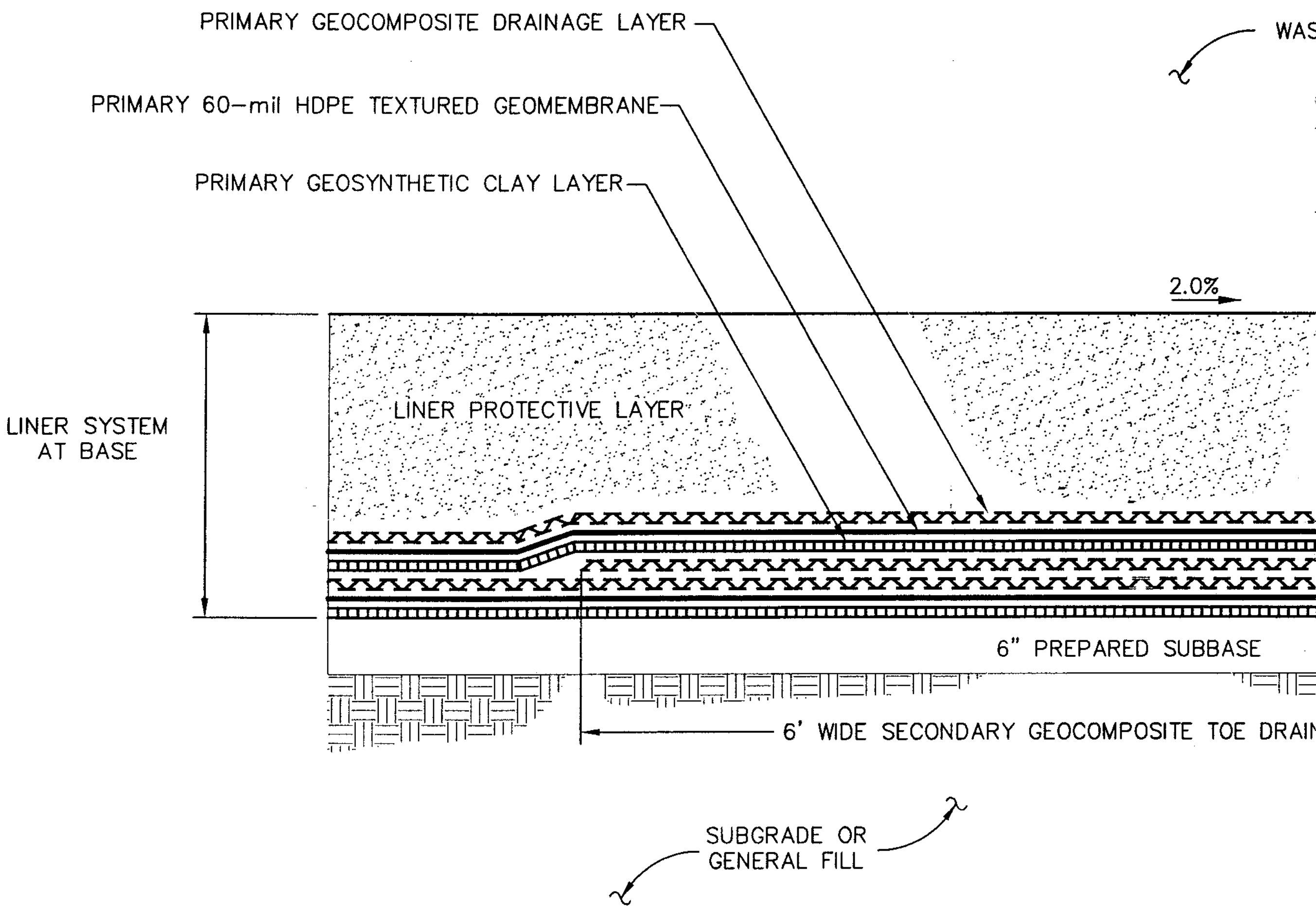
AUTHORIZATION CERTIFICATE NO. 00004321

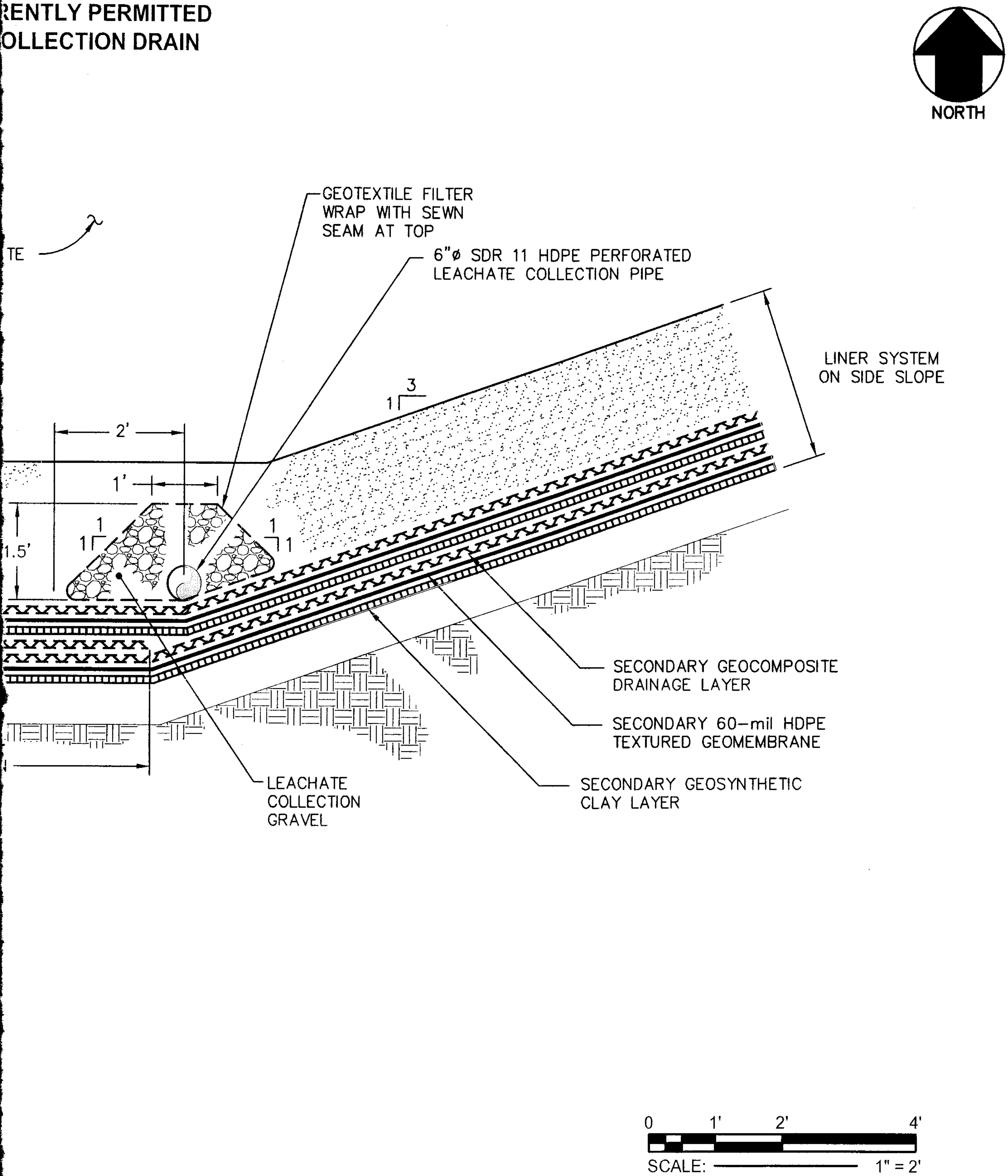
PROJECT NO.	FL0957.01	FIGURE NO.	3
DATE.	18 MAY 2006	FILE NO.	FL0957.01F01002

A Gupta
22 May 2006
AYUSHMAN GUPTA
LICENSE NUMBER 54023

DETAILS FOR CURR
TOE LEACHATE C



RENTLY PERMITTED
OLLECTION DRAIN



22 May 2006

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LICENSE NUMBER 54023

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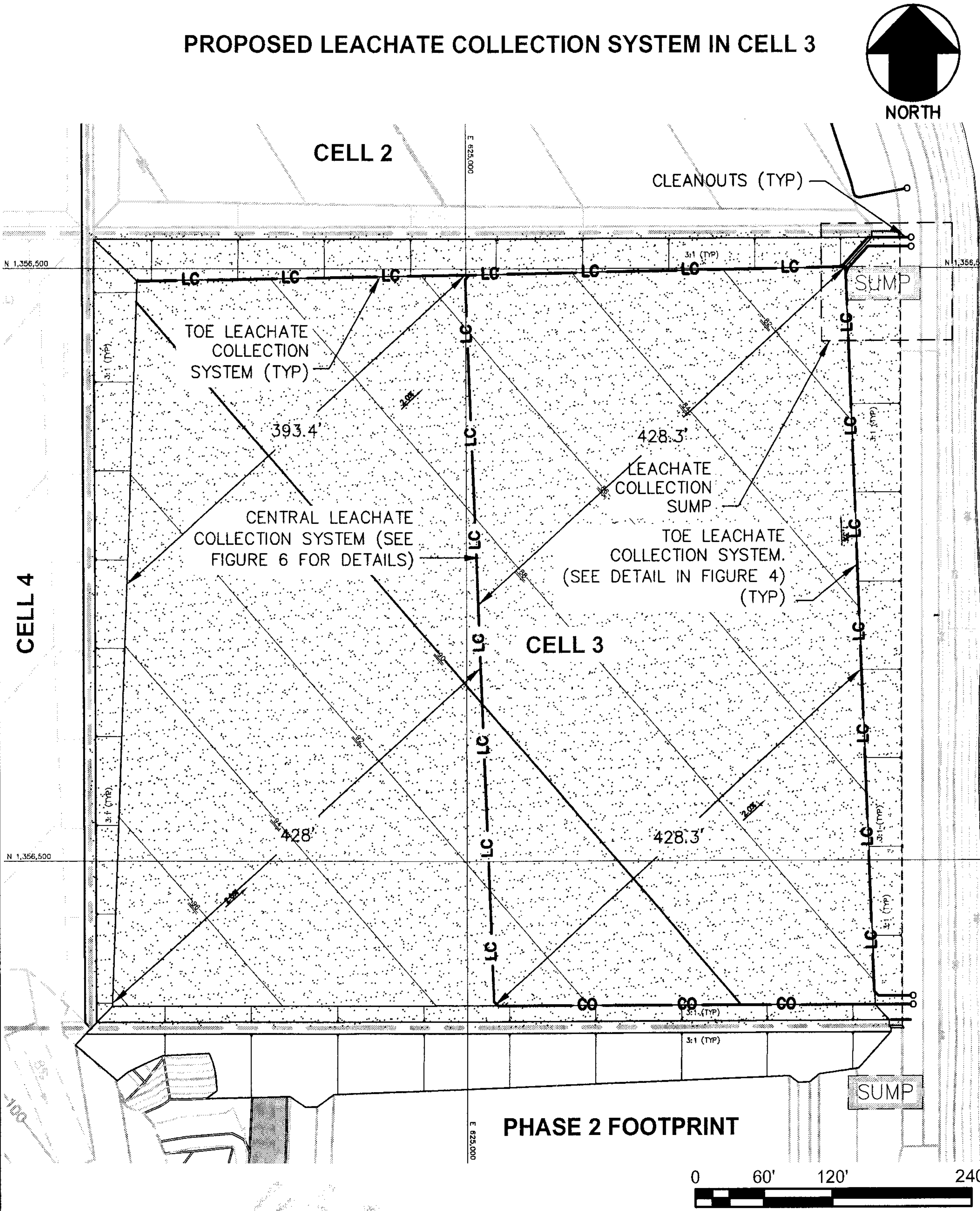
AUTHORIZATION CERTIFICATE NO. 00004321

PROJECT NO.	FL09527.01	**FIGURE NO.**	4
DATE.	18 MAY 2006	**FILE NO.**	FL0957.01F01005

PROPOSED LEACHATE COLLECTION SYSTEM IN CELL 3



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22 May 2006
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TAMPA, FLORIDA 33637 USA
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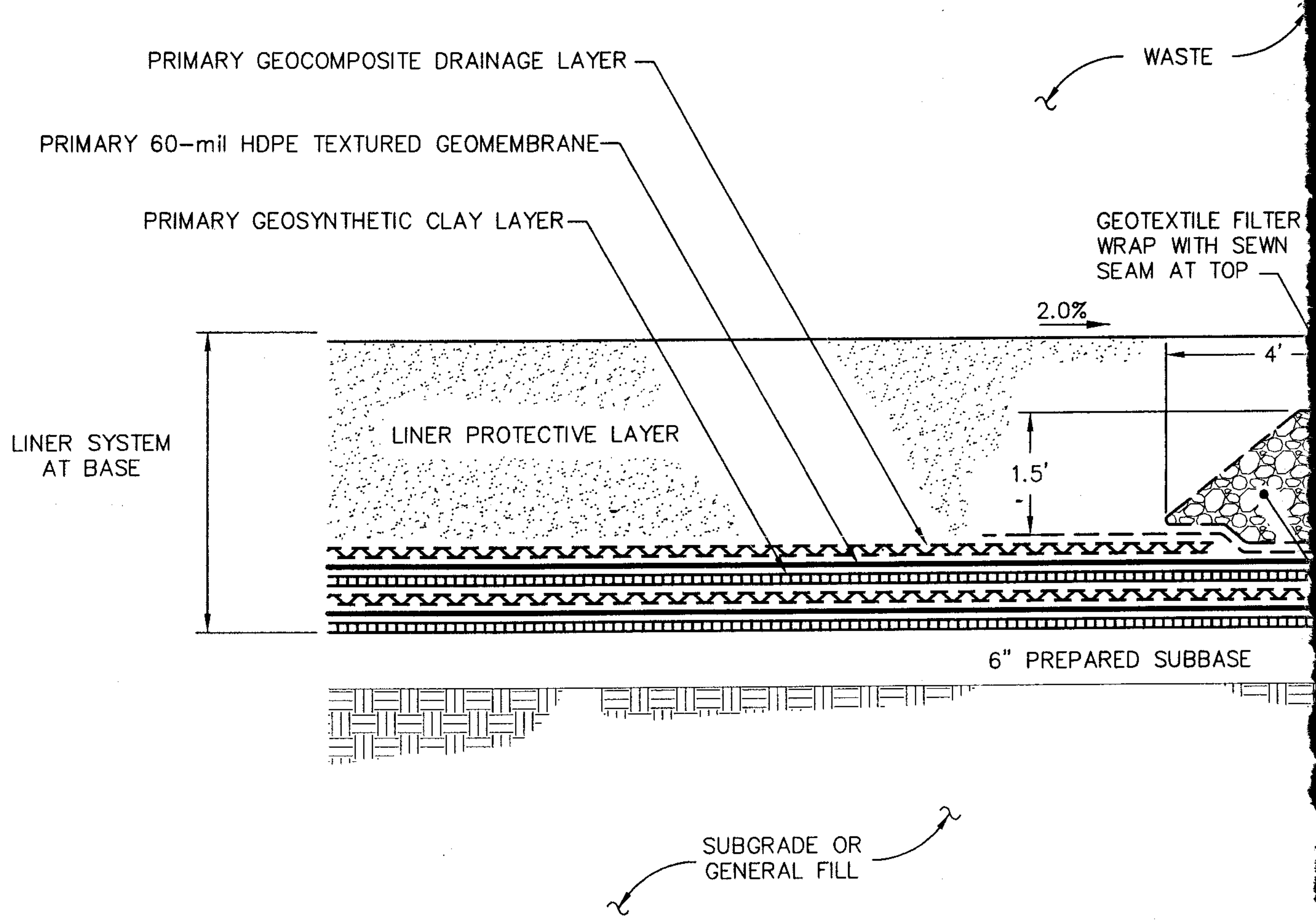
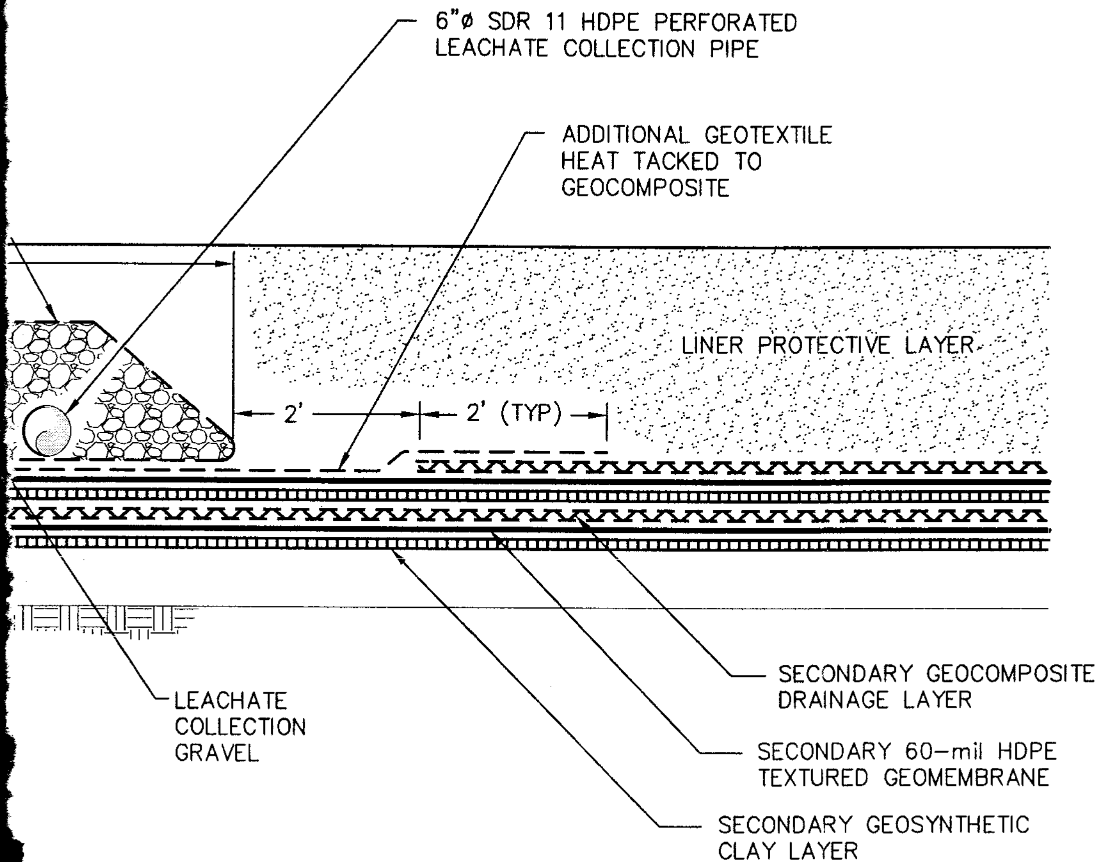
AUTHORIZATION CERTIFICATE NO. 00004321

PROJECT NO.	FL0957.01	FIGURE NO.	5
DATE.	18 MAY 2006	FILE NO.	FL0957.01F01003

DETAILS FOR PROPOSED CENTRAL LE



ACHATE COLLECTION DRAIN IN CELL 3



0 1' 2' 4'

SCALE: 1" = 2'

A Gupta
22 May 2006
AYUSHMAN GUPTA
LICENSE NUMBER 54023

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TAMPA, FLORIDA 33637 USA
TEL: (813) 558-0990 FAX: (813) 558-9726
AUTHORIZATION CERTIFICATE NO. 00004321

PROJECT NO.	FL09527.01	FIGURE NO.	6
DATE.	18 MAY 2006	FILE NO.	FL0957.01F01004

Appendix A

FDEP FORM FOR CELL 3 MINOR MODIFICATION APPLICATION

DEP Form # 62-701.900(1)
Form Title Solid Waste Management Facility Permit
Effective Date 05-27-01
DEP Application No. ______ (Filled by DEP)

Florida Department of Environmental Protection
Twin Towers Office Bldg. • 2600 Blair Stone Road • Tallahassee, FL 32399-2400

STATE OF FLORIDA
DEPARTMENT OF ENVIRONMENTAL PROTECTION

APPLICATION FOR A PERMIT TO CONSTRUCT, OPERATE, MODIFY OR CLOSE A SOLID WASTE MANAGEMENT FACILITY

APPLICATION INSTRUCTIONS AND FORMS

Northwest District	Northeast District	Central District	Southwest District	South District	Southeast District
160 Governmental Center	7825 Baymeadows Way, Ste. B200	3319 Maguire Blvd., Ste. 232	3804 Coconut Palm Dr.	2295 Victoria Ave., Ste. 364	400 North Congress Ave.
Pensacola, FL 32501-5794	Jacksonville, FL 32256-7590	Orlando, FL 32803-3767	Tampa, FL 33619	Fort Myers, FL 33901-3881	West Palm Beach, FL 33401
850-595-8360	904-448-4300	407-894-7555	813-744-6100	941-332-6975	561-681-6600

INSTRUCTIONS TO APPLY FOR A SOLID WASTE MANAGEMENT FACILITY PERMIT

I. General

Solid Waste Management Facilities shall be permitted pursuant to Section 403.707, Florida Statutes,(FS) and in accordance with Florida Administrative Code (FAC) Chapter 62-701. A minimum of four copies of the application shall be submitted to the Department's District Office having jurisdiction over the facility. The appropriate fee in accordance with Rule 62-701.315, FAC, shall be submitted with the application by check made payable to the Department of Environmental Protection (DEP).

Complete appropriate sections for the type of facility for which application is made. Entries shall be typed or printed in ink. All blanks shall be filled in or marked "not applicable" or "no substantial change". Information provided in support of the application shall be marked "submitted" and the location of this information in the application package indicated. The application shall include all information, drawings, and reports necessary to evaluate the facility. Information required to complete the application is listed on the attached pages of this form.

II. Application Parts Required for Construction and Operation Permits

A. Landfills and Ash Monofills - Submit parts A,B, D through T
B. Asbestos Monofills - Submit parts A,B,D,E,F,G,J,L,N, P through S, and T
C. Industrial Solid Waste Facilities - Submit parts A,B, D through T
D. Non-Disposal Facilities - Submit parts A,C,D,E,J,N,S and T

NOTE: Portions of some parts may not be applicable.

NOTE: For facilities that have been satisfactorily constructed in accordance with their construction permit, the information required for A,B,C and D type facilities does not have to be resubmitted for an operation permit if the information has not substantially changed during the construction period. The appropriate portion of the form should be marked "no substantial change".

III. Application Parts Required for Closure Permits

A. Landfills and Ash Monofills - Submit parts A,B,M, O through T
B. Asbestos Monofills - Submit parts A,B,N, P through T
C. Industrial Solid Waste Facilities - Submit parts A,B, M through T
D. Non-Disposal Facilities - Submit parts A,C,N,S and T

NOTE: Portions of some parts may not be applicable.

IV. Permit Renewals

The above information shall be submitted at time of permit renewal in support of the new permit. However, facility information that was submitted to the Department to support the expiring permit, and which is still valid, does not need to be re-submitted for permit renewal. Portions of the application not re-submitted shall be marked "no substantial change" on the application form.

V. Application Codes

S	-	Submitted
LOCATION	-	Physical location of information in application
N/A	-	Not Applicable
N/C	-	No Substantial Change

VI. LISTING OF APPLICATION PARTS

PART A: GENERAL INFORMATION

PART B: DISPOSAL FACILITY GENERAL INFORMATION

PART C: NON-DISPOSAL FACILITY GENERAL INFORMATION

PART D: PROHIBITIONS

PART E: SOLID WASTE MANAGEMENT FACILITY PERMIT REQUIREMENTS, GENERAL

PART F: LANDFILL PERMIT REQUIREMENTS

PART G: GENERAL CRITERIA FOR LANDFILLS

PART H: LANDFILL CONSTRUCTION REQUIREMENTS

PART I: HYDROGEOLOGICAL INVESTIGATION REQUIREMENTS

PART J: GEOTECHNICAL INVESTIGATION REQUIREMENTS

PART K: VERTICAL EXPANSION OF LANDFILLS

PART L: LANDFILL OPERATION REQUIREMENTS

PART M: WATER QUALITY AND LEACHATE MONITORING REQUIREMENTS

PART N: SPECIAL WASTE HANDLING REQUIREMENTS

PART O: GAS MANAGEMENT SYSTEM REQUIREMENTS

PART P: LANDFILL CLOSURE REQUIREMENTS

PART Q: CLOSURE PROCEDURES

PART R: LONG TERM CARE REQUIREMENTS

PART S: FINANCIAL RESPONSIBILITY REQUIREMENTS

PART T: CERTIFICATION BY APPLICANT AND ENGINEER OR PUBLIC OFFICER

STATE OF FLORIDA
DEPARTMENT OF ENVIRONMENTAL PROTECTION
APPLICATION FOR A PERMIT TO CONSTRUCT, OPERATE, MODIFY OR CLOSE
A SOLID WASTE MANAGEMENT FACILITY

Please Type or Print

A. GENERAL INFORMATION

1. Type of facility (check all that apply):

[✓] Disposal
- [✓] Class I Landfill
- [ ] Class II Landfill
- [ ] Class III Landfill
- [ ] Other Describe: ______
- [ ] Ash Monofill
- [ ] Asbestos Monofill
- [ ] Industrial Solid Waste

[ ] Non-Disposal
- [ ] Incinerator For Non-biomedical Waste
- [ ] Waste to Energy Without Power Plant Certification
- [ ] Other Describe: ______

NOTE: Waste Processing Facilities should apply on Form 62-701.900(4), FAC; Land Clearing Disposal Facilities should notify on Form 62-701.900(3), FAC; Compost Facilities should apply on Form 62-701.900(10), FAC; and C&D Disposal Facilities should apply on Form 62-701.900(6), FAC

2. Type of application:
- [ ] Construction
- [ ] Operation
- [✓] Construction/Operation
- [ ] Closure

3. Classification of application:
- [ ] New
- [ ] Renewal
- [ ] Substantial Modification
- [ ] Intermediate Modification
- [✓] Minor Modification

4. Facility name: **Oak Hammock Disposal Facility (OHDF)**

5. DEP ID number: ______ County: **Osceola**

6. Facility location (main entrance): **Approximately 5 miles south of Holopaw, Florida on highway U.S. 441**

7. Location coordinates:

Section: **11&14** Township: **28S** Range: **33E**

Latitude: **28** ° **03** ' **32** " Longitude: **81** ° **05** ' **46** "

DEP FORM 62-701.900(1)
Effective 05-27-01

8. Applicant name (operating authority): Omni Waste of Osceola County, LLC / Waste Services, Inc

Mailing address: 1051 Omni Way, St. Cloud, FL 34773
Street or P.O. Box City State Zip

Contact person: Shawn McCash Telephone: (561) 237-3414

Title: Senior Vice President

smccash@wasteservicesinc.com
E-Mail address (if available)

9. Authorized agent/Consultant: GeoSyntec Consultants

Mailing address: 14055 Riveredge Dr. Suite 300, Tampa, FL 33637
Street or P.O. Box City State Zip

Contact person: Ayushman Gupta Telephone: (813) 558-0990

Title: Senior Engineer

agupta@geosyntec.com
E-Mail address (if available)

10. Landowner(if different than applicant): ______

Mailing address: ______
Street or P.O. Box City State Zip

Contact person: ______ Telephone: (___) ______

______
E-Mail address (if available)

11. Cities, towns and areas to be served: Osceola and other Counties

12. Population to be served:

Current: ______ Five-Year Projection: ______

13. Date site will be ready to be inspected for completion: N/A

14. Expected life of the facility: 30 years

15. Estimated costs:

Total Construction: $ N/A Closing Costs: $ N/A

16. Anticipated construction starting and completion dates:

From: N/A To: N/A

17. Expected volume or weight of waste to be received:

______ yds^3/day 1,700 tons/day ______ gallons/day

B. DISPOSAL FACILITY GENERAL INFORMATION

1. Provide brief description of disposal facility design and operations planned under this application:

This minor modification permit application is submitted to permit minor design changes to currently permitted Cell 3 leachate collection system. The minor design change includes addition of a central leachate collection drain system in Cell 3

2. Facility site supervisor: **Matt Orr**

Title: **Manager** Telephone: (407) **891-3720**

morr@wasteservicesinc.com
E-Mail address (if available)

3. Disposal area: Total **264** acres; Used **53** acres; Available **211** acres.

4. Weighing scales used: [✓] Yes [ ] No

5. Security to prevent unauthorized use: [✓] Yes [ ] No

6. Charge for waste received: ________ $/yds³ ________ $/ton

7. Surrounding land use, zoning:

[ ] Residential
[✓] Agricultural
[ ] Commercial
[ ] Industrial
[ ] None
[ ] Other Describe: ________

8. Types of waste received:

[✓] Residential
[✓] Commercial
[ ] Incinerator/WTE ash
[ ] Treated biomedical
[ ] Water treatment sludge
[ ] Air treatment sludge
[ ] Agricultural
[ ] Asbestos
[ ] Other Describe: ________
[✓] C & D debris
[ ] Shredded/cut tires
[ ] Yard trash
[ ] Septic tank
[ ] Industrial
[ ] Industrial sludge
[ ] Domestic sludge

9. Salvaging permitted: [ ] Yes [✓] No

10. Attendant: [ ] Yes [ ] No Trained operator: [✓] Yes [ ] No

11. Spotters: Yes [✓] No [ ] Number of spotters used: Min. of 1 per workface

12. Site located in: [✓] Floodplain [✓] Wetlands [ ] Other ________

13. Property recorded as a Disposal Site in County Land Records: [✓] Yes [ ] No

14. Days of operation: **Monday thru Friday, half day on Saturday**

15. Hours of operation: **Typical Hours: 7 am to 6 pm Mon - Fri; 8 am to noon Sat**

16. Days Working Face covered: **Each Working Day**

17. Elevation of water table: **79** Ft. (NGVD 1929)

18. Number of monitoring wells: **45**

19. Number of surface monitoring points: **4**

20. Gas controls used: [✓] Yes [ ] No Type controls: [✓] Active [ ] Passive

Gas flaring: [✓] Yes [ ] No Gas recovery: [ ] Yes [✓] No

21. Landfill unit liner type:

[ ] Natural soils
[ ] Single clay liner
[ ] Single geomembrane
[ ] Single composite
[ ] Slurry wall
[ ] Other Describe: ______
[ ] Double geomembrane
[ ] Geomembrane & composite
[✓] Double composite
[ ] None

22. Leachate collection method:

[✓] Collection pipes
[✓] Geonets
[ ] Well points
[ ] Perimeter ditch
[ ] Other Describe: ______
[✓] Sand layer
[ ] Gravel layer
[ ] Interceptor trench
[ ] None

23. Leachate storage method:

[ ] Tanks
[✓] Surface impoundments (with flexible storage containers)
[ ] Other Describe: ______

24. Leachate treatment method:

[ ] Oxidation
[ ] Secondary
[ ] Advanced
[✓] None
[ ] Other ______
[ ] Chemical treatment
[ ] Settling

25. Leachate disposal method:

- [ ] Recirculated
- [✓] Transported to WWTP
- [ ] Injection well
- [ ] Evaporation
- [ ] Other ______________________________
- [ ] Pumped to WWTP
- [ ] Discharged to surface water
- [ ] Percolation ponds

26. For leachate discharged to surface waters:

Name and Class of receiving water: **N/A**

27. Storm Water:

Collected: [✓] Yes [ ] No

Type of treatment: Dry and wet retention for landfill and dry retention for acess road

Name and Class of receiving water: __Bull Creek, Class III____________________

28. Environmental Resources Permit (ERP) number or status: ______________________

__ ERp 49 - 0199752 - 001 & 002__________________________

C. NON-DISPOSAL FACILITY GENERAL INFORMATION ---N/A----

1. Provide brief description of the non-disposal facility design and operations planned under this application:

____

____

____

____

2. Facility site supervisor: ______________________________

Title: ____________________ Telephone: (___) ____________________

____
E-Mail address (if available)

3. Site area: Facility __________ acres; Property __________ acres

4. Security to prevent unauthorized use: [ ] Yes [ ] No

5. Site located in: [ ] Floodplain [ ] Wetlands [ ] Other __________

6. Days of operation: ______________________________

7. Hours of operation: ______________________________

8. Number of operating staff: ______________

9. Expected useful life: ________ Years

10. Weighing scales used: [ ] Yes [ ] No

11. Normal processing rate: ________ yd^3/day ________ tons/day ________ gal/day

12. Maximum processing rate: ________ yd^3/day ________ tons/day ________ gal/day

13. Charge for waste received: ______________________________

14. Storm Water Collected: [ ] Yes [ ] No

Type of treatment: ______________________________

Name and Class of receiving water: ______________________________

15. Environmental Resources Permit (ERP) number or status: ______________________________

____

16. Final residue produced:

________ % of normal processing rate ________ % of maximum processing rate

________ Tons/day ________ Tons/day

Disposed of at:

Facility name: ____________________ County: ____________________

17. Estimated operating costs: $ ________________

Total cost/ton: $ ____________________ Net cost/ton: $ ____________________

18. Provide a site plan, at a scale not greater than 200 feet to the inch, which shows the facility location and identifies the proposed waste and final residue storage areas, total acreage of the site, and any other features which are relevant to the prohibitions or location restrictions in Rule 62-701.300, FAC, such as water bodies or wetlands on or within 200 feet of the site, and potable water wells on or within 500 feet of the site.

19. Provide a description of how the waste and final residue will be managed to not be expected to cause violations of the Department's ground water, surface water or air standards or criteria

20. Provide an estimate of the maximum amount of waste and final residue that will be store on-site.

21. Provide a detailed description of the technology use at the facility and the functions of all processing equipment that will be utilized. The descriptions shall explain the flow of waste and residue through all the proposed unit operations and shall include: (1) regular facility operations as they are expected to occur; (2) procedures for start up operations, and scheduled and unscheduled shut down operations; (3) potential safety hazards and control methods, including fire detection and control; (4) a description of any expected air emissions and wastewater discharges from the facility which may be potential pollution sources; (5) a description and usage rate of any chemical or biological additives that will be used in the process; and (6) process flow diagrams for the facility operations.

22. Provide a description of the loading, unloading and processing areas.

23. Provide a description of the leachate control system that will be used to prevent discharge of leachate to the environment and mixing of leachate with stormwater. Note: Ground water monitoring may be required for the facility depending on the method of leachate control used.

24. Provide an operation plan for the facility which includes: (1) a description of general facility operations, the number of personnel responsible for the operations including their respective job descriptions, and the types of equipment that will be used at the facility; (2) procedures to ensure any unauthorized wastes received at the site will be properly managed; (3) a contingency plan to cover operation interruptions and emergencies such as fires, explosions, or natural disasters; (4) procedures to ensure operational records needed for the facility will be adequately prepared and maintained; and (5) procedures to ensure that the wastes and final residue will be managed to not be expected to cause pollution.

25. Provide a closure plan that describes the procedures that will be implemented when the facility closes including: (1) estimated time to complete closure; (2) procedures for removing and properly managing or disposing of all wastes and final residues; (3) notification of the Department upon ceasing operations and completion of final closure.

D. **PROHIBITIONS** (62-701.300, FAC) ---- N/C -----

S	LOCATION	N/A	N/C	
___	___	___	___	1. Provide documentation that each of the siting criteria will be satisfied for the facility; (62-701.300(2), FAC)
___	___	___	___	2. If the facility qualifies for any of the exemptions contained in Rules 62-701.300(12) through (16), FAC, then document this qualification(s).
___	___	___	___	3. Provide documentation that the facility will be in compliance with the burning restrictions; (62-701.300(3), FAC)
___	___	___	___	4. Provide documentation that the facility will be in compliance with the hazardous waste restrictions; (62-701.300(4), FAC)
___	___	___	___	5. Provide documentation that the facility will be in compliance with the PCB disposal restrictions; (62-701.300(5), FAC)
___	___	___	___	6. Provide documentation that the facility will be in compliance with the biomedical waste restrictions; (62-701.300(6), FAC)
___	___	___	___	7. Provide documentation that the facility will be in compliance with the Class I surface water restrictions; (62-701.300(7), FAC)
___	___	___	___	8. Provide documentation that the facility will be in compliance with the special waste for landfills restrictions; (62-701.300(8), FAC)
___	___	___	___	9. Provide documentation that the facility will be in compliance with the special waste for waste-to-energy facilities restrictions; (62-701.300(9), FAC)
___	___	___	___	10. Provide documentation that the facility will be in compliance with the liquid restrictions; (62-701.300(10), FAC)
___	___	___	___	11. Provide documentation that the facility will be in compliance with the used oil restrictions; (62-701.300(11), FAC)

E. **SOLID WASTE MANAGEMENT FACILITY PERMIT REQUIREMENTS, GENERAL** (62-701.320, FAC)

S	LOCATION	N/A	N/C	
X	Attached			1. Four copies, at minimum, of the completed application form, all supporting data and reports; (62-701.320(5)(a),FAC)
X	Attached			2. Engineering and/or professional certification (signature, date and seal) provided on the applications and all engineering plans, reports and supporting information for the application; (62-701.320(6),FAC)
X	Attached			3. A letter of transmittal to the Department; (62-701.320(7)(a),FAC)
X	Attached			4. A completed application form dated and signed by the applicant; (62-701.320(7)(b),FAC)
X	Attached			5. Permit fee specified in Rule 62-701.315, FAC in check or money order, payable to the Department; (62-701.320(7)(c),FAC)
X	Attached			6. An engineering report addressing the requirements of this rule and with the following format: a cover sheet, text printed on 8 1/2 inch by 11 inch consecutively numbered pages, a table of contents or index, the body of the report and all appendices including an operation plan, contingency plan, illustrative charts and graphs, records or logs of tests and investigations, engineering calculations; (62-701.320(7)(d),FAC)
			X	7. Operation Plan and Closure Plan; (62-701.320(7)(e)1,FAC)
			X	8. Contingency Plan; (62-701.320(7)(e)2,FAC)
				9. Plans or drawings for the solid waste management facilities in appropriate format (including sheet size restrictions, cover sheet, legends, north arrow, horizontal and vertical scales, elevations referenced to NGVD 1929) showing; (62-702.320(7)(f),FAC)
			X	a. A regional map or plan with the project location;
			X	b. A vicinity map or aerial photograph no more than 1 year old;
			X	c. A site plan showing all property boundaries certified by a registered Florida land surveyor;

S	LOCATION	N/A	N/C	PART E CONTINUED
			X	d. Other necessary details to support the engineering report.
			X	10. Documentation that the applicant either owns the property or has legal authority from the property owner to use the site; (62-701.320(7)(g),FAC)
			X	11. For facilities owned or operated by a county, provide a description of how, if any, the facilities covered in this application will contribute to the county's achievement of the waste reduction and recycling goals contained in Section 403.706,FS; (62-701.320(7)(h),FAC)
			X	12. Provide a history and description of any enforcement actions taken by the Department against the applicant for violations of applicable statutes, rules, orders or permit conditions relating to the operation of any solid waste management facility in this state; (62-701.320(7)(i),FAC)
			X	13. Proof of publication in a newspaper of general circulation of notice of application for a permit to construct or substantially modify a solid waste management facility; (62-702.320(8),FAC)
			X	14. Provide a description of how the requirements for airport safety will be achieved including proof of required notices if applicable. If exempt, explain how the exemption applies; (62-701.320(13),FAC)
			X	15. Explain how the operator training requirements will be satisfied for the facility; (62-701.320(15), FAC)

F. LANDFILL PERMIT REQUIREMENTS (62-701.330, FAC) ------ **N/C** ------

S	LOCATION	N/A	N/C		
___	___________	___	___	1.	Vicinity map or aerial photograph no more than 1 year old and of appropriate scale showing land use and local zoning within one mile of the landfill and of sufficient scale to show all homes or other structures, water bodies, and roads other significant features of the vicinity. All significant features shall be labeled; (62-701.330(3)(a),FAC)
___	___________	___	___	2.	Vicinity map or aerial photograph no more than 1 year old showing all airports that are located within five miles of the proposed landfill; (62-701.330(3)(b),FAC)
___	___________	___	___	3.	Plot plan with a scale not greater than 200 feet to the inch showing; (62-701.330(3)(c),FAC)
___	___________	___	___		a. Dimensions;
___	___________	___	___		b. Locations of proposed and existing water quality monitoring wells;
___	___________	___	___		c. Locations of soil borings;
___	___________	___	___		d. Proposed plan of trenching or disposal areas;
___	___________	___	___		e. Cross sections showing original elevations and proposed final contours which shall be included either on the plot plan or on separate sheets;
___	___________	___	___		f. Any previously filled waste disposal areas;
___	___________	___	___		g. Fencing or other measures to restrict access.
				4.	Topographic maps with a scale not greater than 200 feet to the inch with 5-foot contour intervals showing; (62-701.330(3)(d),FAC):
___	___________	___	___		a. Proposed fill areas;
___	___________	___	___		b. Borrow areas;
___	___________	___	___		c. Access roads;
___	___________	___	___		d. Grades required for proper drainage;
___	___________	___	___		e. Cross sections of lifts;

S	LOCATION	N/A	N/C	PART F CONTINUED
___	___	___	___	f. Special drainage devices if necessary;
___	___	___	___	g. Fencing;
___	___	___	___	h. Equipment facilities.
				5. A report on the landfill describing the following; (62-701.330(3)(e),FAC)
___	___	___	___	a. The current and projected population and area to be served by the proposed site;
___	___	___	___	b. The anticipated type, annual quantity, and source of solid waste, expressed in tons;
___	___	___	___	c. The anticipated facility life;
___	___	___	___	d. The source and type of cover material used for the landfill.
___	___	___	___	6. Provide evidence that an approved laboratory shall conduct water quality monitoring for the facility in accordance with Chapter 62-160,FAC; (62-701.330(3)(h),FAC)
___	___	___	___	7. Provide a statement of how the applicant will demonstrate financial responsibility for the closing and long-term care of the landfill; (62-701.330(3)(i),FAC)

G. GENERAL CRITERIA FOR LANDFILLS (62-701.340,FAC) ----- N/C ------

S	LOCATION	N/A	N/C	
___	___	___	___	1. Describe (and show on a Federal Insurance Administration flood map, if available) how the landfill or solid waste disposal unit shall not be located in the 100-year floodplain where it will restrict the flow of the 100-year flood, reduce the temporary water storage capacity of the floodplain unless compensating storage is provided, or result in a washout of solid waste; (62-701.340(4)(b),FAC)
___	___	___	___	2. Describe how the minimum horizontal separation between waste deposits in the landfill and the landfill property boundary shall be 100 feet, measured from the toe of the proposed final cover slope; (62-701.340(4)(c),FAC)
___	___	___	___	3. Describe what methods shall be taken to screen the landfill from public view where such screening can practically be provided; (62-701.340(4)(d),FAC)

H. LANDFILL CONSTRUCTION REQUIREMENTS (62-701.400,FAC)

S	LOCATION	N/A	N/C	
			X	1. Describe how the landfill shall be designed so that solid waste disposal units will be constructed and closed at planned intervals throughout the design period of the landfill; (62-701.400(2),FAC)
				2. Landfill liner requirements; (62-701.400(3),FAC)
				a. General construction requirements; (62-701.400(3)(a),FAC):
			X	(1) Provide test information and documentation to ensure the liner will be constructed of materials that have appropriate physical, chemical, and mechanical properties to prevent failure;
			X	(2) Document foundation is adequate to prevent liner failure;
			X	(3) Constructed so bottom liner will not be adversely impacted by fluctuations of the ground water;
		X		(4) Designed to resist hydrostatic uplift if bottom liner located below seasonal high ground water table;
			X	(5) Installed to cover all surrounding earth which could come into contact with the waste or leachate.
				b. Composite liners; (62-701.400(3)(b),FAC)
			X	(1) Upper geomembrane thickness and properties;
X	Sec 5 & App C			(2) Design leachate head for primary LCRS including leachate recirculation if appropriate;
			X	(3) Design thickness in accordance with Table A and number of lifts planned for lower soil component.

S	LOCATION	N/A	N/C	PART H CONTINUED
				c. Double liners; (62-701.400(3)(c),FAC)
			X	(1) Upper and lower geomembrane thicknesses and properties;
X	Sec 5 & App C			(2) Design leachate head for primary LCRS to limit the head to one foot above the liner;
			X	(3) Lower geomembrane sub-base design;
X	Sec 5 & App C			(4) Leak detection and secondary leachate collection system minimum design criteria ($k \geq 10$ cm/sec, head on lower liner ≤ 1 inch, head not to exceed thickness of drainage layer);
				d. Standards for geosynthetic components; (62-701.400(3)(d),FAC)
			X	(1) Field seam test methods to ensure all field seams are at least 90 percent of the yield strength for the lining material;
			X	(2) Geomembranes to be used shall pass a continuous spark test by the manufacturer;
			X	(3) Design of 24-inch-thick protective layer above upper geomembrane liner;
			X	(4) Describe operational plans to protect the liner and leachate collection system when placing the first layer of waste above 24-inch-thick protective layer.
			X	(5) HDPE geomembranes, if used, meet the specifications in GRI GM13;
		X		(6) PVC geomembranes, if used, meet the specifications in PGI 1197;
			X	(7) Interface shear strength testing results of the actual components which will be used in the liner system;
X	Sec 5 & App D			(8) Transmissivity testing results of geonets if they are used in the liner system;
			X	(9) Hydraulic conductivity testing results of geosynthetic clay liners if they are used in the liner system;

S	LOCATION	N/A	N/C	PART H CONTINUED
				e. Geosynthetic specification requirements; (62-701.400(3)(e),FAC)
			X	(1) Definition and qualifications of the designer, manufacturer, installer, QA consultant and laboratory, and QA program;
			X	(2) Material specifications for geomembranes, geocomposites, geotextiles, geogrids, and geonets;
			X	(3) Manufacturing and fabrication specifications including geomembrane raw material and roll QA, fabrication personnel qualifications, seaming equipment and procedures, overlaps, trial seams, destructive and nondestructive seam testing, seam testing location, frequency, procedure, sample size and geomembrane repairs;
			X	(4) Geomembrane installation specifications including earthwork, conformance testing, geomembrane placement, installation personnel qualifications, field seaming and testing, overlapping and repairs, materials in contact with geomembrane and procedures for lining system acceptance;
			X	(5) Geotextile and geogrid specifications including handling and placement, conformance testing, seams and overlaps, repair, and placement of soil materials and any overlying materials;
			X	(6) Geonet and geocomposite specifications including handling and placement, conformance testing, stacking and joining, repair, and placement of soil materials and any overlying materials;
			X	(7) Geosynthetic clay liner specifications including handling and placement, conformance testing, seams and overlaps, repair, and placement of soil material and any overlying materials;
				f. Standards for soil components (62-710.400(3)(f),FAC):
			X	(1) Description of construction procedures including overexcavation and backfilling to preclude structural inconsistencies and procedures for placing and compacting soil component in layers;

S	LOCATION	N/A	N/C	PART H CONTINUED
			X	(2) Demonstration of compatibility of the soil component with actual or simulated leachate in accordance with EPA Test Method 9100 or an equivalent test method;
			X	(3) Procedures for testing in-situ soils to demonstrate they meet the specifications for soil liners;
				(4) Specifications for soil component of liner including at a minimum:
			X	(a) Allowable particle size distribution, Atterberg limits, shrinkage limit;
			X	(b) Placement moisture and dry density criteria;
			X	(c) Maximum laboratory-determined saturated hydraulic conductivity using simulated leachate;
			X	(d) Minimum thickness of soil liner;
			X	(e) Lift thickness;
			X	(f) Surface preparation (scarification);
			X	(g) Type and percentage of clay mineral within the soil component;
			X	(5) Procedures for constructing and using a field test section to document the desired saturated hydraulic conductivity and thickness can be achieved in the field.
				3. Leachate collection and removal system (LCRS); (62-701.400(4),FAC)
				a. The primary and secondary LCRS requirements; (62-701.400(4)(a),FAC)
X	Sec 3			(1) Constructed of materials chemically resistant to the waste and leachate;
X	Sec 3			(2) Have sufficient mechanical properties to prevent collapse under pressure;
X	Sec 3			(3) Have granular material or synthetic geotextile to prevent clogging;
X	Sec 4			(4) Have method for testing and cleaning clogged pipes or contingent designs for rerouting leachate around failed areas;

S	LOCATION	N/A	N/C	PART H CONTINUED
				b. Primary LCRS requirements; (62-701.400(4)(b),FAC)
X	Sec 4			(1) Bottom 12 inches having hydraulic conductivity $\geq 1 \times 10^{-3}$ cm/sec;
X	Sec 4			(2) Total thickness of 24 inches of material chemically resistant to the waste and leachate;
X	App C			(3) Bottom slope design to accomodate for predicted settlement;
X	Sec 4			(4) Demonstration that synthetic drainage material, if used, is equivalent or better than granular material in chemical compatibility, flow under load and protection of geomembrane liner.
				4. Leachate recirculation; (62-701.400(5),FAC) ---N/A---
				a. Describe general procedures for recirculating leachate;
				b. Describe procedures for controlling leachate runoff and minimizing mixing of leachate runoff with storm water;
				c. Describe procedures for preventing perched water conditions and gas buildup;
				d. Describe alternate methods for leachate management when it cannot be recirculated due to weather or runoff conditions, surface seeps, wind-blown spray, or elevated levels of leachate head on the liner;
				e. Describe methods of gas management in accordance with Rule 62-701.530, FAC;
				f. If leachate irrigation is proposed, describe treatment methods and standards for leachate treatment prior to irrigation over final cover and provide documentation that irrigation does not contribute significantly to leachate generation.

S	LOCATION	N/A	N/C	PART H CONTINUED
				5. Leachate storage tanks and leachate surface impoundments; (62-701.400(6),FAC)
				a. Surface impoundment requirements; ---N/C--- (62-701.400(6)(b),FAC)
___	___	___	___	(1) Documentation that the design of the bottom liner will not be adversely impacted by fluctuations of the ground water;
___	___	___	___	(2) Designed in segments to allow for inspection and repair as needed without interruption of service;
				(3) General design requirements;
___	___	___	___	(a) Double liner system consisting of an upper and lower 60-mil minimum thickness geomembrane;
___	___	___	___	(b) Leak detection and collection system with hydraulic conductivity ≥ 1 cm/sec;
___	___	___	___	(c) Lower geomembrane placed on subbase ≥ 6 inches thick with $k \leq 1x10^{-5}$ cm/sec or on an approved geosynthetic clay liner with $k \leq 1x10^{-7}$ cm/sec;
___	___	___	___	(d) Design calculation to predict potential leakage through the upper liner;
___	___	___	___	(e) Daily inspection requirements and notification and corrective action requirements if leakage rates exceed that predicted by design calculations;
___	___	___	___	(4) Description of procedures to prevent uplift, if applicable;
___	___	___	___	(5) Design calculations to demonstrate minimum two feet of freeboard will be maintained;
___	___	___	___	(6) Procedures for controlling disease vectors and off-site odors.

S	LOCATION	N/A	N/C

PART H CONTINUED

b. Above-ground leachate storage tanks; ---N/A--- (62-701.400(6)(c),FAC)

(1) Describe tank materials of construction and ensure foundation is sufficient to support tank;

(2) Describe procedures for cathodic protection if needed for the tank;

(3) Describe exterior painting and interior lining of the tank to protect it from the weather and the leachate stored;

(4) Describe secondary containment design to ensure adequate capacity will be provided and compatibility of materials of construction;

(5) Describe design to remove and dispose of stormwater from the secondary containment system;

(6) Describe an overfill prevention system such as level sensors, gauges, alarms and shutoff controls to prevent overfilling;

(7) Inspections, corrective action and reporting requirements;

(a) Overfill prevention system weekly;

(b) Exposed tank exteriors weekly;

(c) Tank interiors when tank is drained or at least every three years;

(d) Procedures for immediate corrective action if failures detected;

(e) Inspection reports available for department review.

c. Underground leachate storage tanks; ---N/A--- (62-701.400(6)(d),FAC)

(1) Describe materials of construction;

(2) A double-walled tank design system to be used with the following requirements;

S	LOCATION	N/A	N/C	PART H CONTINUED
				(a) Interstitial space monitoring at least weekly;
				(b) Corrosion protection provided for primary tank interior and external surface of outer shell;
				(c) Interior tank coatings compatible with stored leachate;
				(d) Cathodic protection inspected weekly and repaired as needed;
				(3) Describe an overfill prevention system such as level sensors, gauges, alarms and shutoff controls to prevent overfilling and provide for weekly inspections;
				(4) Inspection reports available for department review.
			X	d. Schedule provided for routine maintenance of LCRS; (62-701.400(6)(e),FAC)---N/C---
				6. Liner systems construction quality assurance (CQA); (62-701.400(7),FAC)
				a. Provide CQA Plan including: ---N/C---
				(1) Specifications and construction requirements for liner system;
				(2) Detailed description of quality control testing procedures and frequencies;
				(3) Identification of supervising professional engineer;
				(4) Identify responsibility and authority of all appropriate organizations and key personnel involved in the construction project;
				(5) State qualifications of CQA professional engineer and support personnel;
				(6) Description of CQA reporting forms and documents;

S	LOCATION	N/A	N/C

PART H CONTINUED

b. An independent laboratory experienced in the testing of geosynthetics to perform required testing;

7. Soil Liner CQA (62-701.400(8)FAC) ----N/C---

a. Documentation that an adequate borrow source has been located with test results or description of the field exploration and laboratory testing program to define a suitable borrow source;

b. Description of field test section construction and test methods to be implemented prior to liner installation;

c. Description of field test methods including rejection criteria and corrective measures to insure proper liner installation.

8. Surface water management systems; (62-701.400(9),FAC)-N/C-

a. Provide a copy of a Department permit for stormwater control or documentation that no such permit is required;

b. Design of surface water management system to isolate surface water from waste filled areas and to control stormwater run-off;

c. Details of stormwater control design including retention ponds, detention ponds, and drainage ways;

9. Gas control systems; (62-701.400(10),FAC)---N/C---

a. Provide documentation that if the landfill is receiving degradable wastes, it will have a gas control system complying with the requirements of Rule 62-701.530, FAC;

10. For landfills designed in ground water, provide documentation that the landfill will provide a degree of protection equivalent to landfills designed with bottom liners not in contact with ground water; (62-701.400(11),FAC) ---N/C---

I. HYDROGEOLOGICAL INVESTIGATION REQUIREMENTS (62-701.410(1), FAC) ----N/C----

S	LOCATION	N/A	N/C		
				1.	Submit a hydrogeological investigation and site report including at least the following information:
___	___	___	___	a.	Regional and site specific geology and hydrogeology;
___	___	___	___	b.	Direction and rate of ground water and surface water flow including seasonal variations;
___	___	___	___	c.	Background quality of ground water and surface water;
___	___	___	___	d.	Any on-site hydraulic connections between aquifers;
___	___	___	___	e.	Site stratigraphy and aquifer characteristics for confining layers, semi-confining layers, and all aquifers below the landfill site that may be affected by the landfill;
___	___	___	___	f.	Description of topography, soil types and surface water drainage systems;
___	___	___	___	g.	Inventory of all public and private water wells within a one-mile radius of the landfill including, where available, well top of casing and bottom elevations, name of owner, age and usage of each well, stratigraphic unit screened, well construction technique and static water level;
___	___	___	___	h.	Identify and locate any existing contaminated areas on the site;
___	___	___	___	i.	Include a map showing the locations of all potable wells within 500 feet, and all community water suupply wells within 1000 feet, of the waste storage and disposal areas;
___	___	___	___	2.	Report signed, sealed and dated by PE or PG.

J. GEOTECHNICAL INVESTIGATION REQUIREMENTS (62-701.410(2),FAC) ----N/C----

S	LOCATION	N/A	N/C		
				1.	Submit a geotechnical site investigation report defining the engineering properties of the site including at least the following:
___	___	___	___	a.	Description of subsurface conditions including soil stratigraphy and ground water table conditions;
___	___	___	___	b.	Investigate for the presence of muck, previously filled areas, soft ground, lineaments and sink holes;
___	___	___	___	c.	Estimates of average and maximum high water table across the site;
				d.	Foundation analysis including:
___	___	___	___	(1)	Foundation bearing capacity analysis;
___	___	___	___	(2)	Total and differential subgrade settlement analysis;
___	___	___	___	(3)	Slope stability analysis;
___	___	___	___	e.	Description of methods used in the investigation and includes soil boring logs, laboratory results, analytical calculations, cross sections, interpretations and conclusions;
___	___	___	___	f.	An evaluation of fault areas, seismic impact zones, and unstable areas as described in 40 CFR 258.13, 40 CFR 258.14 and 40 CFR 258.15.
___	___	___	___	2.	Report signed, sealed and dated by PE or PG.

K. **VERTICAL EXPANSION OF LANDFILLS** (62-701.430,FAC) ----N/A----

S	LOCATION	N/A	N/C		
___	___________	___	___	1.	Describe how the vertical expansion shall not cause or contribute to leachate leakage from the existing landfill or adversely affect the closure design of the existing landfill;
___	___________	___	___	2.	Describe how the vertical expansion over unlined landfills will meet the requirements of Rule 62-701.400, FAC with the exceptions of Rule 62-701.430(1)(c),FAC;
___	___________	___	___	3.	Provide foundation and settlement analysis for the vertical expansion;
___	___________	___	___	4.	Provide total settlement calculations demonstrating that the final elevations of the lining system, that gravity drainage, and that no other component of the design will be adversely affected;
___	___________	___	___	5.	Minimum stability safety factor of 1.5 for the lining system component interface stability and deep stability;
___	___________	___	___	6.	Provide documentation to show the surface water management system will not be adversely affected by the vertical expansion;
___	___________	___	___	7.	Provide gas control designs to prevent accumulation of gas under the new liner for the vertical expansion.

L. **LANDFILL OPERATION REQUIREMENTS** (62-701.500,FAC) ----N/C----

___ ___________ ___ ___ 1. Provide documentation that landfill will have at least one trained operator during operation and at least one trained spotter at each working face; (62-701.500(1),FAC)

2. Provide a landfill operation plan including procedures for: (62-701.500(2), FAC)

___ ___________ ___ ___ a. Designating responsible operating and maintenance personnel;

___ ___________ ___ ___ b. Contingency operations for emergencies;

___ ___________ ___ ___ c. Controlling types of waste received at the landfill;

___ ___________ ___ ___ d. Weighing incoming waste;

___ ___________ ___ ___ e. Vehicle traffic control and unloading;

___ ___________ ___ ___ f. Method and sequence of filling waste;

___ ___________ ___ ___ g. Waste compaction and application of cover;

___ ___________ ___ ___ h. Operations of gas, leachate, and stormwater controls;

___ ___________ ___ ___ i. Water quality monitoring.

___ ___________ ___ ___ j. Maintaining and cleaning the leachate collection system;

___ ___________ ___ ___ 3. Provide a description of the landfill operation record to be used at the landfill; details as to location of where various operational records will be kept (i.e. FDEP permit, engineering drawings, water quality records, etc.) (62-701.500(3),FAC)

___ ___________ ___ ___ 4. Describe the waste records that will be compiled monthly and provided to the Department quarterly; (62-701.500(4),FAC)

___ ___________ ___ ___ 5. Describe methods of access control; (62-701.500(5),FAC)

___ ___________ ___ ___ 6. Describe load checking program to be implemented at the landfill to discourage disposal of unauthorized wastes at the landfill; (62-701.500(6),FAC)

7. Describe procedures for spreading and compacting waste at the landfill that include: (62-701.500(7),FAC)

___ ___________ ___ ___ a. Waste layer thickness and compaction frequencies;

S	LOCATION	N/A	N/C

PART L CONTINUED

b. Special considerations for first layer of waste placed above liner and leachate collection system;

c. Slopes of cell working face and side grades above land surface, planned lift depths during operation;

d. Maximum width of working face;

e. Description of type of initial cover to be used at the facility that controls:

(1) Disease vector breeding/animal attraction

(2) Fires

(3) Odors

(4) Blowing litter

(5) Moisture infiltration

f. Procedures for applying initial cover including minimum cover frequencies;

g. Procedures for applying intermediate cover;

h. Time frames for applying final cover;

i. Procedures for controlling scavenging and salvaging.

j. Description of litter policing methods;

k. Erosion control procedures.

8. Describe operational procedures for leachate management including; (62-701.500(8),FAC)

a. Leachate level monitoring, sampling, analysis and data results submitted to the Department;

b. Operation and maintenance of leachate collection and removal system, and treatment as required;

c. Procedures for managing leachate if it becomes regulated as a hazardous waste;

d. Agreements for off-site discharge and treatment of leachate;

e. Contingency plan for managing leachate during emergencies or equipment problems;

S	LOCATION	N/A	N/C

PART L CONTINUED

f. Procedures for recording quantities of leachate generated in gal/day and including this in the operating record;

g. Procedures for comparing precipitation experienced at the landfill with leachate generation rates and including this information in the operating record;

h. Procedures for water pressure cleaning or video inspecting leachate collection systems.

9. Describe how the landfill receiving degradable wastes shall implement a gas management system meeting the requirements of Rule 62-701.530, FAC; (62-701.500(9),FAC)

10. Describe procedures for operating and maintaining the landfill stormwater management system to comply with the requirements of Rule 62-701.400(9); (62-701.500(10),FAC)

11. Equipment and operation feature requirements; (62-701.500(11),FAC)

a. Sufficient equipment for excavating, spreading, compacting and covering waste;

b. Reserve equipment or arrangements to obtain additional equipment within 24 hours of breakdown;

c. Communications equipment;

d. Dust control methods;

e. Fire protection capabilities and procedures for notifying local fire department authorities in emergencies;

f. Litter control devices;

g. Signs indicating operating authority, traffic flow, hours of operation, disposal restrictions.

12. Provide a description of all-weather access road, inside perimeter road and other roads necessary for access which shall be provided at the landfill; (62-701.500(12),FAC)

13. Additional record keeping and reporting requirements; (62-701.500(13),FAC)

S	LOCATION	N/A	N/C
___	___________	___	___
___	___________	___	___
___	___________	___	___
___	___________	___	___

PART L CONTINUED

a. Records used for developing permit applications and supplemental information maintained for the design period of the landfill;

b. Monitoring information, calibration and maintenance records, copies of reports required by permit maintained for at least 10 years;

c. Maintain annual estimates of the remaining life of constructed landfills and of other permitted areas not yet constructed and submit this estimate annually to the Department;

d. Procedures for archiving and retrieving records which are more than five year old.

M. **WATER QUALITY AND LEACHATE MONITORING REQUIREMENTS** (62-701.510, FAC) ----N/C----

S	LOCATION	N/A	N/C	
___	___	___	___	1. Water quality and leachate monitoring plan shall be submitted describing the proposed ground water, surface water and leachate monitoring systems and shall meet at least the following requirements;
___	___	___	___	a. Based on the information obtained in the hydrogeological investigation and signed, dated and sealed by the PG or PE who prepared it; (62-701.510(2)(a),FAC)
___	___	___	___	b. All sampling and analysis preformed in accordance with Chapter 62-160, FAC; (62-701.510(2)(b),FAC)
				c. Ground water monitoring requirements; (62-701.510(3),FAC)
___	___	___	___	(1) Detection wells located downgradient from and within 50 feet of disposal units;
___	___	___	___	(2) Downgradient compliance wells as required;
___	___	___	___	(3) Background wells screened in all aquifers below the landfill that may be affected by the landfill;
___	___	___	___	(4) Location information for each monitoring well;
___	___	___	___	(5) Well spacing no greater than 500 feet apart for downgradient wells and no greater than 1500 feet apart for upgradient wells unless site specific conditions justify alternate well spacings;
___	___	___	___	(6) Well screen locations properly selected;
___	___	___	___	(7) Procedures for properly abandoning monitoring wells;
___	___	___	___	(8) Detailed description of detection sensors if proposed.

S	LOCATION	N/A	N/C	PART M CONTINUED
				d. Surface water monitoring requirements; (62-701.510(4),FAC)
___	___	___	___	(1) Location of and justification for all proposed surface water monitoring points;
___	___	___	___	(2) Each monitoring location to be marked and its position determined by a registered Florida land surveyor;
___	___	___	___	e. Leachate sampling locations proposed; (62-701.510(5),FAC)
				f. Initial and routine sampling frequency and requirements; (62-701.510(6),FAC)
___	___	___	___	(1) Initial background ground water and surface water sampling and analysis requirements;
___	___	___	___	(2) Routine leachate sampling and analysis requirements;
___	___	___	___	(3) Routine monitoring well sampling and analysis requirements;
___	___	___	___	(4) Routine surface water sampling and analysis requirements.
___	___	___	___	g. Describe procedures for implementing evaluation monitoring, prevention measures and corrective action as required; (62-701.510(7),FAC)
___	___	___	___	h. Water quality monitoring report requirements; (62-701.510(9),FAC)
___	___	___	___	(1) Semi-annual report requirements;
___	___	___	___	(2) Bi-annual report requirements signed, dated and sealed by PG or PE.

N. **SPECIAL WASTE HANDLING REQUIREMENTS** (62-701.520, FAC) -----N/C-----

S	LOCATION	N/A	N/C		
___	___	___	___	1.	Describe procedures for managing motor vehicles; (62-701.520(1),FAC)
___	___	___	___	2.	Describe procedures for landfilling shredded waste; (62-701.520(2),FAC)
___	___	___	___	3.	Describe procedures for asbestos waste disposal; (62-701.520(3),FAC)
___	___	___	___	4.	Describe procedures for disposal or management of contaminated soil; (62-701.520(4), FAC)
___	___	___	___	5.	Describe procedures for disposal of biological wastes; (62-701.520(5), FAC)

O. **GAS MANAGEMENT SYSTEM REQUIREMENTS** (62-701.530,FAC) -----N/C----

1. Provide the design for a gas management systems that will (62-701.530(1), FAC):

___	___	___	___	a.	Be designed to prevent concentrations of combustible gases from exceeding 25% the LEL in structures and 100% the LEL at the property boundary;
___	___	___	___	b.	Be designed for site-specific conditions;
___	___	___	___	c.	Be designed to reduce gas pressure in the interior of the landfill;
___	___	___	___	d.	Be designed to not interfere with the liner, leachate control system or final cover.
___	___	___	___	2.	Provide documentation that will describe locations, construction details and procedures for monitoring gas at ambient monitoring points and with soil monitoring probes; (62-701.530(2), FAC):
___	___	___	___	3.	Provide documentation describing how the gas remediation plan and odor remediation plan will be implemented; (62-701.530(3), FAC):

4. Landfill gas recovery facilities; (62-701.530(5), FAC):

___	___	___	___	a.	Information required in Rules 62-701.320(7) and 62-701.330(3), FAC supplied;
___	___	___	___	b.	Information required in Rule 62-701.600(4), FAC supplied where relevant and practical;
___	___	___	___	c.	Estimate of current and expected gas generation rates and description of condensate disposal methods provided;

PART O CONTINUED

~~S~~	~~LOCATION~~	~~N/A~~	~~N/C~~		
___	___	___	___	d.	Description of procedures for condensate sampling, analyzing and data reporting provided;

___ ______________ ___ ___ e. Closure plan provided describing methods to control gas after recovery facility ceases operation and any other requirements contained in Rule 62-701.400(10), FAC;

___ ______________ ___ ___ f. Performance bond provided to cover closure costs if not already included in other landfill closure costs.

P. LANDFILL FINAL CLOSURE REQUIREMENTS (62-701.600,FAC) ----N/C----

1. Closure schedule requirements; (62-701.600(2),FAC)

___ ______________ ___ ___ a. Documentation that a written notice including a schedule for closure will be provided to the Department at least one year prior to final receipt of wastes;

___ ______________ ___ ___ b. Notice to user requirements within 120 days of final receipt of wastes;

___ ______________ ___ ___ c. Notice to public requirements within 10 days of final receipt of wastes.

2. Closure permit general requirements; (62-701.600(3),FAC)

___ ______________ ___ ___ a. Application submitted to Department at least 90 days prior to final receipt of wastes;

b. Closure plan shall include the following:

___ ______________ ___ ___ (1) Closure report;

___ ______________ ___ ___ (2) Closure design plan;

___ ______________ ___ ___ (3) Closure operation plan;

___ ______________ ___ ___ (4) Closure procedures;

___ ______________ ___ ___ (5) Plan for long term care;

___ ______________ ___ ___ (6) A demonstration that proof of financial responsibility for long term care will be provided.

3. Closure report requirements; (62-701.600(4),FAC)

a. General information requirements;

___ ______________ ___ ___ (1) Identification of landfill;

S	LOCATION	N/A	N/C

PART P CONTINUED

(2) Location, description and vicinity map;

(3) Total acres of disposal areas and landfill property;

(4) Legal property description;

(5) History of landfill;

(6) Identification of types of waste disposed of at the landfill.

b. Geotechnical investigation report and water quality monitoring plan required by Rule 62-701.330(3),FAC;

c. Land use information report indicating: identification of adjacent landowners; zoning; present land uses; and roads, highways right-of-way, or easements.

d. Report on actual or potential gas migration at landfills containing degradable wastes which would allow migration of gas off the landfill property;

e. Report assessing the effectiveness of the landfill design and operation including results of geotechnical investigations, surface water and storm water management, gas migration and concentrations, condition of existing cover, and nature of waste disposed of at the landfill;

4. Closure design requirements to be included in the closure design plan: (62-701.600(5),FAC)

a. Plan sheet showing phases of site closing;

b. Drawings showing existing topography and proposed final grades;

c. Provisions to close units when they reach approved design dimensions;

d. Final elevations before settlement;

e. Side slope design including benches, terraces, down slope drainage ways, energy dissipators and discussion of expected precipitation effects;

f. Final cover installation plans including:

(1) CQA plan for installing and testing final cover;

S	LOCATION	N/A	N/C

PART P CONTINUED

(2) Schedule for installing final cover after final receipt of waste;

(3) Description of drought-resistant species to be used in the vegetative cover;

(4) Top gradient design to maximize runoff and minimize erosion;

(5) Provisions for cover material to be used for final cover maintenance.

g. Final cover design requirements:

(1) Protective soil layer design;

(2) Barrier soil layer design;

(3) Erosion control vegetation;

(4) Geomembrane barrier layer design;

(5) Geosynthetic clay liner design if used;

(6) Stability analysis of the cover system and the disposed waste.

h. Proposed method of stormwater control;

i. Proposed method of access control;

j. Description of proposed final use of the closed landfill, if any;

k. Description of the proposed or existing gas management system which complies with Rule 62-701.530, FAC.

5. Closure operation plan shall include: (62-701.600(6),FAC)

a. Detailed description of actions which will be taken to close the landfill;

b. Time schedule for completion of closing and long term care;

c. Describe proposed method for demonstrating financial responsibility;

d. Indicate any additional equipment and personnel needed to complete closure.

S	LOCATION	N/A	N/C	PART P CONTINUED
___	___	___	___	e. Development and implementation of the water quality monitoring plan required in Rule 62-701.510, FAC.
___	___	___	___	f. Development and implementation of gas management system required in Rule 62-701.530, FAC.
___	___	___	___	6. Justification for and detailed description of procedures to be followed for temporary closure of the landfill, if desired; (62-701.600(7),FAC)

Q. **CLOSURE PROCEDURES** (62-701.610,FAC) ----N/C----

S	LOCATION	N/A	N/C		
___	___	___	___	1.	Survey monuments; (62-701.610(2),FAC)
___	___	___	___	2.	Final survey report; (62-701.610(3),FAC)
___	___	___	___	3.	Certification of closure construction completion; (62-701.610(4),FAC)
___	___	___	___	4.	Declaration to the public; (62-701.610(5),FAC)
___	___	___	___	5.	Official date of closing; (62-701.610(6),FAC)
___	___	___	___	6.	Use of closed landfill areas; (62-701.610(7),FAC)
___	___	___	___	7.	Relocation of wastes; (62-701.610(8), FAC)

R. **LONG TERM CARE REQUIREMENTS** (62-701.620,FAC) -----N/C----

___	___	___	___	1.	Maintaining the gas collection and monitoring system; (62-701.620(5), FAC)
___	___	___	___	2.	Right of property access requirements; (62-701.620(6),FAC)
___	___	___	___	3.	Successors of interest requirements; (62-701.620(7),FAC)
___	___	___	___	4.	Requirements for replacement of monitoring devices; (62-701.620(9),FAC)
___	___	___	___	5.	Completion of long term care signed and sealed by professional engineer (62-701.620(10), FAC).

S. **FINANCIAL RESPONSIBILITY REQUIREMENTS** (62-701.630,FAC) ---N/C---

___	___	___	___	1.	Provide cost estimates for closing, long term care, and corrective action costs estimated by a PE for a third party performing the work, on a per unit basis, with the source of estimates indicated; (62-701.630(3)&(7), FAC).
___	___	___	___	2.	Describe procedures for providing annual cost adjustments to the Department based on inflation and changes in the closing, long-term care, and corrective action plans; (62-701.630(4)&(8), FAC).
___	___	___	___	3.	Describe funding mechanisms for providing proof of financial assurance and include appropriate financial assurance forms; (62-701.630(5),(6),&(9), FAC).

T. CERTIFICATION BY APPLICANT AND ENGINEER OR PUBLIC OFFICER

1. Applicant:

The undersigned applicant or authorized representative of OMNI WASTE OF OSCEOLA COUNTY, LLC is aware that statements made in this form and attached information are an application for a MINOR MODIFICATION Permit from the Florida Department of Environmental Protection and certifies that the information in this application is true, correct and complete to the best of his/her knowledge and belief. Further, the undersigned agrees to comply with the provisions of Chapter 403, Florida Statutes, and all rules and regulations of the Department. It is understood that the Permit is not transferable, and the Department will be notified prior to the sale or legal transfer of the permitted facility.

R. Shawn McCash
Signature of Applicant or Agent

1501 Omni Way
Mailing Address

Shawn McCash, Senior Vice President
Name and Title (please type)

St. Cloud, Florida 34773
City, State, Zip Code

smccash@wasteservices.com
E-Mail address (if available)

(407) 891-3720
Telephone Number

Date: 5/11/2006

Attach letter of authorization if agent is not a governmental official, owner, or corporate officer.

2. Professional Engineer registered in Florida (or Public Officer if authorized under Sections 403.707 and 403.7075, Florida Statutes):

This is to certify that the engineering features of this solid waste management facility have been designed/examined by me and found to conform to engineering principles applicable to such facilities. In my professional judgment, this facility, when properly maintained and operated, will comply with all applicable statutes of the State of Florida and rules of the Department. It is agreed that the undersigned will provide the applicant with a set of instructions of proper maintenance and operation of the facility.

A. Gupta
Signature

14055 Riveredge Dr. Suite 300
Mailing Address

Ayushman Gupta, Senior Enginieer
Name and Title (please type)

Tampa, Florida 33637
City, State, Zip Code

agupta@geosyntec.com
E-Mail address (if available)

54023
Florida Registration Number
(please affix seal)

(813) 558-0990
Telephone Number

Date: 22 May 2006

Appendix B

GSE BROCHURE FOR PERMANET GEOCOMPOSITES

GSE Advantage Products

GSE GundSeal • GSE Conductive • GSE White • GSE PermaNet • GSE BioDrain System

Performance and Properties of GSE PermaNet Geonets and Geocomposites

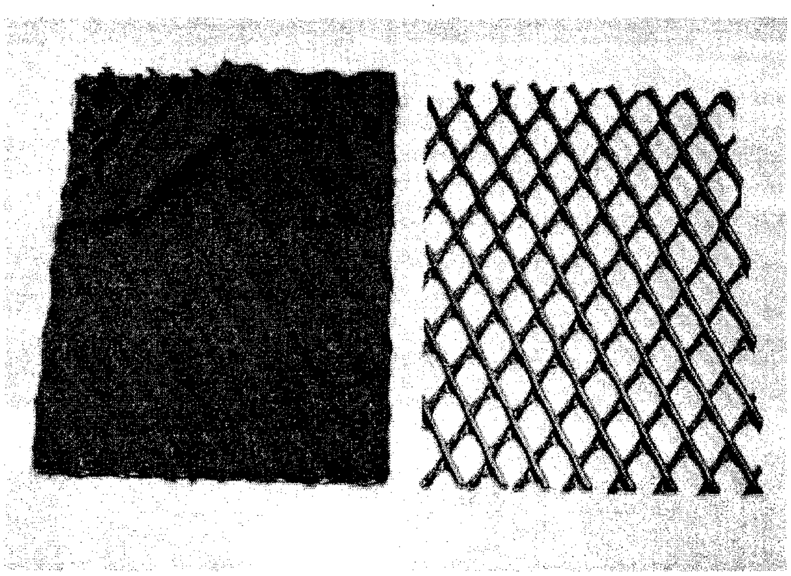
GSE®

www.gseworld.com

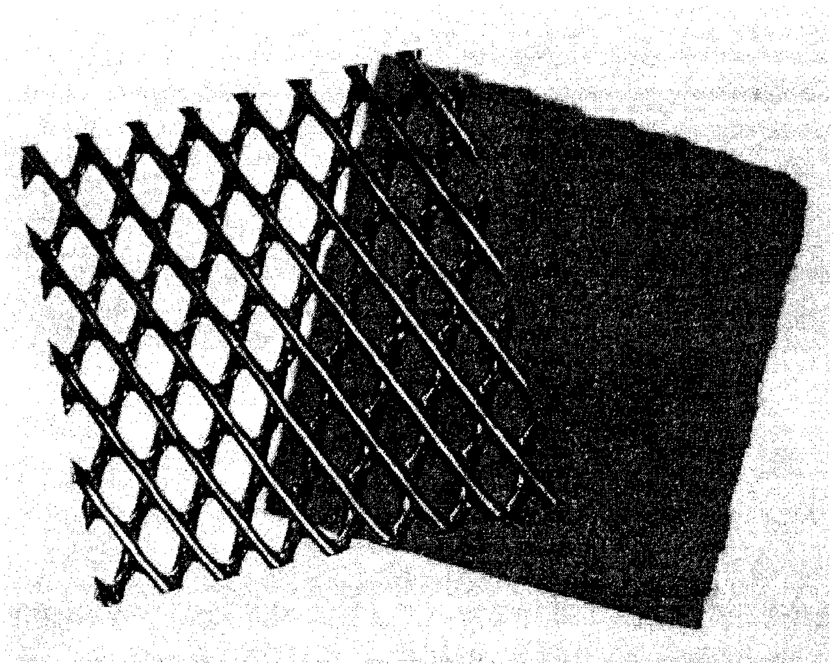
Introducing... GSE PermaNet Geonets

PermaNet geonets are manufactured with a biplanar structure (U.S. patent pending) that is specifically designed to sustain high stress. The design elements that endow PermaNet geonet with exceptional properties are its unique strand structure, vertical strand orientation, and high junction strength. The difference between PermaNet's structure and that of conventional biplanar geonets is clearly visible by comparing their samples. While the strands of the conventional biplanar geonet are positioned at a definite angle with respect to the vertical, this angle is zero for the PermaNet geonet. You can also see that the PermaNet strands are much bulkier and their junctions are much sturdier. The strand compression and rotation that cause compression creep in biplanar geonets, therefore, is virtually absent in PermaNet geonets. The resulting capacity of PermaNet geonets to withstand higher loads for much longer times results in sustained high transmissivity.

When your project requires high transmissivity at high stress - or you simply want a higher factor of safety - PermaNet geonets and geocomposites are clearly the materials of choice. Please contact us for further information to address your specific needs and concerns.



A conventional Biplanar Geonet and Geocomposite

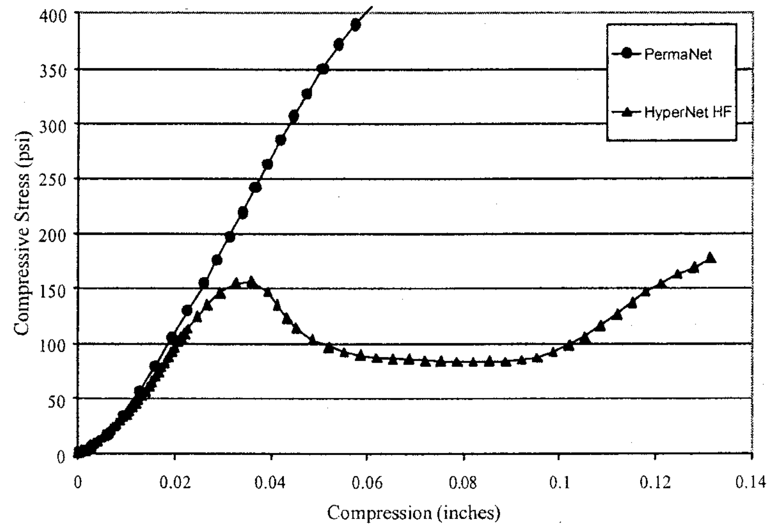


A PermaNet Geonet and Geocomposite

Superior Compression Strength with PermaNet Geonets

One of the most important properties of a geonet is its compression strength - the stress level at which its ribs bend or collapse during a compression test. The transmissivity of geonets and geocomposites decreases sharply after such bending or collapse – often by an order of magnitude. It is therefore crucial that the compression strength of a geonet be high enough to withstand overburden stress throughout the design life of a project.

The graph on the next page illustrates the difference in stress-compression behavior between a conventional and a PermaNet geonet. Note that the PermaNet is not subject to the distinct roll-over that is typical of biplanar and triplanar geonets. This means that PermaNet geonets can sustain high transmissivity even at high stress levels. The curve for PermaNet shows no failure even when subjected to a stress of 400 psi (57,600 psf), which is equivalent to a landfill height of 576 feet at a waste density of 100 pounds/cubic feet. If your project involves high stress levels, or if you simply require a higher factor of safety, PermaNet is clearly the material of choice.



Stress-Compression Behavior of PermaNet and HyperNet Geonets

Superior Creep Resistance with PermaNet Geonets

Geonets progressively decrease in thickness when subjected to constant stress, in a process called compression creep. Since the transmissivity of geonets and geocomposites depends primarily on the thickness and structure of their core, any eventual decrease in thickness or distortion in structure will diminish their transmissivity. A product with higher resistance to creep will therefore sustain a higher transmissivity – and is therefore a superior product.

The effect of creep on transmissivity is represented by the reduction factor for creep in the following equation:

$$\theta_{allow} = \frac{\theta_{100}}{RF_{cr} x RF_{cc} x RF_{bc}}$$

where θ_{allow} = allowable transmissivity; θ_{100} = 100-hour transmissivity; RF_{cr} = reduction factor for creep; RF_{cc} = reduction factor for chemical clogging; and RF_{bc} = reduction factor for biological clogging.

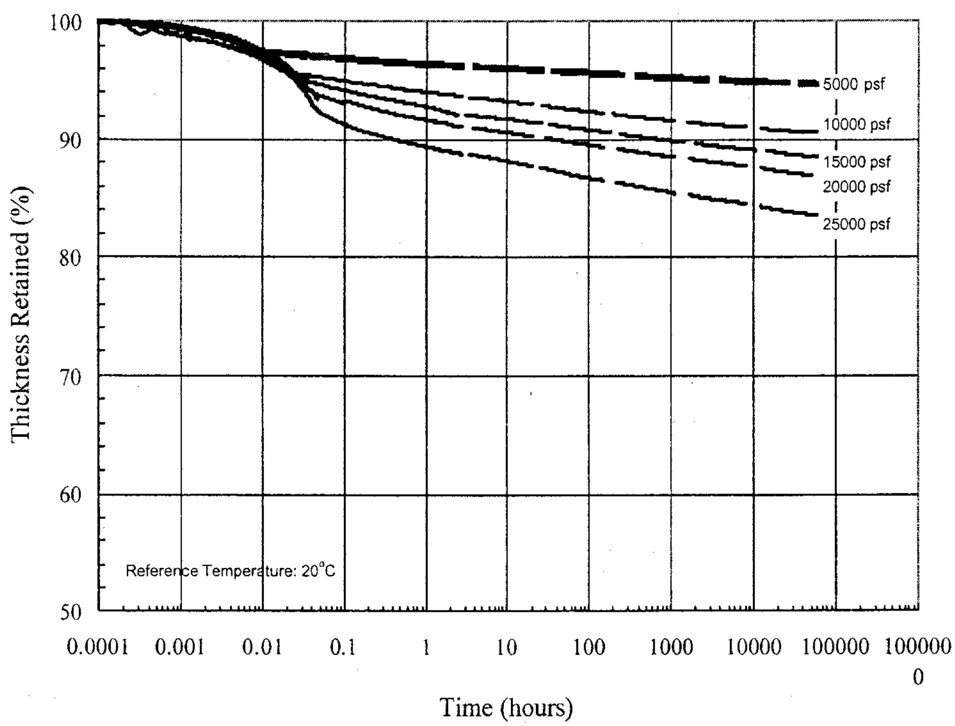
The above-given reduction factor for creep is derived from the following equation:

$$RF_{cr} = \left[\frac{t_{co} - \frac{\mu}{\rho}}{t_{cr} - \frac{\mu}{\rho}} \right]^3$$

where t_{co} = thickness at 100 hours; t_{cr} = projected thickness after 30 years; μ = mass per unit area of geonet; and ρ = polymer density of geonet. This equation employs a t_o value at 100 hours because θ_{100} in the allowable transmissivity equation already includes the creep effect for up to 100 hours.

The figure below presents the results of creep tests performed on a PermaNet geonet. The data shows the linear relationship between time and thickness retention, which can then be extrapolated to project future thickness, for example after 30 years, if used as t_{cr} in the above equation.

Based on this data, the resulting creep reduction factors are next presented in a table. At stress levels equal to and higher than 15,000 psf, PermaNet's values for creep reduction are far lower than those of conventional biplanar geonets. Indeed, at these elevated stress levels, the creep reduction factor of conventional biplanar geonets can be 3 or 4 times greater than that of PermaNet.



Creep Curves for a PermaNet Geonet; Mass = 0.42lbs/ft^2; thickness = 330 mils

Creep Reduction Factors for a PermaNet Geonet

Stress (psf)	Creep Reduction Factor (RF_{cr})
5,000	1.05
10,000	1.12
15,000	1.13
20,000	1.19
25,000	1.22

Performance Transmissivity of PermaNet Geonets and Geocomposites

GSE developed PermaNet geonets and geocomposites for applications involving very high stress, such as canyon landfills, piggy-back landfills, and very deep or "mega-landfills". For stresses that exceed 15,000 psf, PermaNet's design makes it distinctly superior to conventional biplanar and triplanar geonets. For stresses lower than 15,000 psf, a conventional biplanar geonet may well be more cost-effective, but a PermaNet product can nonetheless offer better performance and a higher factor of safety.

The following four figures illustrate the performance transmissivity of PermaNet HL and UL geonets and geocomposites when subjected to stresses of 20,000 psf and 30,000 psf. Test data produced under other conditions (e.g., a different gradient or stress, or different boundary conditions) can be obtained from GSE by calling 800-435-2008.

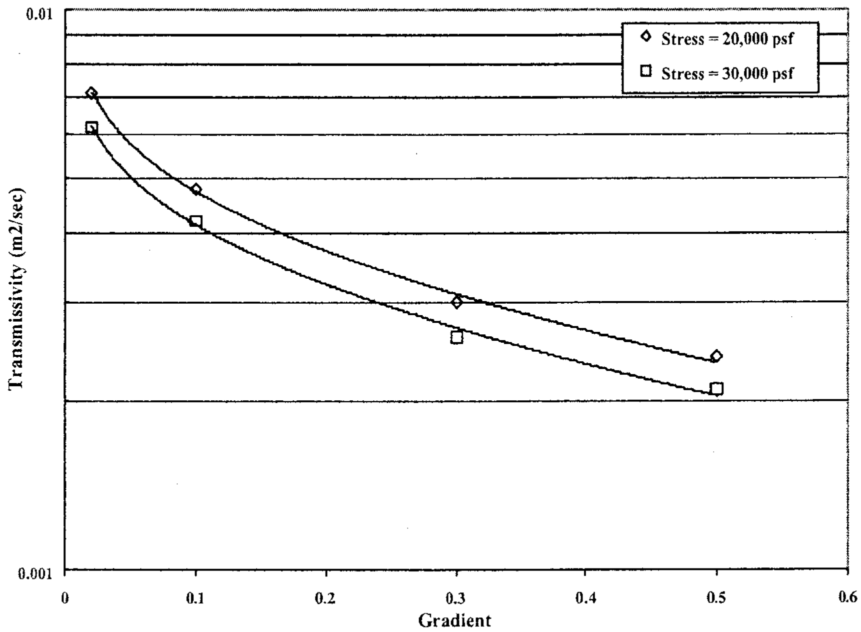
The transmissivity data provided in the figures should be used as θ_{100} in the following equation from GRI GC8 to calculate allowable transmissivity, θ_{allow}:

$$\theta_{allow} = \frac{\theta_{100}}{RF_{cr} \times RF_{cc} \times RF_{bc}}$$

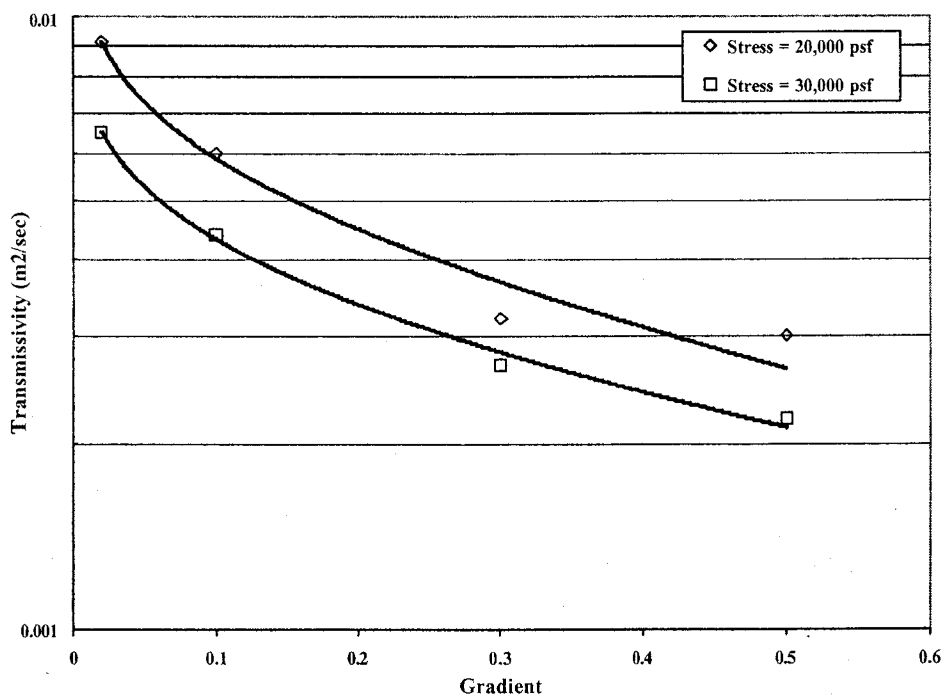
where RF_{cr} is provided elsewhere in the literature on PermaNet, and default values proposed in GRI GC8 are used, as is common, for RF_{cc} and RF_{bc}. Based on θ_{allow} from the above equation, a factor of safety can be calculated as:

$$FS = \frac{\theta_{allow}}{\theta_{req}}$$

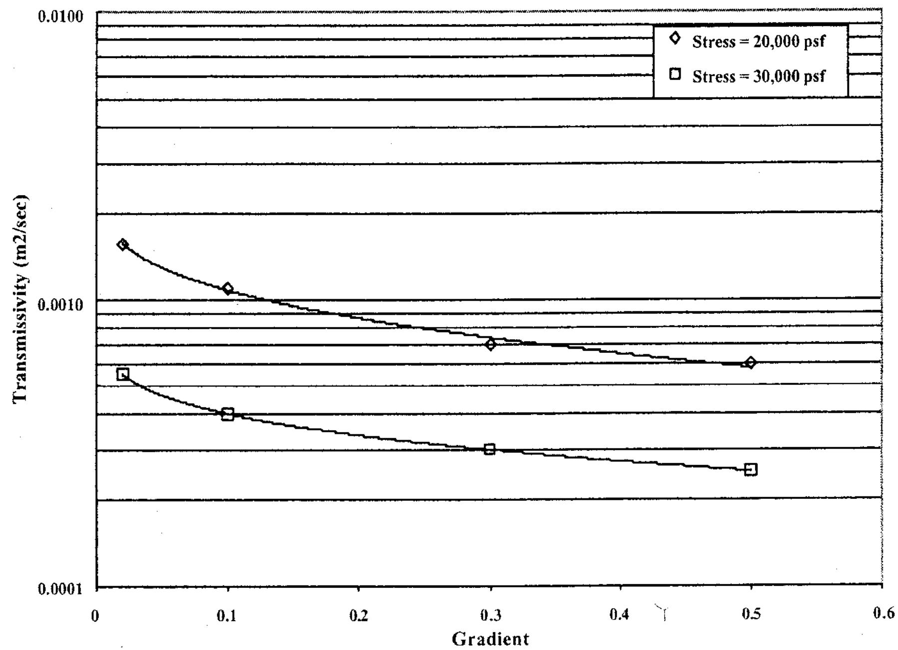
where θ_{req} - required transmissivity – for landfill primary and secondary drainage layers is derived from the commonly employed impingement rate from HELP



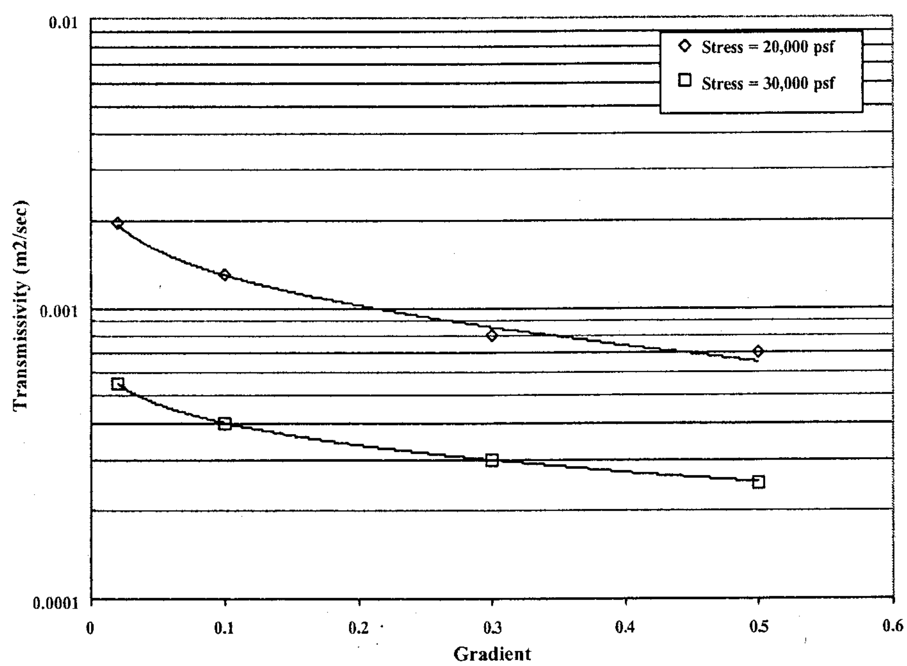
100-hour Transmissivity of PermaNet HL Geonet at 20,000 and 30,000 psf
(Geomembrane/Geonet/Geomembrane)



100-hour Transmissivity of PermaNet UL Geonet at 20,000 and 30,000 psf
(Geomembrane/Geonet/Geomembrane)



100-hour Transmissivity of GSE PermaNet HL Geocomposite at 20,000 and 30,000 psf (Soil/Geocomposite/Geomembrane)



100-hour Transmissivity of GSE PermaNet UL Geocomposite at 20,000 and 30,000 psf (Soil/Geocomposite/Geomembrane)

Model analysis for a specific landfill cell. Methods for calculating θ_{req} are provided in the GSE Drainage Design Manual, as well as in other literature on drainage.

The transmissivity requirements for a given project do not directly address the issues of compression strength and creep failure. It is important for the total overburden stress on a drainage layer to be significantly smaller than its compression strength. In general, the stress on a drainage layer should be less than 50% of its compression strength, if failure due to creep is to be prevented.

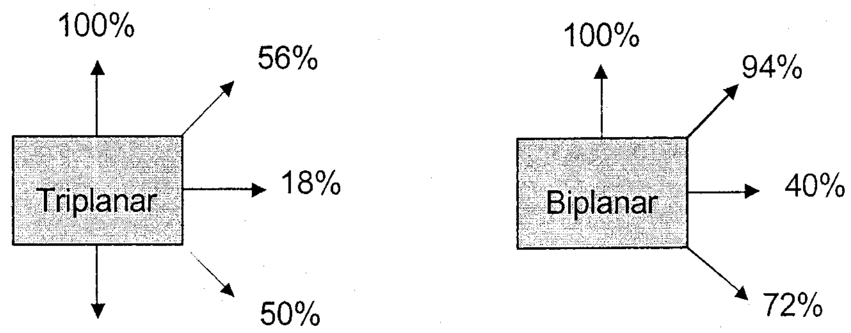
PermaNet vs. Triplanar: Compare the Facts

Compare for yourself. Examine the project specifications available at www.tenaxus.com and www.gseworld.com, and you will see how PermaNet geonets and geocomposites meet or exceed the product specifications of comparable triplanar products (as of February 21, 2006). For example, PermaNet UL and Tenax Tendrain High Load are equivalent products in terms of machine direction transmissivity. And based on this same single criterion, PermaNet HL geocomposite is equivalent to Tenax Tendrain Low Load.

A truly comprehensive comparison, however, must take into account other properties as well, such as geotextile quality, resin quality, roll width and cross-directional transmissivity. When geotextiles are used with PermaNet geocomposites, they exhibit much higher mechanical and hydraulic properties than when triplanar is employed. For example, product specifications show that PermaNet's geotextile grab strength and permittivity are much higher than those of triplanar geonets. GSE geotextiles also provide greater flow into the geocomposite, and withstand higher installation and project overburden stresses.

Roll width matters. GSE PermaNet geonets and geocomposites come in a standard nominal roll width of 15 feet, while Tenax triplanar geonets and geocomposites have a roll width of either 7 feet or 13 feet. This means installation costs for GSE PermaNet geonets and geocomposites are lower than those of triplanar products.

The most important advantage PermaNet geonets and geocomposites have over their triplanar equivalents is the significantly better multi-directional flow they provide. The diagram below shows that triplanar geonet transmissivity at an angle to the machine direction (MD) is 18% to 56% of that in MD, while the same for a biplanar geonet is 40% to 94%. Triplanar products must therefore be installed down-slope – a requirement that can create design and installation problems when no clear slope exists, as is the case on many cell floors, for example.



A Comparison of Flow Characteristics of Triplanar and Biplanar Structures (from *Sieracke & Maxon, GFR, Vol. 19, No. 8, 2001*)

Lastly, GSE uses only prime quality resin purchased directly from resin manufacturers. This superior material endows PermaNet products with better long-term performance, including greater chemical resistance and higher stress crack resistance. A prime quality resin with established specifications assures you that Permanet geonets and geocomposites will deliver unvarying reliability.

GSE

Report Date
04/18/06

Hydraulic Transmissivity Test Results
ASTM D 4716

Job Information

Job Name : PermaNet UL Composite
Sales Order #

Sample Information

Roll No. : 131205471
Manufacturing Date : 3/16/2006
Product I.D. : FR82080080
Geotextile (A) : 8 oz
Geotextile (B) : 8 oz
Net Thickness : 308 Mils
Mass/Area : 0.581 lbs/ft^2

Test Information

Boundary Conditions:
Plate
Sand
Geocomposite
Textured HDPE Liner
Plate

Normal Load : 1000 psf
Gradient : 0.50, 0.30, 0.10 & 0.02
Seating Time : 100 Hours

Results :

Transmissivity, m^2/sec

	Gradient			
Seating Time	**0.50**	**0.30**	**0.10**	**0.02**
15 Minutes	1.09E-03	1.31E-03	1.97E-03	3.42E-03
100 Hours	1.03E-03	1.25E-03	1.86E-03	3.03E-03

Test Date: **4/11/2006**
Technician: **DC**

GSE

Report Date
04/18/06

Hydraulic Transmissivity Test Results
ASTM D 4716

Job Information

Job Name : PermaNet UL
Sales Order #

Sample Information

Roll No. : 131204977
Manufacturing Date :
Product I.D. : 300 Mil Double Sided Composite
Geotextile (A) :
Geotextile (B) :
Net Thickness : 336 mils (prior to lamination)
Mass/Area : 0.62 lbs/ft^2

Test Information

Boundary Conditions: Plate
Soil
Geocomposite
Textured Liner
Plate

Normal Load : 10000 psf
Gradient : 0.50, 0.30, 0.10, 0.02
Seating Time : 100 hrs.

Results :

Transmissivity, m^2/sec

	Gradient			
Seating Time	**0.50**	**0.30**	**0.10**	**0.02**
100 Hours	1.33E-03	1.48E-03	2.36E-03	4.00E-03

Test Date: 3/27/2006
Technician: CM

Report Date
04/18/06

Hydraulic Transmissivity Test Results
ASTM D 4716

Job Information

Job Name : PermaNet UL
Sales Order #

Sample Information

Roll No. : 131204987
Manufacturing Date :
Product I.D. : 300 Mil Double Sided Composite
Geotextile (A) :
Geotextile (B) :
Net Thickness : 326 mils (after lamination)
Mass/Area : 0.614 lbs/ft^2

Test Information

Boundary Conditions:
Plate
Soil
Geocomposite
Textured Liner
Plate

Normal Load : 10000 psf
Gradient : 0.50, 0.30, 0.10, 0.02
Seating Time : 100

Results :

Transmissivity, m^2/sec

	Gradient			
Seating Time	**0.50**	**0.30**	**0.10**	**0.02**
100 Hours	1.15E-03	1.39E-03	2.09E-03	4.27E-03

Test Date: **3/27/2006**
Technician: **JT**

GSE Lining Technology, Inc.

Transmissivity Report
ASTM D4716

Roll No. 131204977

ROLL IDENTIFICATION		CUSTOMER INFORMATION	
Roll Number	131204977	Order Number	44598
Product Name	FR82080080T	Customer Name	Atlantic Lining Company, Inc.
Production Date	3/10/2006	Project Name	Cape May
Resin Lot #	C060202A04	Location	Cape May, NJ

Pressure (psf)	Gradient	Net/Composite	Transmissivity Results (m^2/sec)	(gal/min/ft)	Seat Time (min)	Boundary
10000	0.50	Composite	1.33E-03	6.12	100	Sand / Liner
10000	0.30	Composite	1.48E-03	6.80	100	Sand / Liner
10000	0.10	Composite	2.36E-03	10.90	100	Sand / Liner
10000	0.02	Composite	2.71E-03	12.48	100	Sand / Liner

GSE

Report Date

04/18/06

Hydraulic Transmissivity Test Results
ASTM D 4716

Job Information

Job Name : PermaNet UL Composite

Sales Order #

Sample Information

Roll No. : 131205471

Manufacturing Date : 3/16/2006

Product I.D. : FR82080080

Geotextile (A) : 8 oz

Geotextile (B) : 8 oz

Net Thickness : 322 Mils

Mass/Area : 0.592 lbs/ft^2

Test Information

Boundary Conditions: Plate

Sand

Geocomposite

Textured HDPE Liner

Plate

Normal Load : 10,000 psf

Gradient : 0.50, 0.30, 0.10 & 0.02

Seating Time : 100 Hours

Results :

Transmissivity, m^2/sec

	Gradient			
Seating Time	**0.50**	**0.30**	**0.10**	**0.02**
15 Minutes	1.10E-03	1.30E-03	2.11E-03	3.80E-03
100 Hours	9.92E-04	1.20E-03	1.80E-03	3.22E-03

Test Date: 4/17/2006

Technician: DC

GSE

GSE Lining Technology, Inc.

19103 Gundle Road
Houston, Texas 77073
800-435-2008
281-230-5855
Fax: 281-230-6736

April 21, 2006

Mr. Ayushman Gupta
Geosyntec Consultants
14055 River Edge Drive, Suite 300
Tampa, FL 33637

Ref.: Oak Hammock Landfill
Drainage Geocomposite Prequalification Information

Dear Ayushman,

Thank you for your interest in GSE PermaNet UL geocomposite for the leachate collection and removal system of the above referenced project. As you already know through our previous correspondence, PermaNet geonet was formulated and developed specifically to provide high performance over the design life of a project. The product has very low creep reduction factors at stresses as high as 25,000 psf. The attached brochure on PermaNet provides an overview of the product features.

Approximately 1.3 million square feet of PermaNet UL drainage geocomposite is currently being installed at Cape May Landfill, Cape May, NJ for which the design engineer is IT/Emcon. About 0.5 million square feet of this material is currently approved for use on Hardy County Landfill in FL where the design firm is SCS Engineers. Although the product is relatively new, the technology of biplanar geonets is the same that GSE has utilized over the last twenty years. GSE PermaNet is a high quality product manufactured using prime quality resin and supported by performance data as well as quality control and conformance testing.

One of the attached documents provides transmissivity test data requested by you. You will notice that there are four different tests with 100-hour transmissivity at 10,000 psf varying from 2.7×10^{-3} m^2/sec to 4×10^{-3} m^2/sec. We hereby certify that GSE PermaNet UL geocomposite will provide transmissivity in the range of 2.5 to 3.5×10^{-3} m^2/sec for this specific project. GSE will provide quality control data on transmissivity under the same conditions as the attached 100-hour data and you can specify conformance testing to provide independent verification of the performance as well.

I have also included some representative interface shear strength data as requested by you. Please be aware that although GSE guarantees the transmissivity performance, we do not do the same for interface shear strength. The attached data is representative and should help you in your design. However, it is the responsibility of the engineer and the contractor to address all aspects of interface shear strength. We believe that, based on the attached data, GSE PermaNet drainage geocomposite should provide you adequate interface shear strength against the geomembrane as well as the operations layer.

Please do not hesitate to contact me if I can be of further help on this project.

Sincerely

Dhani Narejo, Ph.D., P.E.
Product Manager, Drainage

Encl:

1. PermaNet Brochure
2. Data Sheet and Samples
3. Transmissivity Test Data
4. Interface Shear Strength Data

Appendix C

CALCULATION PACKAGE FOR CELL 3 LEACHATE MANAGEMENT SYSTEM

CELL 3 LEACHATE MANAGEMENT SYSTEM

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   2.2 Liner System
   2.3 Cover System
   2.4 Initial and Intermediate Cover
   2.5 Landfill Development

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   4.3 Geocomposite Properties
   4.4 Reduction Factors
   4.5 Required Transmissivity Values
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      4.6.1 Weather Data Description
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   5.1 HELP Model Analysis
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6. VERIFICATION OF HEADS
   6.1 McEnroe's Equation for Head
   6.2 Giroud, et al. Solution for Head

7. LEACHATE STORAGE CAPACITY

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   8.1 Peak Leachate Flow
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8.2.1 Central Leachate Collection Pipe in Cell 3
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9 LEACHATE TRANSMISSION SYSTEM

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FIGURE

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Attachment 1: Summary of HELP Model Input Data
Attachment 2: HELP Model Output Files
Attachment 3: Spreadsheets for Verification of Heads Using Giroud's Method
Attachment 4: Minimum Primary Geocomposite Transmissivity Computations Using Giroud's Method

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Table C-2 Heads on Primary Liner System Computed Using Giroud's Method

LIST OF FIGURE

Figure C-1 Comparison between Tenax Tendrain and GSE PermaNet UL

1. INTRODUCTION

The minor modification application includes minor design changes to the primary leachate collection system in Cell 3. Cell is one of the four cells (Cells 1 through 4) currently permitted Phase 1 development of the Oak Hammock Disposal Facility (OHDF). The purpose of this calculation package is to perform the engineering design and evaluate the performance of the proposed primary leachate collection system in Cell 3. The engineering design and evaluation of the leachate management system for the four cells in Phase 1 of the OHDF was discussed in Appendix K titled "Leachate Management System" of the May 2002 Permit Application. For ease of comparison during the review process, the organization of this calculation package is same as the calculation package included in Appendix K of the May 2002 Permit Application.

The leachate management system is made up of the primary and secondary leachate collection and removal systems, the leachate transmission pipeline, and the flexible leachate storage containers. The primary leachate collection system is a component of the proposed primary liner system that consists of a geocomposite drainage layer on top of the primary geomembrane liner. This primary geocomposite drainage layer is designed to collect the leachate that percolates vertically through the waste and convey it to a sump for removal from the cell. The primary leachate collection system components include a primary geocomposite drainage layer, primary leachate collection pipes, and primary leachate collection sumps. According to Chapter 62-701.400(3)(c)1, FAC, the primary leachate collection system is designed to limit the leachate head to no more than 1 foot above the primary geomembrane.

The secondary leachate collection system is a component of the proposed liner system that consists of a lateral drainage layer between the primary and secondary liners. This secondary lateral drainage layer is designed to collect any leachate that may leak through the primary liner system and convey it to a sump for removal. The secondary leachate collection system components include a secondary geocomposite drainage layer and a secondary leachate collection sump. According to Chapter 62-701.400(3)(c)2, FAC, the secondary drainage system is designed to limit the leachate head on the secondary geomembrane to the thickness of the secondary drainage geocomposite.

2. DESCRIPTION OF RELEVANT SYSTEMS AND OPERATIONS

2.1 General Layout

The layout of the primary leachate collection system proposed in Cell 3 is discussed in Section 4 and is indicated in Figure 5 of the minor modification application. The primary leachate collection system is designed to collect the leachate that percolates vertically through the waste and convey it to a sump for removal from the cell.

The secondary geocomposite drainage system collects leachate that may leak through the primary liner system. Leachate is collected and conveyed to the secondary leachate sump. As noted in the 2002 Permit Documents, a double thickness of the geocomposite is placed along the edges of the cells to increase the flow capacity in these areas. Submersible pumps will remove the leachate from the secondary sumps and transfer it to the leachate transmission pipeline.

2.2 Liner System

There are no changes to the bottom liner system in Cell 3. The liner system is same as discussed in Section 2.2 of Appendix K in the May 2002 Permit Application.

2.3 Cover System

There are no changes to the landfill final cover system. The landfill final cover system is same as discussed in Section 2.3 of Appendix K in the May 2002 Permit Application.

2.4 Initial and Intermediate Covers

There are no changes to the initial and intermediate covers. The initial and intermediate covers are same as discussed in Section 2.4 of Appendix K in the May 2002 Permit Application.

3. DESIGN REQUIREMENTS

As noted in Section 3 of Appendix K in the May 2002 Permit Application, the highlights of the leachate management system requirements specified in the regulations that were used in the design are listed below.

- the primary leachate collection system must be designed to limit the leachate head buildup on the primary geomembrane liner to no more than 1 foot during routine landfill operations after placement of initial cover (Chapter 62-701.400(3)(c)1, FAC);

- the primary leachate collection system must be designed with a bottom slope to maintain a leachate head less than the maximum allowable leachate head after the predicted settlements of the foundation (Chapter 62-701.400(4)(b), FAC);

- the secondary leachate collection system must have a minimum hydraulic conductivity of 10 cm/sec and must be designed to not allow the leachate head on the secondary geomembrane liner to exceed the thickness of the drainage layer (Chapter 62-701.400(3)(c)2, FAC); and

- the transmissivity of geonets shall be tested with method ASTM D4716, or an equivalent method to demonstrate that the design transmissivity will be maintained for the design period of the facility using the actual boundary materials intended for the geonet at the maximum design normal load for the landfill and at the design load expected from one lift of waste (Chapter 62-701.400(3)(d)8, FAC).

4. HELP MODEL ANALYSES

4.1 Purpose

The Hydrogeologic Evaluation of Landfill Performance (HELP) model, Version 3.07 [Schroeder, et. al., EPA/600/R-94/168a and EPA/600/R-94/168b, 1994] was used to estimate leachate generation rates, leakage through geomembranes, and maximum head on geomembranes for the proposed leachate collection system in Cell 3 of the OHDF. The HELP model is a quasi-two dimensional water balance computer program used to evaluate the vertical movement of water through the waste and components of the liner system. The computer program, along with site-specific weather data and design information, was utilized to estimate runoff, evapotranspiration, drainage, leachate collection, and liner leakage in Cell 3 for the initial startup, intermediate development, and permitted final configurations.

The estimated leachate generation rates and other information obtained from the HELP Model were used to evaluate the performance of the proposed primary and secondary leachate collection systems. The leachate generation rates for the modified leachate collection system in Cell 3 were also compared to the leachate generation rates for the currently permitted system to indicate that no changes are required to the existing leachate transmission system and the leachate storage facility at the OHDF for the proposed modifications in Cell 3.

4.2 Cell 3 Development Conditions Analyzed

To estimate leachate generation rates for different development conditions, four waste configurations were analyzed assuming an area of 1 acre. The leachate generation rate for each configuration was conservatively evaluated using only the final top slope of 5 percent.

Analysis was not performed for final cover side slope of 25 percent as it results in lower leachate generation rates in comparison to the final top slope of 5 percent.

The leachate generation rates, leakage through the geomembranes, and the maximum head on the geomembranes were estimated for the cases and scenarios described below:

- Case 1 Startup conditions (10 ft of waste) and
- Case 2 Intermediate development conditions before construction of the final cover system (30 ft, 60 ft, and 95 ft of waste).

It is noted that Case 3 representing post-closure conditions (after construction of the final cover system atop 95 ft of waste presented in Appendix K in the May 2002 Permit Application) was not analyzed as this scenario is not critical with respect to leachate generation rates due to significantly reduced infiltration through the final cover system.

<u>Case 1</u>

This scenario considered the initial conditions of the Cell 3 operation after the placement of a start-up lift and additional lifts of waste for a total of 10 ft of waste. Case 1 includes 6 inches of daily cover, no runoff, and no surface vegetation. The HELP model identified this scenario as the critical condition for lateral drainage in the primary geocomposite drainage layer. The limited waste thickness resulted in very little storage of precipitation, no runoff due to the fact that the waste height is below the perimeter berm, and limited evapotranspiration due to the lack of vegetation. This scenario typically represents the critical condition for head build-up on the primary geomembrane because of the large amount of leachate that must be carried by the primary geocomposite drainage layer.

<u>Case 2</u>

This scenario considered waste configurations in Cell 3 after the initial 10-ft of waste is placed and before construction of the final cover. The intermediate conditions considered a 30 ft, 60 ft, and 95 ft heights of waste in Cell 3, which are referred to as Case 2-A, Case 2-B and Case 2-C, respectively, in this calculation package. For these cases, runoff from the intermediate cover surfaces was allowed and surface vegetation was assumed.

<u>Case 3</u>

As noted above, this scenario (which considers post-closure condition in Cell 3 with 95 ft of waste and the final cover installed) was not analyzed. This case represents the lowest potential for leachate generation, leakage, and head in the primary and secondary leachate collection systems as the final cover system over the waste minimizes percolation of rainfall through the waste. As a result, this case is not included in this calculation package.

4.3 Geocomposite Properties

The geocomposite properties used in the calculation of heads, leachate generation rate, and leakage for Cell 3 are based on properties of commercially available geocomposites. It is not the objective of this section to identify specific geocomposites for use in the construction of Cell 3. However, the performance of commercially available materials should correspond to the minimum requirements used in design.

Geocomposites with relatively high transmissivity values (even under high stress loading) were identified for use as the primary geocomposite drainage layer in Cell 3. As noted in Section 3 of the minor modification application, Tenax Tendrain, GSE PermaNet HL, or GSE PermaNet UL will be used as the primary geocomposite drainage layer in Cell 3. Properties of GSE PermaNet UL were used in the HELP model analysis presented herein and are indicated in Figure C-1 (and in Appendix B). Figure C-1 also presents a comparison between the properties of GSE PermaNet UL and Tenax Tendrain geocomposites since properties of Tenax Tendrain geocomposite were used in the HELP model analysis presented in the May 2002 Permit Application (see Attachments 1 and 3 to Appendix K in the May 2002 Permit Application).

For the secondary geocomposite drainage layer, the properties used in the HELP model analysis presented herein are same as those used in the May 2002 Permit Application (see Attachments 1 and 3 to Appendix K in the May 2002 Permit Application).

4.4 Reduction Factors

All reduction factors used in the analysis presented herein are same as the reduction factors discussed in Section 4.4 of Appendix K in the May 2002 Permit Application, except for the reduction factor for creep deformation (RF_{cr}). As discussed in Section 3 of the minor modification application, the PermaNet geonets have a biplanar structure that is specifically designed to sustain high stresses. A GSE brochure discussing the properties of PermaNet geonets and geocomposites is included in Appendix B. As noted in the GSE brochure, PermaNet geonets have relatively high resistance to creep and as a result these geonets maintain high transmissivities even under high stresses.

The waste height in Cell 3 varies from about 10 feet at toe to currently permitted maximum height of 95 ft near the west edge of Cell 3. The vertical stress corresponding to these waste heights ranges from 500 psf at the toe to 5,000 psf at the west end of the cell. Based on the creep test results and recommended creep reduction factors presented in the

GSE brochure included in Appendix B, a creep reduction factor of 1.05 was used for the all the cases (Cases 1, 2-A, 2-B, and 2-C) presented in this report. All the reductions factors used for the primary geocomposite drainage layer are summarized in the table below.

Case	RF_{in}	RF_{cr}	RF_{cc}	RF_{bc}	IIRF
1 (initial condition)	1.0	1.05	1.5	1.5	2.36
2 (intermediate conditions)	1.1	1.05	1.75	1.75	3.54

The reductions factors used for the secondary geocomposite drainage layer are same as those used in the May 2002 Permit Application and are summarized in the table below (see Section 4.4.2 of Appendix K in the May 2002 Permit Application).

Case	RF_{in}	RF_{cr}	RF_{cc}	RF_{bc}	IIRF
1 (initial condition)	1.0	1.05	1.5	1.5	2.36
2 (intermediate conditions)	1.1	1.20	1.75	1.75	4.04

4.5 Required Transmissivity Values

Typical measured transmissivity values ($\theta_{measured}$) for a candidate primary geocomposite drainage layer (i.e., GSE PermaNet UL used in the analysis) were provided by the manufacturer and are presented in Figure C-1 and in Appendix B. It is noted that the measured transmissivity values are for 100-hour seating time; at 0.02 gradient (corresponding to the initial 2 percent slope of Cell 3 floor); under normal loads of 1,000 psf and 10,000 psf (i.e., stress range applicable to Cell 3); and with the same boundary conditions as in the field (i.e., geocomposite drainage layer sandwiched between sand and texture geomembrane).

Typical measured transmissivity values ($\theta_{measured}$) for a candidate secondary geocomposite drainage layer are same as those discussed in the May 2002 Permit Application (see Attachment 3 to Appendix K in the May 2002 Permit Application).

The transmissivity values ($\theta_{req'd}$) used in the HELP model analysis are obtained by applying the reduction factors and an assumed factor of safety of 2 to the measured transmissivity values ($\theta_{measured}$) as discussed in Section 4.4.1 of Appendix K in the May

2002 Permit Application. The following tables summarize the calculated values for each candidate geocomposite. The thickness of the geocomposite under the various normal stresses is also listed for reference. It should be noted that normal stresses were calculated based on the depth versus density relationship for waste presented in Figure 4 of Appendix K in the May 2002 Permit Application.

Primary Geocomposite Drainage Layer

Case	Depth of Waste ft	Reduction Factor	θ from Manufacturer m^2/sec	Geonet Thickness in	$\theta_{req'd}$ m^2/sec	k cm/sec
1	10	4.72	5.40E-03	0.285	$1.14e^{-3}$	15.80
2-A	30	7.08	5.10E-03	0.283	$7.20e^{-4}$	10.02
2-B	60	7.08	4.80E-03	0.281	$6.78e^{-4}$	9.50
2-C	95	7.08	4.50E-03	0.278	$6.36e^{-4}$	9.00

Secondary Geocomposite Drainage Layer

Case	Depth of Waste ft	Reduction Factor	θ from Manufacturer m^2/sec	Geonet Thickness in	$\theta_{req'd}$ m^2/sec	k cm/sec
1	10	4.72	2.40E-03	0.181	$5.08e^{-4}$	11.05
2-A	30	8.08	2.00E-03	0.179	$2.48e^{-4}$	5.44
2-B	60	8.08	1.40E-03	0.173	$1.73e^{-4}$	3.94
2-C	95	8.08	1.10E-03	0.167	$1.36e^{-4}$	3.20

4.6 Input Data for HELP Model

The HELP model requires weather, soil, and basic design data as input and uses solution techniques that account for more than 10 above-surface and subsurface hydraulic processes including precipitation, runoff, and evapotranspiration. The simulation period used in the HELP model analysis for Cell 3 was 25 years.

4.6.1 Weather Data Description

The weather data used in the HELP model analysis presented herein is same as that used in the May 2002 Permit Application.

4.6.2 Soil and Design Data

The soil and design data used in the HELP model analysis presented herein is same as that used in the May 2002 Permit Application.

4.6.3 Miscellaneous Input

4.6.3.1 Geomembrane Liner

Pinhole density and installation defects used in the HELP model analysis presented herein are same as those used in the May 2002 Permit Application.

4.6.3.2 Liner System and Final Cover Drainage Path Lengths

The longest drainage path for the proposed primary leachate collection system in Cell 3 is shown on Figure 5 of the minor modification application. As noted in figure 5, the drainage path for the proposed primary leachate collection system in Cell 3 varies from 0 to approximately 430 ft. The HELP model analysis for Cell 3 was performed using a 400-ft long drainage path. The drainage path for the secondary leachate collection system in Cell 3 varies from 0 to approximately 860 ft. The HELP model analysis for Cell 3 was performed using 800-ft long drainage path. An average final cover slope length of 765 ft corresponding to top slope of 5 percent was used in the analysis (same as in the May 2002 Permit Application).

4.6.3.3 Surface Soil Texture and Surface Vegetation

The surface soil texture and the surface vegetation used in the HELP model analysis presented herein are same as those used in the May 2002 Permit Application.

5. LEACHATE GENERATION , HEAD, AND LEAKAGE

5.1 HELP Model Analysis

HELP model analysis was performed for the four cases (Cases 1, 2-A, 2-B, 2-C, and 2-D) to evaluate the leachate generation rate, leakage, and heads for the proposed primary and secondary leachate collection systems in Cell 3. A summary of the input data used in the HELP model analysis is presented in Attachment 1 to this calculation package. Output files from the HELP model for each case are included in Attachment 2.

5.2 Leachate Generation, Head, and Leakage Estimates

Table C-1 presents a summary of the leachate generation rate, leakage, and heads for the proposed leachate collection system in Cell 3 for the four cases. Table C-1 also compares the HELP model analysis results for the proposed design modifications (identified as PDM) in Cell 3 to the currently permitted design (identified as CPD) presented in the May 2002 Permit Application.

The properties of the primary geocomposite drainage layer used in analysis for the proposed design modifications are presented in Table C-1. Further, the computations for the proposed leachate collection system in Cell 3 assumed an initial minimum liner system slope of 2 percent (Case 1), a slope of 1.5 percent for the intermediate stages of construction with 30 ft (Case 2-A) and 60 ft of waste (Case 2-B), and a minimum liner system slope of 1 percent for the intermediate Case 2-C with 95 ft of waste, as noted in the table. The results for leachate generation rate, leakage, and head calculations include the following:

<u>Leachate Generation Rate</u>

- The volume of peak daily lateral drainage in the primary and secondary geocomposites on a per acre basis.
- The volume of average annual lateral drainage in the primary and secondary geocomposites on a per acre basis.

<u>Leakage</u>

- The volume of peak daily leakage to the subgrade, which was interpreted as the leakage through the secondary geocomposite clay liner on a per acre basis.
- The volume of average annual leakage to the subgrade on a per acre basis.

<u>Heads</u>

- Peak daily maximum head and peak daily average head on top of the primary geomembrane showing all heads to be less than 12 inches.
- Peak daily maximum heads on top of the secondary geomembrane showing all heads to be less than the thickness of the secondary drainage layer.

Based on the results presented in Table C-1, the following observations are noted:

- The volume of lateral drainage in the primary and secondary geocomposites for the proposed design modifications in Cell 3 are similar to the currently permitted design;
- The volume of leakage to the subgrade (on a per acre basis) for the proposed design modifications in Cell 3 are similar to the currently permitted design;
- The average annual leakage to the subgrade for the Cell 3 was estimated to be 0.4 gal/year;

- The peak daily maximum head on the primary geomembrane is less than 0.5 inches for the critical case (i.e., Case 1) for the proposed leachate collection system in Cell 3;

- The peak daily maximum head on the secondary geomembrane is less than the thickness of the secondary geocomposite drainage layer for all cases; and

- The peak daily maximum head and peak daily average head on the primary geomembrane for the proposed design modifications in Cell 3 are less than the currently permitted design for all cases analyzed.

6. VERIFICATION OF HEADS

The heads on the primary liner system were verified using Giroud's method (2001), since the HELP model uses McEnroe's equation, to ensure that the head on the primary liner system is less than 12 inches for all cases analyzed. It has been demonstrated that the maximum head on the liner, as calculated by McEnroe's equation, is valid only when the head lies within the thickness of the geocomposite [Ellithy and Zhao, 2001]. Giroud's method was developed to evaluate drainage systems composed of two layers with the lower layer being a geocomposite.

The results of the head analysis in the HELP model showed heads on the primary geomembrane larger than the thickness of the primary geocomposite drainage layer for some cases. As a result, Giroud's method was used to verify the heads on the primary liner system.

6.1 McEnroe's Equation for Head

HELP Version 3.07 uses McEnroe's equations to calculate maximum saturated depth over landfill liners. These equations are mathematically sensitive under certain ranges of drainage layer slope and hydraulic conductivity and may produce incorrect results. An alternative solution based on simplified assumptions and numerical methods presented by Giroud, et. al. (2001) was used to verify the heads calculated by the HELP model.

6.2 Giroud, et al. Solution for Head

Giroud, et. al. (2001) present a method for calculating the maximum liquid thickness and the maximum head in drainage systems composed of two layers, with the lower layer being a geocomposite. The solution for maximum liquid thickness and maximum head takes into consideration the rate of liquid supply, the hydraulic conductivities of the two layers, the length of the drainage path, and the slope.

The application of the above method for the proposed design modifications in Cell 3 considered values for rate of liquid supply, q_h, as the peak monthly average lateral drainage in the primary geocomposite drainage layer obtained from the HELP analysis for each case. Other parameters used in the analysis and the heads computed using Giroud, et. al. (2001) method are presented in the spreadsheets included in Attachment 3 to this calculation package. The heads on the primary liner system computed using Giroud's method are summarized in Table C-2. As noted, the head on the primary liner system is less than 0.1 inches for all cases analyzed.

Giroud, et. al. (2001) method was also used to iteratively estimate the minimum transmissivity for the primary geocomposite drainage layer that results in a maximum head of approximately 12 inches on the primary liner system. The analysis was performed for waste heights of 10 ft, 95 ft, and 150 ft. It is noted that Cell 3 will have a maximum waste height of approximately 150 ft after the OHDF is vertically expanded. The results of this analysis are summarized in Table C-2 and are identified as PDM 2. The spreadsheets presenting the input parameters and the results are included as Attachment 4 to this calculation package.

7. LEACHATE STORAGE CAPACITY

As discussed in Section 5.2 above, the volume of lateral drainage in the primary and secondary geocomposites for the proposed design modifications in Cell 3 are similar to the currently permitted design presented in the 2002 Permit Documents. As a result, no changes are required to the currently permitted and existing leachate storage facility at the OHDF.

8. CENTRAL LEACHATE COLLECTION SYSTEM PIPE DESIGN

8.1 Peak Leachate Flow

An analysis was performed to evaluate the performance of the proposed central leachate collection system pipe that will be installed in Cell 3 (see Figure 5 of the minor modification application). A 6-in diameter perforated HDPE having a standard dimension ratio (SDR) of 11 will be used in the proposed central leachate collection system in Cell 3 (see Figure 6 of the minor modification application).

The peak daily lateral drainage in the primary geocomposite drainage layer obtained from the HELP model analysis was selected as the flow rate to design the central leachate collection pipe in Cell 3. As noted in Table C-1, the Case 1 with 10 ft of waste represents the critical case for the peak daily lateral drainage in the primary geocomposite drainage layer. A peak daily leachate generation rate of approximately 218 gpm (corresponding to 3,814 cu. ft per acre per day and 11 acre area of Cell 3) was used in the analysis.

8.2 Pipe Flow Capacity

The pipe flow capacity is calculated using Manning's equation as follows:

$$Q_p = \frac{1.486 R_h^{0.66} i_p^{0.5} A_p}{n}$$

where:

Q_p= pipe flow capacity, cfs;
R_h= hydraulic radius (B_i/4 for pipe flowing full);
B_i= pipe inner diameter;
i_p= hydraulic gradient (based on the slope and length of the pipe);
A_p= cross-sectional area of the pipe, ft^2; and
n= Manning's roughness coefficient (Attachment 11).

8.2.1 Central Leachate Collection Pipe in Cell 3

The peak daily leachate generated in the Cell 3 was estimated to be approximately 218 gpm (Table C-1). Due to the proposed configuration of the central leachate collection system in Cell 3, the maximum percent of flow that the proposed central drain pipe is likely to receive is 50 percent of the total Cell 3 flow. Therefore, the design flow for the proposed central drain pipe is approximately 109 gpm. The proposed central drain pipe is a 6-in diameter SDR 11 HDPE pipe that slopes at approximately 1.2 percent (see Figure 6 of the minor modification application).

The flow capacity for the proposed central leachate collection pipe was evaluated for slopes ranging from 0.5 to 2.0 percent using the following input data corresponding to a 6-in diameter SDR 11 HDPE pipe flowing full:

B_i	5.349 in
R_h	1.34 in
i_p	0.5% to 2%
A_p	22.47 in^2
n	0.009

The pipe flow equation yields the following flow capacities for the proposed central leachate collection pipe in Cell 3:

Pipe Slope %	Flow gpm
2.0	384.32
1.0	271.75
0.5	192.16

From the above results it is concluded that the proposed leachate collection pipe in Cell 3 has adequate flow capacity to handle the peak daily leachate generated in the Cell 3.

8.2.2 Leachate Sump Pipes

As discussed in Section 5.2 above, the volume of lateral drainage in the primary and secondary geocomposites for the proposed design modifications in Cell 3 are similar to the currently permitted design presented in the 2002 Permit Documents. As a result, no changes are required to the currently permitted leachate sump pipes in Cell 3.

8.3 Pipe Perforation Sizing

The size and layout of the perforations for the proposed central leachate collection drain pipe will be same as that for the toe leachate collection drain pipe (see Sheet 19 of 50 of the Permit Drawings). The central leachate collection drain pipe will use No. 57 stone, similar to the toe leachate collection drain pipe in the 2002 Permit Documents. As a result, the computations presented in Section 8.3 of Appendix K in the May 2002 Permit Application are still applicable.

8.4 Pipe Structural Stability

Section 8.4 of Appendix K in the May 2002 Permit Application presents the structural stability analysis for a 6-in diameter SDR 11 HDPE pipe under 95 ft of waste and 3 ft of soil cover. Since the maximum height of waste on top of the proposed central leachate collection pipe is less than 95 feet, these computations are still applicable.

9. LEACHATE TRANSMISSION SYSTEM

As discussed in Section 5.2 above, the volume of lateral drainage in the primary and secondary geocomposites for the proposed design modifications in Cell 3 are similar to the currently permitted design presented in the 2002 Permit Documents. As a result, no changes are required to the currently permitted and existing leachate transmission system at the OHDF.

T

HELP MODEL AN
LEACHATE GENERATIO

Analysis Type	Waste Height (ft)	Waste Density Range (lb/ft³)	Vertical Stress (psf)	Drainage Length (ft)	Liner System Slope (%)	Primary Geocomposite Drainage Layer: $\theta_{measured}$ [1] (m^2/sec)	RF*FS	$\theta_{req'd}$ [2] (m^2/sec)	Thickness geonet (in)	Permeability k (cm/s)
Case 1: (10 ft of waste height)										
CPD [3]	10	43 to 45	440	630	2.0	7.80E-03	4.72	1.65E-03	0.297	21.91
PDM [4]	10	43 to 45	440	400	2.0	5.40E-03	4.72	1.14E-03	0.285	15.80
Case 2-A: (30 ft of waste height)										
CPD [3]	30	43 to 51	1,403	630	1.5	7.60E-03	8.08	9.41E-04	0.295	12.55
PDM [4]	30	43 to 51	1,403	400	1.5	5.10E-03	7.08	7.20E-04	0.283	10.02
Case 2-B: (60 ft of waste height)										
CPD [3]	60	43 to 60	3,072	630	1.5	7.00E-03	8.08	8.66E-04	0.289	11.80
PDM [4]	60	43 to 60	3,072	400	1.5	4.80E-03	7.08	6.78E-04	0.281	9.50
Case 2-C: (95 ft of waste height)										
CPD [3]	95	43 to 70	5,028	630	1.0	6.20E-03	8.08	7.67E-04	0.276	10.95
PDM [4]	95	43 to 70	5,028	400	1.0	4.50E-03	7.08	6.36E-04	0.278	9.00

Note:

[1] Measured transmissivity during laboratory testing

[2] Transmissivity after applying reduction assumed factors and factor of safety (Transmissivity used in HELP model analysis)

[3] CPD = Analysis performed for the Currently Permitted Design using Tenax Tendrain transmissivities

[4] PDM = Analysis performed for the Proposed Design Modifications using GSE Permanet UL transmissvities

[5] PGC = Primary geocomposite drainage layer; SGC = Secondary geocomposite drainage layer

able C-1

NALYSIS RESULTS FOR
N RATE, LEAKAGE, AND HEAD

HELP Model Analysis Results										
Peak Daily Lateral Drainage in PGC [6] (ft^3/ac/day)	Avg. Annual Lateral Drainage in PGC [5] (ft^3/ac/yr)	Peak Daily Max. Head on PGC [5] (in)	Peak Daily Avg. Head on PGC [5] (in)	Peak Daily Lateral Drainage in SGC [6] (ft^3/ac/day)	Avg. Annual Lateral Drainage in SGC [5] (ft^3/ac/yr)	Peak Daily Max. Head on SGC [5] (in)	Peak Daily Leakage to Subgrade (ft^3/ac/day)	Avg. Annual Leakage to Subgrade (ft^3/ac/yr)	HELP Model File Name
3,882	44,442	2.87	1.67	1.80E-03	0.003	0.061	0.137	0.005	Case 1D
3,814	43,890	0.46	0.24	2.10E-04	0.002	0.026	0.137	0.005	Case 1B
1,240	24,112	0.40	0.20	2.00E-04	0.003	0.031	0.137	0.005	Case 230
1,240	22,926	0.31	0.16	9.00E-05	0.002	0.073	0	0	Case 230C
812	19,342	0.28	0.14	1.00E-04	0.003	0.029	0.137	0.005	Case 260
782	22,216	0.21	0.11	7.00E-05	0.002	0.030	0.137	0.005	Case 260D
651	29,142	0.36	0.18	1.00E-04	0.007	0.045	0.137	0.005	Case 295
702	23,445	0.29	0.15	0.00E+00	0	0	0.137	0.005	Case 95aa

Table C-

HEADS ON PRIMARY L

COMPUTED USING GIR

Analysis Type	Waste Height (ft)	Waste Density Range (lb/ft³)	Vertical Stress (psf)	Drainage Length (ft)	Liner System Slope (%)	$\theta_{measured}$ [1] (m^2/sec)
Case 1: (10 ft of waste height)						
PDM 1 [3]	10	43 to 45	440	400	2.0	5.40E-03
PDM 2 [4]	10	43 to 45	440	400	2.0	6.28E-04
Case 2-A: (30 ft of waste height)						
PDM 1 [3]	30	43 to 51	1,403	400	1.5	5.10E-03
Case 2-B: (60 ft of waste height)						
PDM 1 [3]	60	43 to 60	3,072	400	1.5	4.80E-03
Case 2-C: (95 ft of waste height)						
PDM 1 [3]	95	43 to 70	5,028	400	1.0	4.50E-03
PDM 2 [4]	95	43 to 70	5,028	400	1.0	1.10E-03
Case 2-D: (150 ft of waste height) [5]						
PDM 1 [3]	150	43 to 80	9,139	400	1.0	2.70E-03
PDM 2 [4]	150	43 to 80	9,139	400	1.0	8.52E-04

Note:

[1] Measured transmissivity during laboratory testing

[2] Transmissivity after applying reduction assumed factors and factor of safety (Transmissivity used in HELP model analysis)

[3] PDM 1 = Analysis performed for the Proposed Design Modifications using GSE Permanet UL transmissvities

[4] PDM 2 = Analysis performed iteratively by changing the transmissivity of the primary geocomposite to obtain a maximum head o

[5] This case represents the maximum vertical stress on the liner system after OHDF is vertically expanded

2

INER SYSTEM

UD'S METHOD

Primary Geocomposite Drainage Layer				Verification of Heads (Giroud's Eqn)		
RF*FS	$\theta_{req'd}$ [2]	Thickness geonet	Permeability k	Peak Monthly Avg. Impingement Rate		Peak Monthly Avg. Head on Primary Geocomposite
	(m^2/sec)	(in)	(cm/s)	(in/ac/month)	(ft^3/ac/day)	(in)
4.72	1.14E-03	0.285	15.80	2.37	287	0.04
4.72	1.33E-04	0.285	1.84	2.37	287	11.00
7.08	7.20E-04	0.283	10.02	1.36	164	0.04
7.08	6.78E-04	0.281	9.50	1.16	141	0.04
7.08	6.36E-04	0.278	9.00	1.41	171	0.07
7.08	1.56E-04	0.278	2.21	1.41	171	11.54
7.54	3.58E-04	0.273	5.16	1.04	126	0.09
7.54	1.13E-04	0.273	1.63	1.04	126	11.56

f approximately 12 inches on the primary geomembrane

Figure C-1

COMPARISON BETWEEN TENAX TENDRAIN AND GSE PERMANET UL

Properties of Tenax Tendrain Geocomposite [1]
(Properties used in May 2002 Permit Application)

Stress psf	θ m^2/sec	Thickness geonet %	Thickness geonet mm
0	N/A [2]	100	7.62
2,000	7.50E-03	97	7.39
15,000	4.20E-03	85	6.48
20,000	2.50E-03	77	5.87

Notes:

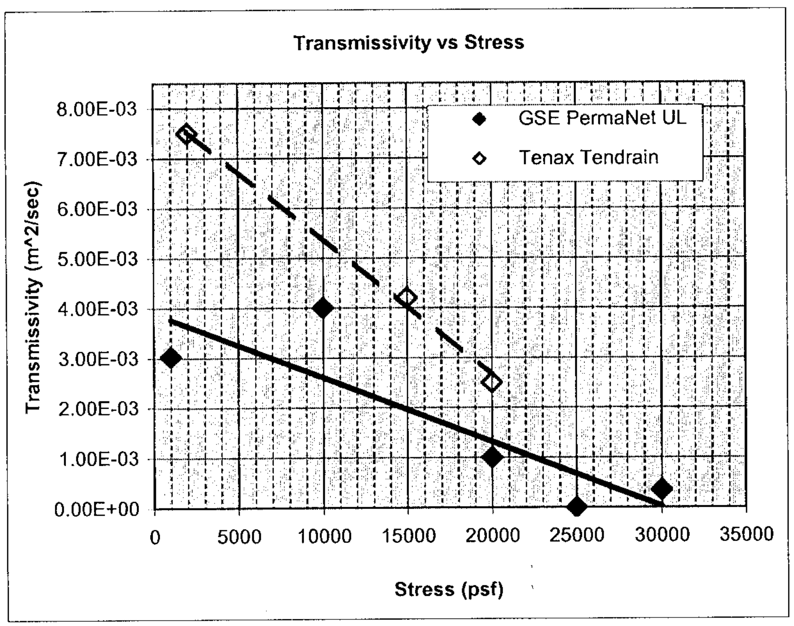
[1] Test results are for 0.02 gradient, 100 hours of seating time, and geocomposite sandwiched between sand and textured geomembrane

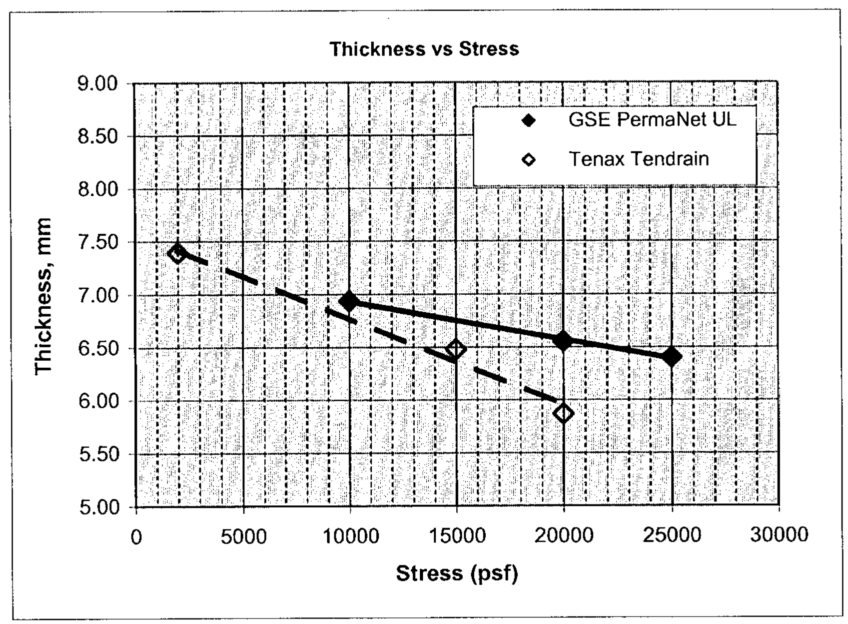
[2] N/A = not available

[3] Thickness after 100,000 hrs of constant stress

Properties of GSE PermaNet UL Gepcomposite [1]
(Properties used in this application)

Stress psf	θ m^2/sec	Thickness geonet [3] %	Thickness geonet [3] mm
0	N/A	100	7.62
1000	3.03E-03	N/A	N/A
10000	4.00E-03	91	6.93
20000	1.00E-03	86	6.55
25000	N/A	84	6.40
30000	3.50E-04	N/A	N/A





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Attachment 1

SUMMARY OF HELP MODEL INPUT DATA

INPUT DATA (CASE 1 - PDM)
CELL 3 LINER SYSTEM WITH 10 FT OF WASTE

WEATHER DATA AND SOIL LAYERS PROPERTIES

A. Evapotranspiration data

Data	Value	Units
Nearby city	Orlando	
State	Florida	
Latitude	27.8	
Evaporative zone depth	12	in
bare	10	
fair	22	
excellent	40	
Maximum leaf area index	0	
bare ground	0	
poor stand of grass	1	
fair stand of grass	2	
good stand of grass	3.5	
excellent stand of grass	5	
Growing season start day	0	
Growing season end day	367	
Average wind speed	8.6	mph
First quarter relative humidity	72	%
Second quarter relative humidity	72	%
Third quarter relative humidity	80	%
Fourth quarter relative humidity	76	%

B. Precipitation

Data	Value
Nearby city	Fort Drum
State	Florida
Years for data generation	25

C. Temperature

Data	Value
Nearby city	Orlando
State	Florida
Years for data generation	25

Normal mean monthly temperature (°F)

January	60.5	July	82.4
February	61.5	August	82.5
March	66.8	September	81.1
April	72	October	74.9
May	77.3	November	67.5
June	80.9	December	62

D. Solar Radiation

Data	Value
Nearby city	Orlando
State	Florida
Years for data generation	25

E. Geomembrane and Area

Placement of geomembrane	good
Pinhole (# of defects/area)	2
Defect density per acre	2
Area assumed in program (acre)	1
Total area (cell 3)	11 acre

Runoff curve number

Soil texture	18	waste type
Vegetation	1	bare ground

Variables

Area of runoff	0	%
Bottom slope	2	%

Liner path (average)=	400
Surface slope length (average)=	765

F. Properties of soil layers

Layer	Type	Description	Thickness in	Texture number	Porosity vol/vol	Field cap. vol/vol	Wilting point vol/vol	k cm/sec	Length Drain ft	Liner slope %
1	1	Vertical percolation	120	18	0.168	0.073	0.019	0.001		
2	1	Vertical percolation	24	1	0.417	0.045	0.018	0.001		
3	2	Lateral drainage	0.285		0.85	0.01	0.005	15.80	400	2.0
4	4	Geomembrane liner	0.060	35				2E-13		
5	3	GCL	0.250	17	0.750	0.747	0.400	3.00E-09		
6	2	Lateral drainage	0.181		0.850	0.010	0.005	11.05	800	2.0
7	4	Geomembrane liner	0.060	35				2E-13		
8	3	GCL	0.250	17	0.750	0.747	0.400	3.00E-09		
9	1	Vertical percolation	120.000	5	0.457	0.131	0.058	0.001		

INPUT DATA (CASE 2A - PDM)
CELL 3 LINER SYSTEM WITH 30 FT OF WASTE

WEATHER DATA AND SOIL LAYERS PROPERTIES

A. Evapotranspiration data

Data	Value	Units
Nearby city	Orlando	
State	Florida	
Latitude	27.8	
Evaporative zone depth	22	in
bare	10	
fair	22	
excellent	40	
Maximum leaf area index	1	
bare ground	0	
poor stand of grass	1	
fair stand of grass	2	
good stand of grass	3.5	
excellent stand of grass	5	
Growing season start day	0	
Growing season end day	367	
Average wind speed	8.6	mph
First quarter relative humidity	72	%
Second quarter relative humidity	72	%
Third quarter relative humidity	80	%
Fourth quarter relative humidity	76	%

B. Precipitation

Data	Value
Nearby city	Fort Drum
State	Florida
Years for data generation	25

C. Temperature

Data	Value
Nearby city	Orlando
State	Florida
Years for data generation	25

Normal mean monthly temperature (ºF)

January	60.5	July	82.4
February	61.5	August	82.5
March	66.8	September	81.1
April	72	October	74.9
May	77.3	November	67.5
June	80.9	December	62

D. Solar Radiation

Data	Value
Nearby city	Orlando
State	Florida
Years for data generation	25

E. Geomembrane and Area

Placement of geomembrane	good
Pinhole (# of defects/area)	2
Defect density per acre	2
Area assumed in program (acre)	1
Total area (cell 3)	11 acre

Runoff curve number

Soil texture	18	waste type
Vegetation	2	poor grass

Variables

Area of runoff	25	%
Bottom slope	1.5	%

Liner path (average)=	400
Surface slope length (average)=	765

F. Properties of soil layers

Layer	Type	Description	Thickness in	Texture number	Porosity vol/vol	Field cap. vol/vol	Wilting point vol/vol	k cm/sec	Length Drain ft	Liner slope %
1	1	Vertical percolation	360	18	0.168	0.073	0.019	0.001		
2	1	Vertical percolation	24	1	0.417	0.045	0.018	0.001		
3	2	Lateral drainage	0.283		0.85	0.01	0.005	10.02	400	1.5
4	4	Geomembrane liner	0.060	35				2E-13		
5	3	GCL	0.250	17	0.750	0.747	0.400	3.00E-09		
6	2	Lateral drainage	0.179		0.850	0.010	0.005	5.44	800	1.5
7	4	Geomembrane liner	0.060	35				2E-13		
8	3	GCL	0.250	17	0.750	0.747	0.400	3.00E-09		
9	1	Vertical percolation	120	5	0.457	0.131	0.058	0.001		

INPUT DATA (CASE 2B - PDM)
CELL 3 LINER SYSTEM WITH 60 FT OF WASTE

WEATHER DATA AND SOIL LAYERS PROPERTIES

A. Evapotranspiration data

Data	Value	Units
Nearby city	Orlando	
State	Florida	
Latitude	27.8	
Evaporative zone depth	22	in
bare	10	
fair	22	
excellent	40	
Maximum leaf area index	2	
bare ground	0	
poor stand of grass	1	
fair stand of grass	2	
good stand of grass	3.5	
excellent stand of grass	5	
Growing season start day	0	
Growing season end day	367	
Average wind speed	8.6	mph
First quarter relative humidity	72	%
Second quarter relative humidity	72	%
Third quarter relative humidity	80	%
Fourth quarter relative humidity	76	%

B. Precipitation

Data	Value
Nearby city	Fort Drum
State	Florida
Years for data generation	25

C. Temperature

Data	Value
Nearby city	Orlando
State	Florida
Years for data generation	25

Normal mean monthly temperature (°F)

January	60.5	July	82.4
February	61.5	August	82.5
March	66.8	September	81.1
April	72	October	74.9
May	77.3	November	67.5
June	80.9	December	62

D. Solar Radiation

Data	Value
Nearby city	Orlando
State	Florida
Years for data generation	25

E. Geomembrane and Area

Placement of geomembrane	good
Pinhole (# of defects/area)	2
Defect density per acre	2
Area assumed in program (acre)	1
Total area (cell 3)	11 acre

Runoff curve number

Soil texture	18	waste type
Vegetation	3	fair grass

Variables

Area of runoff	50	%
Bottom slope	1.5	%

Liner path (average)=	400
Surface slope length (average)=	765

F. Properties of soil layers

Layer	Type	Description	Thickness in	Texture number	Porosity vol/vol	Field cap. vol/vol	Wilting point vol/vol	k cm/sec	Length Drain ft	Liner slope %
1	1	Vertical percolation	720	18	0.168	0.073	0.019	0.001		
2	1	Vertical percolation	24	1	0.417	0.045	0.018	0.001		
3	2	Lateral drainage	0.281		0.85	0.01	0.005	9.50	400	1.5
4	4	Geomembrane liner	0.060	35				2E-13		
5	3	GCL	0.250	17	0.750	0.747	0.400	3.00E-09		
6	2	Lateral drainage	0.173		0.850	0.010	0.005	3.938	800	1.5
7	4	Geomembrane liner	0.060	35				2E-13		
8	3	GCL	0.250	17	0.750	0.747	0.400	3.00E-09		
9	1	Vertical percolation	120	5	0.457	0.131	0.058	0.001		

INPUT DATA (CASE 2C - PDM)
CELL 3 LINER SYSTEM WITH 95 FT OF WASTE

WEATHER DATA AND SOIL LAYERS PROPERTIES

A. Evapotranspiration data

Data	Value	Units
Nearby city	Orlando	
State	Florida	
Latitude	27.8	
Evaporative zone depth	22	in
bare	10	
fair	22	
excellent	40	
Maximum leaf area index	3.5	
bare ground	0	
poor stand of grass	1	
fair stand of grass	2	
good stand of grass	3.5	
excellent stand of grass	5	
Growing season start day	0	
Growing season end day	367	
Average wind speed	8.6	mph
First quarter relative humidity	72	%
Second quarter relative humidity	72	%
Third quarter relative humidity	80	%
Fourth quarter relative humidity	76	%

B. Precipitation

Data	Value
Nearby city	Fort Drum
State	Florida
Years for data generation	25

C. Temperature

Data	Value
Nearby city	Orlando
State	Florida
Years for data generation	25

Normal mean monthly temperature (°F)

January	60.5	July	82.4
February	61.5	August	82.5
March	66.8	September	81.1
April	72	October	74.9
May	77.3	November	67.5
June	80.9	December	62

D. Solar Radiation

Data	Value
Nearby city	Orlando
State	Florida
Years for data generation	25

E. Geomembrane and Area

Placement of geomembrane	good
Pinhole (# of defects/area)	2
Defect density per acre	2
Area assumed in program (acre)	1
Total area (cell 3)	11 acre

Runoff curve number

Soil texture	18	waste type
Vegetation	4	good grass

Variables

Area of runoff	100	%
Bottom slope	1.0	%

Liner path (average)=	400
Surface slope length (average)=	765

F. Properties of soil layers

Layer	Type	Description	Thickness in	Texture number	Porosity vol/vol	Field cap. vol/vol	Wilting point vol/vol	k cm/sec	Length Drain ft	Slope %
1	1	Vertical percolation	12	1	0.417	0.045	0.018	0.001		
2	1	Vertical percolation	1140	18	0.168	0.073	0.019	0.001		
3	1	Vertical percolation	24	1	0.417	0.045	0.018	0.001		
4	2	Lateral drainage	0.278		0.85	0.01	0.005	9.00	400	1.0
5	4	Geomembrane liner	0.060	35				2E-13		
6	3	GCL	0.250	17	0.750	0.747	0.400	3.00E-09		
7	2	Lateral drainage	0.167		0.850	0.010	0.005	3.20	800	1.0
8	4	Geomembrane liner	0.060	35				2E-13		
9	3	GCL	0.250	17	0.750	0.747	0.400	3.00E-09		
10	1	Vertical percolation	120.000	5	0.457	0.131	0.058	0.001		

Attachment 2

HELP MODEL OUTPUT FILES

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


PRECIPITATION DATA FILE:      C:\DOCUME~1\SEUN\DESKTOP\ZHELP3~1\FURTDRUM.D4
TEMPERATURE DATA FILE:        C:\DOCUME~1\SEUN\DESKTOP\ZHELP3~1\CASE1.D7
SOLAR RADIATION DATA FILE:    C:\DOCUME~1\SEUN\DESKTOP\ZHELP3~1\CASE1.D13
EVAPOTRANSPIRATION DATA:      C:\DOCUME~1\SEUN\DESKTOP\ZHELP3~1\CASE1.D11
SOIL AND DESIGN DATA FILE:    C:\DOCUME~1\SEUN\DESKTOP\ZHELP3~1\CASE1B.D10
OUTPUT DATA FILE:             C:\DOCUME~1\SEUN\DESKTOP\ZHELP3~1\CASE1b.OUT


TIME:  10:48     DATE:   5/22/2006


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

     TITLE:  Oak Hammock Disposal Facility

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


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


                                  LAYER  1
                                  --------

                      TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER  18
           THICKNESS                  =    120.00   INCHES
           POROSITY                   =      0.6710 VOL/VOL
           FIELD CAPACITY             =      0.2920 VOL/VOL
           WILTING POINT              =      0.0770 VOL/VOL
           INITIAL SOIL WATER CONTENT =      0.2779 VOL/VOL
           EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC
```

LAYER 2

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	24.00	INCHES
POROSITY	=	0.4170	VOL/VOL
FIELD CAPACITY	=	0.0450	VOL/VOL
WILTING POINT	=	0.0180	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0810	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.999999978000E-02	CM/SEC

LAYER 3

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	0.28	INCHES
POROSITY	=	0.8500	VOL/VOL
FIELD CAPACITY	=	0.0100	VOL/VOL
WILTING POINT	=	0.0050	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0123	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	15.8000002000	CM/SEC
SLOPE	=	2.00	PERCENT
DRAINAGE LENGTH	=	400.0	FEET

LAYER 4

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35

THICKNESS	=	0.06	INCHES
POROSITY	=	0.0000	VOL/VOL
FIELD CAPACITY	=	0.0000	VOL/VOL
WILTING POINT	=	0.0000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.199999996000E-12	CM/SEC
FML PINHOLE DENSITY	=	2.00	HOLES/ACRE
FML INSTALLATION DEFECTS	=	2.00	HOLES/ACRE
FML PLACEMENT QUALITY	=	3 - GOOD	

LAYER 5

TYPE 3 - BARRIER SOIL LINER

MATERIAL TEXTURE NUMBER 17

THICKNESS	=	0.25 INCHES
POROSITY	=	0.7500 VOL/VOL
FIELD CAPACITY	=	0.7470 VOL/VOL
WILTING POINT	=	0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.7500 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000003000E-08 CM/SEC

LAYER 6

TYPE 2 - LATERAL DRAINAGE LAYER

MATERIAL TEXTURE NUMBER 0

THICKNESS	=	0.18 INCHES
POROSITY	=	0.8500 VOL/VOL
FIELD CAPACITY	=	0.0100 VOL/VOL
WILTING POINT	=	0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0100 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	11.0500002000 CM/SEC
SLOPE	=	2.00 PERCENT
DRAINAGE LENGTH	=	800.0 FEET

LAYER 7

TYPE 4 - FLEXIBLE MEMBRANE LINER

MATERIAL TEXTURE NUMBER 35

THICKNESS	=	0.06 INCHES
POROSITY	=	0.0000 VOL/VOL
FIELD CAPACITY	=	0.0000 VOL/VOL
WILTING POINT	=	0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY	=	2.00 HOLES/ACRE
FML INSTALLATION DEFECTS	=	2.00 HOLES/ACRE
FML PLACEMENT QUALITY	=	3 - GOOD

LAYER 8

TYPE 3 - BARRIER SOIL LINER

MATERIAL TEXTURE NUMBER 17

THICKNESS	=	0.25 INCHES
POROSITY	=	0.7500 VOL/VOL
FIELD CAPACITY	=	0.7470 VOL/VOL
WILTING POINT	=	0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.7500 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000003000E-08 CM/SEC

LAYER 9

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 5

THICKNESS	=	120.00	INCHES
POROSITY	=	0.4570	VOL/VOL
FIELD CAPACITY	=	0.1310	VOL/VOL
WILTING POINT	=	0.0580	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1310	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000005000E-02	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: -SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE #18 WITH BARE GROUND CONDITIONS, A SURFACE SLOPE OF 5.% AND A SLOPE LENGTH OF 765. FEET.

SCS RUNOFF CURVE NUMBER	=	79.30	
FRACTION OF AREA ALLOWING RUNOFF	=	0.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	12.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	1.816	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	8.052	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	0.924	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	51.395	INCHES
TOTAL INITIAL WATER	=	51.395	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM ORLANDO FLORIDA

STATION LATITUDE	=	27.80	DEGREES
MAXIMUM LEAF AREA INDEX	=	0.00	
START OF GROWING SEASON (JULIAN DATE)	=	0	
END OF GROWING SEASON (JULIAN DATE)	=	367	
EVAPORATIVE ZONE DEPTH	=	12.0	INCHES
AVERAGE ANNUAL WIND SPEED	=	8.60	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	72.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	72.00	%

AVERAGE 3RD QUARTER RELATIVE HUMIDITY = 80.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY = 76.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR TAMPA FLORIDA

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR ORLANDO FLORIDA

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
60.50	61.50	66.80	72.00	77.30	80.90
82.40	82.50	81.10	74.90	67.50	62.00

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR ORLANDO FLORIDA
AND STATION LATITUDE = 27.80 DEGREES

****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 25

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	2.70	3.02	3.34	2.49	5.46	7.98
	8.01	6.39	6.10	3.58	1.66	2.20
STD. DEVIATIONS	2.07	1.86	2.03	1.59	3.34	4.05
	3.71	2.12	2.58	1.87	0.95	1.17
RUNOFF						
TOTALS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000

STD. DEVIATIONS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000

EVAPOTRANSPIRATION

TOTALS	2.047	2.362	2.810	2.779	3.711	5.434
	5.347	4.891	4.402	3.164	2.043	1.763
STD. DEVIATIONS	0.772	0.972	1.469	1.252	1.369	1.474
	1.144	1.205	1.059	0.922	0.844	0.690

LATERAL DRAINAGE COLLECTED FROM LAYER 3

TOTALS	0.1952	0.4126	0.5432	0.5319	0.3507	1.0492
	2.3438	2.1709	1.8079	1.7516	0.6777	0.2560
STD. DEVIATIONS	0.2674	0.7760	0.8351	0.6450	0.4753	1.2721
	3.1097	1.7413	1.5069	1.6734	0.7532	0.1714

PERCOLATION/LEAKAGE THROUGH LAYER 5

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

LATERAL DRAINAGE COLLECTED FROM LAYER 6

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

PERCOLATION/LEAKAGE THROUGH LAYER 8

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

PERCOLATION/LEAKAGE THROUGH LAYER 9

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 4

AVERAGES	0.0014	0.0033	0.0039	0.0040	0.0025	0.0078
	0.0169	0.0156	0.0135	0.0126	0.0050	0.0018
STD. DEVIATIONS	0.0019	0.0061	0.0060	0.0048	0.0034	0.0095
	0.0224	0.0125	0.0112	0.0121	0.0056	0.0012

DAILY AVERAGE HEAD ON TOP OF LAYER 7

AVERAGES	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

****

****

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 25

	INCHES		CU. FEET	PERCENT
PRECIPITATION	52.95	(8.270)	192196.9	100.00
RUNOFF	0.000	(0.0000)	0.00	0.000
EVAPOTRANSPIRATION	40.752	(4.0702)	147931.16	76.969
LATERAL DRAINAGE COLLECTED FROM LAYER 3	12.09086	(6.05804)	43889.809	22.83586
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.00000	(0.00000)	0.011	0.00001
AVERAGE HEAD ON TOP OF LAYER 4	0.007	(0.004)		
LATERAL DRAINAGE COLLECTED FROM LAYER 6	0.00000	(0.00000)	0.002	0.00000
PERCOLATION/LEAKAGE THROUGH LAYER 8	0.00000	(0.00000)	0.009	0.00000
AVERAGE HEAD ON TOP OF LAYER 7	0.000	(0.000)		
PERCOLATION/LEAKAGE THROUGH LAYER 9	0.00000	(0.00001)	0.005	0.00000
CHANGE IN WATER STORAGE	0.104	(0.9821)	375.91	0.196

****

****

PEAK DAILY VALUES FOR YEARS 1 THROUGH 25

	(INCHES)	(CU. FT.)
PRECIPITATION	5.78	20981.400
RUNOFF	0.000	0.0000
DRAINAGE COLLECTED FROM LAYER 3	1.05077	3814.28223
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.000000	0.00025
AVERAGE HEAD ON TOP OF LAYER 4	0.235	
MAXIMUM HEAD ON TOP OF LAYER 4	0.459	
LOCATION OF MAXIMUM HEAD IN LAYER 3 (DISTANCE FROM DRAIN)	8.4 FEET	
DRAINAGE COLLECTED FROM LAYER 6	0.00000	0.00021
PERCOLATION/LEAKAGE THROUGH LAYER 8	0.000000	0.00002
AVERAGE HEAD ON TOP OF LAYER 7	0.000	
MAXIMUM HEAD ON TOP OF LAYER 7	0.026	
LOCATION OF MAXIMUM HEAD IN LAYER 6 (DISTANCE FROM DRAIN)	0.0 FEET	
PERCOLATION/LEAKAGE THROUGH LAYER 9	0.000038	0.13712
SNOW WATER	0.00	0.0000

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.6355
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0777

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

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

****

****

FINAL WATER STORAGE AT END OF YEAR 25

LAYER	(INCHES)	(VOL/VOL)
1	34.5824	0.2882
2	3.2805	0.1367
3	0.0242	0.0850
4	0.0000	0.0000
5	0.1875	0.7500
6	0.0018	0.0100
7	0.0000	0.0000
8	0.1875	0.7500
9	15.7200	0.1310
SNOW WATER	0.000	

****
****

CASE 2A - PDM 1

```
****************************************************************************
****************************************************************************
**                                                                        **
**                                                                        **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE             **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)              **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                 **
**                    USAE WATERWAYS EXPERIMENT STATION                   **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY            **
**                                                                        **
**                                                                        **
****************************************************************************
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PRECIPITATION DATA FILE:    C:\DOCUME~1\SEUN\DESKTOP\ZHELP3~1\FURTDRUM.D4
TEMPERATURE DATA FILE:      C:\DOCUME~1\SEUN\DESKTOP\ZHELP3~1\CASE230.D7
SOLAR RADIATION DATA FILE:  C:\DOCUME~1\SEUN\DESKTOP\ZHELP3~1\CASE230.D13
EVAPOTRANSPIRATION DATA:    C:\DOCUME~1\SEUN\DESKTOP\ZHELP3~1\CASE230.D11
SOIL AND DESIGN DATA FILE:  C:\DOCUME~1\SEUN\DESKTOP\ZHELP3~1\CASE230C.D10
OUTPUT DATA FILE:           C:\DOCUME~1\SEUN\DESKTOP\ZHELP3~1\CASE230C.OUT


TIME:  11: 3     DATE:   5/22/2006


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

     TITLE:  Oak Hammock Disposal Facility

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


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


                                   LAYER  1
                                   --------

                        TYPE 1 - VERTICAL PERCOLATION LAYER
                          MATERIAL TEXTURE NUMBER  18
            THICKNESS                   =    360.00   INCHES
            POROSITY                    =      0.6710 VOL/VOL
            FIELD CAPACITY              =      0.2920 VOL/VOL
            WILTING POINT               =      0.0770 VOL/VOL
            INITIAL SOIL WATER CONTENT  =      0.2846 VOL/VOL
            EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC
          NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  1.80
```

FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.

LAYER 2

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	24.00	INCHES
POROSITY	=	0.3980	VOL/VOL
FIELD CAPACITY	=	0.2440	VOL/VOL
WILTING POINT	=	0.1360	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2440	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000005000E-02	CM/SEC

LAYER 3

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	0.28	INCHES
POROSITY	=	0.8500	VOL/VOL
FIELD CAPACITY	=	0.0100	VOL/VOL
WILTING POINT	=	0.0050	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0100	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	10.0200005000	CM/SEC
SLOPE	=	1.50	PERCENT
DRAINAGE LENGTH	=	400.0	FEET

LAYER 4

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35

THICKNESS	=	0.06	INCHES
POROSITY	=	0.0000	VOL/VOL
FIELD CAPACITY	=	0.0000	VOL/VOL
WILTING POINT	=	0.0000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.199999996000E-12	CM/SEC
FML PINHOLE DENSITY	=	2.00	HOLES/ACRE
FML INSTALLATION DEFECTS	=	2.00	HOLES/ACRE
FML PLACEMENT QUALITY	=	3 - GOOD	

LAYER 5

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 17

THICKNESS	=	0.25 INCHES
POROSITY	=	0.7500 VOL/VOL
FIELD CAPACITY	=	0.7470 VOL/VOL
WILTING POINT	=	0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.7500 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000003000E-08 CM/SEC

LAYER 6

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	0.18 INCHES
POROSITY	=	0.8500 VOL/VOL
FIELD CAPACITY	=	0.0100 VOL/VOL
WILTING POINT	=	0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0100 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.800000012000 CM/SEC
SLOPE	=	1.50 PERCENT
DRAINAGE LENGTH	=	800.0 FEET

LAYER 7

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35

THICKNESS	=	0.06 INCHES
POROSITY	=	0.0000 VOL/VOL
FIELD CAPACITY	=	0.0000 VOL/VOL
WILTING POINT	=	0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY	=	2.00 HOLES/ACRE
FML INSTALLATION DEFECTS	=	2.00 HOLES/ACRE
FML PLACEMENT QUALITY	=	3 - GOOD

LAYER 8

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 17

THICKNESS	=	0.25 INCHES
POROSITY	=	0.7500 VOL/VOL
FIELD CAPACITY	=	0.7470 VOL/VOL
WILTING POINT	=	0.4000 VOL/VOL

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

LAYER 9

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 5

THICKNESS	=	120.00 INCHES
POROSITY	=	0.4570 VOL/VOL
FIELD CAPACITY	=	0.1310 VOL/VOL
WILTING POINT	=	0.0580 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1310 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000005000E-02 CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE #18 WITH A POOR STAND OF GRASS, A SURFACE SLOPE OF 25.% AND A SLOPE LENGTH OF 236. FEET.

SCS RUNOFF CURVE NUMBER	=	74.70	
FRACTION OF AREA ALLOWING RUNOFF	=	25.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	22.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	3.750	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	14.762	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	1.694	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	124.402	INCHES
TOTAL INITIAL WATER	=	124.402	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM ORLANDO FLORIDA

STATION LATITUDE	=	27.80 DEGREES
MAXIMUM LEAF AREA INDEX	=	1.00
START OF GROWING SEASON (JULIAN DATE)	=	0
END OF GROWING SEASON (JULIAN DATE)	=	367
EVAPORATIVE ZONE DEPTH	=	22.0 INCHES
AVERAGE ANNUAL WIND SPEED	=	8.60 MPH

AVERAGE 1ST QUARTER RELATIVE HUMIDITY = 72.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY = 72.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY = 80.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY = 76.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR TAMPA FLORIDA

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR ORLANDO FLORIDA

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
60.50	61.50	66.80	72.00	77.30	80.90
82.40	82.50	81.10	74.90	67.50	62.00

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR ORLANDO FLORIDA
AND STATION LATITUDE = 27.80 DEGREES

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 25

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	2.70	3.02	3.34	2.49	5.46	7.98
	8.01	6.39	6.10	3.58	1.66	2.20
STD. DEVIATIONS	2.07	1.86	2.03	1.59	3.34	4.05
	3.71	2.12	2.58	1.87	0.95	1.17

RUNOFF

TOTALS	0.013	0.001	0.003	0.000	0.020	0.045
	0.030	0.013	0.051	0.007	0.000	0.000
STD. DEVIATIONS	0.046	0.002	0.008	0.001	0.045	0.084
	0.101	0.026	0.104	0.029	0.000	0.000

EVAPOTRANSPIRATION

TOTALS	2.089	2.483	3.163	3.461	4.643	6.072
	6.120	5.713	4.924	3.637	2.256	1.768
STD. DEVIATIONS	0.691	0.977	1.387	1.257	1.179	1.595
	0.982	0.846	0.748	0.779	0.735	0.643

LATERAL DRAINAGE COLLECTED FROM LAYER 3

TOTALS	0.0811	0.1357	0.3502	0.3488	0.1337	0.3186
	0.8761	1.1390	1.0608	1.2697	0.5539	0.0480
STD. DEVIATIONS	0.1237	0.3683	0.7013	0.6081	0.3582	0.6236
	1.2074	1.4701	1.3399	1.3732	1.0302	0.1071

PERCOLATION/LEAKAGE THROUGH LAYER 5

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

LATERAL DRAINAGE COLLECTED FROM LAYER 6

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

PERCOLATION/LEAKAGE THROUGH LAYER 8

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

PERCOLATION/LEAKAGE THROUGH LAYER 9

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 4

AVERAGES	0.0012	0.0022	0.0053	0.0055	0.0020	0.0050
	0.0133	0.0173	0.0166	0.0192	0.0087	0.0007
STD. DEVIATIONS	0.0019	0.0061	0.0106	0.0095	0.0054	0.0098
	0.0183	0.0223	0.0210	0.0208	0.0161	0.0016

DAILY AVERAGE HEAD ON TOP OF LAYER 7

AVERAGES	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 25

	INCHES	CU. FEET	PERCENT
PRECIPITATION	52.95 (8.270)	192196.9	100.00
RUNOFF	0.183 (0.2172)	664.22	0.346
EVAPOTRANSPIRATION	46.330 (4.2343)	168176.78	87.502
LATERAL DRAINAGE COLLECTED FROM LAYER 3	6.31573 (5.45564)	22926.100	11.92845
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.00000 (0.00000)	0.006	0.00000
AVERAGE HEAD ON TOP OF LAYER 4	0.008 (0.007)		
LATERAL DRAINAGE COLLECTED FROM LAYER 6	0.00000 (0.00000)	0.002	0.00000
PERCOLATION/LEAKAGE THROUGH LAYER 8	0.00000 (0.00000)	0.004	0.00000
AVERAGE HEAD ON TOP OF LAYER 7	0.000 (0.000)		
PERCOLATION/LEAKAGE THROUGH LAYER 9	0.00000 (0.00000)	0.000	0.00000
CHANGE IN WATER STORAGE	0.118 (1.1797)	429.75	0.224

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 25

	(INCHES)	(CU. FT.)
PRECIPITATION	5.78	20981.400
RUNOFF	0.358	1299.6200
DRAINAGE COLLECTED FROM LAYER 3	0.34150	1239.64563
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.000000	0.00017
AVERAGE HEAD ON TOP OF LAYER 4	0.160	
MAXIMUM HEAD ON TOP OF LAYER 4	0.314	
LOCATION OF MAXIMUM HEAD IN LAYER 3 (DISTANCE FROM DRAIN)	7.9 FEET	
DRAINAGE COLLECTED FROM LAYER 6	0.00000	0.00009
PERCOLATION/LEAKAGE THROUGH LAYER 8	0.000000	0.00002
AVERAGE HEAD ON TOP OF LAYER 7	0.000	
MAXIMUM HEAD ON TOP OF LAYER 7	0.073	
LOCATION OF MAXIMUM HEAD IN LAYER 6 (DISTANCE FROM DRAIN)	0.0 FEET	
PERCOLATION/LEAKAGE THROUGH LAYER 9	0.000000	0.00000
SNOW WATER	0.00	0.0000

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.4730
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0770

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

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

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FINAL WATER STORAGE AT END OF YEAR 25

LAYER	(INCHES)	(VOL/VOL)
1	105.1214	0.2920
2	6.1260	0.2553
3	0.0172	0.0609
4	0.0000	0.0000
5	0.1875	0.7500
6	0.0018	0.0100
7	0.0000	0.0000
8	0.1875	0.7500
9	15.7200	0.1310
SNOW WATER	0.000	

****
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CASE 2B - PDM 1

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

```
PRECIPITATION DATA FILE:    C:\DOCUME~1\SEUN\DESKTOP\ZHELP3~1\FURTDRUM.D4
TEMPERATURE DATA FILE:      C:\DOCUME~1\SEUN\DESKTOP\ZHELP3~1\CASE260.D7
SOLAR RADIATION DATA FILE:  C:\DOCUME~1\SEUN\DESKTOP\ZHELP3~1\CASE260.D13
EVAPOTRANSPIRATION DATA:    C:\DOCUME~1\SEUN\DESKTOP\ZHELP3~1\CASE260.D11
SOIL AND DESIGN DATA FILE:  C:\DOCUME~1\SEUN\DESKTOP\ZHELP3~1\CASE260D.D10
OUTPUT DATA FILE:           C:\DOCUME~1\SEUN\DESKTOP\ZHELP3~1\CASE260d.OUT
```

TIME: 11: 6   DATE: 5/22/2006

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

     TITLE:  Oak Hammock Disposal Facility

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

LAYER 1

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18

```
THICKNESS                  =    720.00    INCHES
POROSITY                   =      0.6710 VOL/VOL
FIELD CAPACITY             =      0.2920 VOL/VOL
WILTING POINT              =      0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.2867 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC
SUBSURFACE INFLOW          =      0.82    INCHES/YR
```

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

LAYER 2

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	24.00	INCHES
POROSITY	=	0.4170	VOL/VOL
FIELD CAPACITY	=	0.0450	VOL/VOL
WILTING POINT	=	0.0180	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1202	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000005000E-02	CM/SEC

LAYER 3

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	0.28	INCHES
POROSITY	=	0.8500	VOL/VOL
FIELD CAPACITY	=	0.0100	VOL/VOL
WILTING POINT	=	0.0050	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0182	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	9.50000000000	CM/SEC
SLOPE	=	1.50	PERCENT
DRAINAGE LENGTH	=	400.0	FEET

LAYER 4

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35

THICKNESS	=	0.06	INCHES
POROSITY	=	0.0000	VOL/VOL
FIELD CAPACITY	=	0.0000	VOL/VOL
WILTING POINT	=	0.0000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.199999996000E-12	CM/SEC
FML PINHOLE DENSITY	=	2.00	HOLES/ACRE
FML INSTALLATION DEFECTS	=	2.00	HOLES/ACRE
FML PLACEMENT QUALITY	=	3 - GOOD	

LAYER 5

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 17

THICKNESS	=	0.25	INCHES
POROSITY	=	0.7500	VOL/VOL
FIELD CAPACITY	=	0.7470	VOL/VOL
WILTING POINT	=	0.4000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.7500	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000003000E-08	CM/SEC

LAYER 6

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	0.17	INCHES
POROSITY	=	0.8500	VOL/VOL
FIELD CAPACITY	=	0.0100	VOL/VOL
WILTING POINT	=	0.0050	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0100	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	3.93799996000	CM/SEC
SLOPE	=	1.50	PERCENT
DRAINAGE LENGTH	=	800.0	FEET

LAYER 7

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35

THICKNESS	=	0.06	INCHES
POROSITY	=	0.0000	VOL/VOL
FIELD CAPACITY	=	0.0000	VOL/VOL
WILTING POINT	=	0.0000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.199999996000E-12	CM/SEC
FML PINHOLE DENSITY	=	2.00	HOLES/ACRE
FML INSTALLATION DEFECTS	=	2.00	HOLES/ACRE
FML PLACEMENT QUALITY	=	3 - GOOD	

LAYER 8

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 17

THICKNESS	=	0.25	INCHES
POROSITY	=	0.7500	VOL/VOL
FIELD CAPACITY	=	0.7470	VOL/VOL

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

LAYER 9

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 5

```
THICKNESS                     =     120.00   INCHES
POROSITY                      =       0.4570 VOL/VOL
FIELD CAPACITY                =       0.1310 VOL/VOL
WILTING POINT                 =       0.0580 VOL/VOL
INITIAL SOIL WATER CONTENT    =       0.1310 VOL/VOL
EFFECTIVE SAT. HYD. COND.     =  0.100000005000E-02 CM/SEC
```

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE #18 WITH A FAIR STAND OF GRASS, A SURFACE SLOPE OF 5.% AND A SLOPE LENGTH OF 765. FEET.

```
SCS RUNOFF CURVE NUMBER            =     54.20
FRACTION OF AREA ALLOWING RUNOFF   =     50.0     PERCENT
AREA PROJECTED ON HORIZONTAL PLANE =      1.000   ACRES
EVAPORATIVE ZONE DEPTH             =     22.0     INCHES
INITIAL WATER IN EVAPORATIVE ZONE  =      2.636   INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE =     14.762   INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE =      1.694   INCHES
INITIAL SNOW WATER                 =      0.000   INCHES
INITIAL WATER IN LAYER MATERIALS   =    225.438   INCHES
TOTAL INITIAL WATER                =    225.438   INCHES
TOTAL SUBSURFACE INFLOW            =      0.82    INCHES/YEAR
```

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
ORLANDO FLORIDA

```
STATION LATITUDE                        =  27.80 DEGREES
MAXIMUM LEAF AREA INDEX                 =   2.00
START OF GROWING SEASON (JULIAN DATE)   =      0
END OF GROWING SEASON (JULIAN DATE)     =    367
EVAPORATIVE ZONE DEPTH                  =  22.0  INCHES
```

AVERAGE ANNUAL WIND SPEED = 8.60 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY = 72.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY = 72.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY = 80.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY = 76.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR TAMPA FLORIDA

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR ORLANDO FLORIDA

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
60.50	61.50	66.80	72.00	77.30	80.90
82.40	82.50	81.10	74.90	67.50	62.00

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR ORLANDO FLORIDA AND STATION LATITUDE = 27.80 DEGREES

****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 25

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	2.70	3.02	3.34	2.49	5.46	7.98
	8.01	6.39	6.10	3.58	1.66	2.20
STD. DEVIATIONS	2.07	1.86	2.03	1.59	3.34	4.05
	3.71	2.12	2.58	1.87	0.95	1.17

RUNOFF

TOTALS	0.000	0.000	0.000	0.000	0.000	0.001
	0.003	0.000	0.004	0.000	0.000	0.000
STD. DEVIATIONS	0.000	0.000	0.000	0.000	0.000	0.005
	0.014	0.000	0.014	0.000	0.000	0.000

EVAPOTRANSPIRATION

TOTALS	2.023	2.800	3.559	3.549	4.084	6.102
	6.346	5.878	5.048	3.976	2.411	1.693
STD. DEVIATIONS	0.592	0.836	1.415	1.711	1.583	1.759
	1.101	0.884	0.804	0.797	0.780	0.592

SUBSURFACE INFLOW INTO LAYER 1

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

LATERAL DRAINAGE COLLECTED FROM LAYER 3

TOTALS	0.2327	0.1230	0.3612	0.2556	0.1787	0.1917
	0.3929	0.9140	0.9857	1.1982	0.8063	0.4800
STD. DEVIATIONS	0.3660	0.0676	0.6942	0.5068	0.2383	0.3129
	0.5894	1.2790	1.0832	1.1798	1.0033	0.7922

PERCOLATION/LEAKAGE THROUGH LAYER 5

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

LATERAL DRAINAGE COLLECTED FROM LAYER 6

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

PERCOLATION/LEAKAGE THROUGH LAYER 8

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

PERCOLATION/LEAKAGE THROUGH LAYER 9

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 4

AVERAGES	0.0037	0.0022	0.0058	0.0042	0.0029	0.0032
	0.0063	0.0146	0.0163	0.0191	0.0133	0.0077
STD. DEVIATIONS	0.0058	0.0012	0.0111	0.0084	0.0038	0.0052
	0.0094	0.0204	0.0179	0.0188	0.0166	0.0127

DAILY AVERAGE HEAD ON TOP OF LAYER 7

AVERAGES	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 25

	INCHES	CU. FEET	PERCENT
PRECIPITATION	52.95 (8.270)	192196.9	100.00
RUNOFF	0.008 (0.0194)	29.36	0.015
EVAPOTRANSPIRATION	47.468 (4.6751)	172308.14	89.652
SUBSURFACE INFLOW INTO LAYER 1	0.00000	0.000	0.00000
LATERAL DRAINAGE COLLECTED FROM LAYER 3	6.12005 (4.52792)	22215.766	11.55886
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.00000 (0.00000)	0.011	0.00001
AVERAGE HEAD ON TOP OF LAYER 4	0.008 (0.006)		
LATERAL DRAINAGE COLLECTED FROM LAYER 6	0.00000 (0.00000)	0.002	0.00000
PERCOLATION/LEAKAGE THROUGH	0.00000 (0.00000)	0.009	0.00000

LAYER 8

AVERAGE HEAD ON TOP OF LAYER 7	0.000 (	0.000)		
PERCOLATION/LEAKAGE THROUGH LAYER 9	0.00000 (	0.00001)	0.005	0.00000
CHANGE IN WATER STORAGE	0.169 (	1.3140)	613.83	0.319

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 25

	(INCHES)	(CU. FT.)
PRECIPITATION	5.78	20981.400
RUNOFF	0.062	225.9237
DRAINAGE COLLECTED FROM LAYER 3	0.21530	781.53967
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.000000	0.00011
AVERAGE HEAD ON TOP OF LAYER 4	0.107	
MAXIMUM HEAD ON TOP OF LAYER 4	0.210	
LOCATION OF MAXIMUM HEAD IN LAYER 3 (DISTANCE FROM DRAIN)	5.8 FEET	
DRAINAGE COLLECTED FROM LAYER 6	0.00000	0.00007
PERCOLATION/LEAKAGE THROUGH LAYER 8	0.000000	0.00002
AVERAGE HEAD ON TOP OF LAYER 7	0.000	
MAXIMUM HEAD ON TOP OF LAYER 7	0.030	
LOCATION OF MAXIMUM HEAD IN LAYER 6 (DISTANCE FROM DRAIN)	0.0 FEET	
PERCOLATION/LEAKAGE THROUGH LAYER 9	0.000038	0.13712
SNOW WATER	0.00	0.0000
MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.4615	
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0770	

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

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

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FINAL WATER STORAGE AT END OF YEAR 25

LAYER	(INCHES)	(VOL/VOL)
1	209.8171	0.2914
2	3.7484	0.1562
3	0.0033	0.0118
4	0.0000	0.0000
5	0.1875	0.7500
6	0.0017	0.0100
7	0.0000	0.0000
8	0.1875	0.7500
9	15.7200	0.1310
SNOW WATER	0.000	

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CASE 2C - PDM 1

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


PRECIPITATION DATA FILE:     C:\DOCUME~1\SEUN\DESKTOP\ZHELP3~1\FURTDRUM.D4
TEMPERATURE DATA FILE:       C:\DOCUME~1\SEUN\DESKTOP\ZHELP3~1\CASE295.D7
SOLAR RADIATION DATA FILE:   C:\DOCUME~1\SEUN\DESKTOP\ZHELP3~1\CASE295.D13
EVAPOTRANSPIRATION DATA:     C:\DOCUME~1\SEUN\DESKTOP\ZHELP3~1\CASE295.D11
SOIL AND DESIGN DATA FILE:   C:\DOCUME~1\SEUN\DESKTOP\ZHELP3~1\CASE95AA.D10
OUTPUT DATA FILE:            C:\DOCUME~1\SEUN\DESKTOP\ZHELP3~1\CASE95aa.OUT


TIME:  11:12      DATE:   5/22/2006


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

     TITLE:  Oak Hammock Disposal Facility

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


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


                                  LAYER  1
                                  --------

                       TYPE 1 - VERTICAL PERCOLATION LAYER
                           MATERIAL TEXTURE NUMBER   5
           THICKNESS                    =     12.00   INCHES
           POROSITY                     =      0.4570 VOL/VOL
           FIELD CAPACITY               =      0.1310 VOL/VOL
           WILTING POINT                =      0.0580 VOL/VOL
           INITIAL SOIL WATER CONTENT   =      0.0592 VOL/VOL
           EFFECTIVE SAT. HYD. COND.    =  0.100000005000E-02 CM/SEC
         NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  4.63
```

FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.

LAYER 2

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18

THICKNESS	=	1140.00	INCHES
POROSITY	=	0.6710	VOL/VOL
FIELD CAPACITY	=	0.2920	VOL/VOL
WILTING POINT	=	0.0770	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2904	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000005000E-02	CM/SEC

LAYER 3

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	24.00	INCHES
POROSITY	=	0.4170	VOL/VOL
FIELD CAPACITY	=	0.0450	VOL/VOL
WILTING POINT	=	0.0180	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1124	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000005000E-02	CM/SEC

LAYER 4

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	0.28	INCHES
POROSITY	=	0.8500	VOL/VOL
FIELD CAPACITY	=	0.0100	VOL/VOL
WILTING POINT	=	0.0050	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0212	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	9.06999969000	CM/SEC
SLOPE	=	1.00	PERCENT
DRAINAGE LENGTH	=	400.0	FEET

LAYER 5

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35

```
THICKNESS                  =      0.06   INCHES
POROSITY                   =      0.0000 VOL/VOL
FIELD CAPACITY             =      0.0000 VOL/VOL
WILTING POINT              =      0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY        =      2.00   HOLES/ACRE
FML INSTALLATION DEFECTS   =      2.00   HOLES/ACRE
FML PLACEMENT QUALITY      =  3 - GOOD


                        LAYER  6
                        --------

              TYPE 3 - BARRIER SOIL LINER
              MATERIAL TEXTURE NUMBER  17
THICKNESS                  =      0.25   INCHES
POROSITY                   =      0.7500 VOL/VOL
FIELD CAPACITY             =      0.7470 VOL/VOL
WILTING POINT              =      0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.7500 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.300000003000E-08 CM/SEC


                        LAYER  7
                        --------

            TYPE 2 - LATERAL DRAINAGE LAYER
              MATERIAL TEXTURE NUMBER   0
THICKNESS                  =      0.17   INCHES
POROSITY                   =      0.8500 VOL/VOL
FIELD CAPACITY             =      0.0100 VOL/VOL
WILTING POINT              =      0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.0100 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.499999987000E-04 CM/SEC
SLOPE                      =      1.00   PERCENT
DRAINAGE LENGTH            =    800.0    FEET


                        LAYER  8
                        --------

            TYPE 4 - FLEXIBLE MEMBRANE LINER
              MATERIAL TEXTURE NUMBER  35
THICKNESS                  =      0.06   INCHES
POROSITY                   =      0.0000 VOL/VOL
FIELD CAPACITY             =      0.0000 VOL/VOL
WILTING POINT              =      0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY        =      2.00   HOLES/ACRE
```

```
FML INSTALLATION DEFECTS     =       2.00   HOLES/ACRE
FML PLACEMENT QUALITY        =  3 - GOOD
```

LAYER 9

```
              TYPE 3 - BARRIER SOIL LINER
              MATERIAL TEXTURE NUMBER  17
THICKNESS                    =      0.25   INCHES
POROSITY                     =      0.7500 VOL/VOL
FIELD CAPACITY               =      0.7470 VOL/VOL
WILTING POINT                =      0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.7500 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.300000003000E-08 CM/SEC
```

LAYER 10

```
           TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   5
THICKNESS                    =    120.00   INCHES
POROSITY                     =      0.4570 VOL/VOL
FIELD CAPACITY               =      0.1310 VOL/VOL
WILTING POINT                =      0.0580 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.1310 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.100000005000E-02 CM/SEC
```

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

```
NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
         SOIL DATA BASE USING SOIL TEXTURE # 5 WITH A
         GOOD STAND OF GRASS, A SURFACE SLOPE OF  5.%
         AND A SLOPE LENGTH OF  765. FEET.

SCS RUNOFF CURVE NUMBER             =      53.40
FRACTION OF AREA ALLOWING RUNOFF    =     100.0    PERCENT
AREA PROJECTED ON HORIZONTAL PLANE  =       1.000  ACRES
EVAPORATIVE ZONE DEPTH              =      22.0    INCHES
INITIAL WATER IN EVAPORATIVE ZONE   =       1.759  INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE  =      12.194  INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE  =       1.466  INCHES
INITIAL SNOW WATER                  =       0.000  INCHES
INITIAL WATER IN LAYER MATERIALS    =     350.519  INCHES
TOTAL INITIAL WATER                 =     350.519  INCHES
TOTAL SUBSURFACE INFLOW             =       0.00   INCHES/YEAR
```

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
ORLANDO FLORIDA

STATION LATITUDE	=	27.80 DEGREES
MAXIMUM LEAF AREA INDEX	=	3.50
START OF GROWING SEASON (JULIAN DATE)	=	0
END OF GROWING SEASON (JULIAN DATE)	=	367
EVAPORATIVE ZONE DEPTH	=	22.0 INCHES
AVERAGE ANNUAL WIND SPEED	=	8.60 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	72.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	72.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	80.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	76.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR TAMPA FLORIDA

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR ORLANDO FLORIDA

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
60.50	61.50	66.80	72.00	77.30	80.90
82.40	82.50	81.10	74.90	67.50	62.00

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR ORLANDO FLORIDA
AND STATION LATITUDE = 27.80 DEGREES

****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 25

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	2.70	3.02	3.34	2.49	5.46	7.98
	8.01	6.39	6.10	3.58	1.66	2.20
STD. DEVIATIONS	2.07	1.86	2.03	1.59	3.34	4.05
	3.71	2.12	2.58	1.87	0.95	1.17
RUNOFF						
TOTALS	0.002	0.000	0.000	0.000	0.000	0.004
	0.010	0.000	0.010	0.000	0.000	0.000
STD. DEVIATIONS	0.008	0.000	0.000	0.000	0.000	0.016
	0.049	0.000	0.034	0.000	0.000	0.000
EVAPOTRANSPIRATION						
TOTALS	1.798	2.946	3.396	3.398	4.088	6.115
	6.239	5.679	4.963	3.838	2.270	1.597
STD. DEVIATIONS	0.465	0.773	1.562	1.691	1.597	1.736
	1.169	1.081	0.882	0.920	0.818	0.511
LATERAL DRAINAGE COLLECTED FROM LAYER 4						
TOTALS	0.3014	0.2003	0.3208	0.2955	0.1991	0.1646
	0.2897	0.8945	0.9635	1.2073	1.0411	0.5810
STD. DEVIATIONS	0.6306	0.3316	0.6501	0.6460	0.3403	0.2687
	0.4132	1.2038	0.9280	1.1281	1.1400	0.9479
PERCOLATION/LEAKAGE THROUGH LAYER 6						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LATERAL DRAINAGE COLLECTED FROM LAYER 7						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH LAYER 9						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

PERCOLATION/LEAKAGE THROUGH LAYER 10

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 5

AVERAGES	0.0076	0.0055	0.0081	0.0077	0.0050	0.0043
	0.0073	0.0224	0.0250	0.0303	0.0270	0.0146
STD. DEVIATIONS	0.0158	0.0092	0.0163	0.0168	0.0085	0.0070
	0.0104	0.0302	0.0241	0.0283	0.0296	0.0238

DAILY AVERAGE HEAD ON TOP OF LAYER 8

AVERAGES	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 25

	INCHES	CU. FEET	PERCENT
PRECIPITATION	52.95 (8.270)	192196.9	100.00
RUNOFF	0.025 (0.0590)	92.15	0.048
EVAPOTRANSPIRATION	46.329 (4.5619)	168175.19	87.502
LATERAL DRAINAGE COLLECTED FROM LAYER 4	6.45860 (4.05337)	23444.703	12.19827
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.00000 (0.00000)	0.013	0.00001
AVERAGE HEAD ON TOP	0.014 (0.009)		

OF LAYER 5

LATERAL DRAINAGE COLLECTED FROM LAYER 7	0.00000 (0.00000)	0.000	0.00000
PERCOLATION/LEAKAGE THROUGH LAYER 9	0.00000 (0.00000)	0.009	0.00000
AVERAGE HEAD ON TOP OF LAYER 8	0.000 (0.000)		
PERCOLATION/LEAKAGE THROUGH LAYER 10	0.00000 (0.00001)	0.005	0.00000
CHANGE IN WATER STORAGE	0.134 (2.0318)	484.82	0.252

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 25

	(INCHES)	(CU. FT.)
PRECIPITATION	5.78	20981.400
RUNOFF	0.201	728.3500
DRAINAGE COLLECTED FROM LAYER 4	0.19349	702.37274
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.000000	0.00016
AVERAGE HEAD ON TOP OF LAYER 5	0.151	
MAXIMUM HEAD ON TOP OF LAYER 5	0.293	
LOCATION OF MAXIMUM HEAD IN LAYER 4 (DISTANCE FROM DRAIN)	10.2 FEET	
DRAINAGE COLLECTED FROM LAYER 7	0.00000	0.00000
PERCOLATION/LEAKAGE THROUGH LAYER 9	0.000000	0.00002
AVERAGE HEAD ON TOP OF LAYER 8	0.000	
MAXIMUM HEAD ON TOP OF LAYER 8	0.000	
LOCATION OF MAXIMUM HEAD IN LAYER 7 (DISTANCE FROM DRAIN)	0.0 FEET	
PERCOLATION/LEAKAGE THROUGH LAYER 10	0.000038	0.13712
SNOW WATER	0.00	0.0000

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.4412

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.0666

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

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

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FINAL WATER STORAGE AT END OF YEAR 25

LAYER	(INCHES)	(VOL/VOL)
1	1.5604	0.1300
2	333.4468	0.2925
3	2.7504	0.1146
4	0.0037	0.0136
5	0.0000	0.0000
6	0.1875	0.7500
7	0.0017	0.0102
8	0.0000	0.0000
9	0.1875	0.7500
10	15.7200	0.1310
SNOW WATER	0.000	

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Attachment 3

SPREADSHEETS FOR VERIFICATION OF HEADS USING GIROUD'S METHOD

Case 1 - PDM 1

LEACHATE HEAD COMPUTATIONS FOR LANDFILLS WITH BOTTOM LINER SYSTEM

Reference: Giroud, J.P., Zhao, A., Tomlinson, H.M., and Zornberg, J.G., 2004, "Liquid Flow Equations for Drainage Systems Composed of Two Layers Including a Geocomposite", Geosynthetics International, Vo. 11, No. 1.
(The indicated equation numbers correspond to the equation number in this paper)

Assumptions:
1. Drainage systems consists of two layers, with the bottom layer being a geocomposite;
2. Hydraulic conductivity of the bottom drainage layer is greater than that of the top drainage layer;
3. The drainage system is underlain by a geomembrane with no defects;
4. Length of drainage layer is measured horizontally;
5. Liquid impingement rate is uniform and constant (steady-state flow conditions); and
6. Liquid impingement rate is smaller than the hydraulic conductivity of top drainage layer.

Manually input numbers in RED

For "Top Drainage Layer" using subscript "t" (same as "2" in the paper)
For "Bottom Drainage Layer" using subscript "b" (same as "1" in the paper)

Geocomposite Permeability (k1) = (kb) =		0.516 ft/sec	Geocomposite Transmissivity (θ1) = (θb) =	1.14E-03 m^2/sec		0.0123 ft^2/sec
Geocomposite Thickness (t1) = (tb) =		0.285 inches				
Sand Permeability (k2) = (kt) =		3.3E-05 ft/sec	0.001 cm/sec	Check k1 or kb > k2 or kt		
Slope angle = β =	1.146 degrees	0.020 radians	Slope (%) = 2	Check =	0.020	
Drainage Length = L =		400 ft				
Liquid Impingement Rate = qh =		7.63E-08 ft/sec	287 ft^3/ac/day	Check qh < k2 or kt < k1 or kb		
Length of Upstream Section = Lu =		3,216.0 ft	(Eqn 18)			
Characteristic Parameter = λ1 = λb		0.000	(Eqn 7)			
Characteristic Parameter = λ2 = λt		5.811	(Eqn 17)			

Maximum Liquid Thickness: Top Layer = t maxt; Bottom Layer = t maxb; Combined = t max
Maximum Head: Top Layer = h maxt; Bottom Layer = h maxb; Combined = h max

Conservative Approach:

Cont'd (Case 1 - PPM 1)

Is applicable when $\lambda < 0.01$; Is an acceptable approximation when t max < one tenth the height of the drainage layer; and
Is rarely valid for granular drainage layers on a relatively flat slope.

For bottom drainage layer:		For top drainage layer:		
t maxb = (qh x L)/(kb x sinβ) =	0.04 inches	t maxt = qh (L-Lu)/(kt x sinβ) =	N/A inches	(Eqns 20 & 29)
h maxb = (t maxb) cosβ =	0.04 inches	h maxt = (t maxt) cosβ =	N/A inches	(Eqn 14)

Rigorous Approach:

Modifying Factor = j2 = jt =	0.917	(Eqn 26)
t max (top) = t max2 =	N/A inches	(Eqn 25)

For Lu > L, flow is in the bottom drainage layer (geocomposite) only and the conservative approach is applicable.

Is conservative approach applicable	Yes	Therefore,	t max = t maxb =	**0.04** inches	(Eqn 20)
for the bottom drainage layer?		and	h max = (t max)cosβ =	**0.04** inches	(Eqn 14)

For Lu < L and $\lambda t < 0.01$, flow is in both the drainage layers and the conservative approach is applicable.

Is conservative approach applicable	No	Therefore,	t max = tb + t maxt =	**N/A** inches	(Eqn 32)
for the top drainage layer?		and	h max = (t max)cosβ =	**N/A** inches	(Eqn 14)

For Lu < L and $\lambda t > 0.01$, flow is in both the drainage layers and the rigorous approach is applicable.

Is rigorous approach applicable	No	Therefore,	t max = tb + t max2 =	**N/A** inches	(Eqn 32)
for the top drainage layer?		and	h max = (t max)cosβ =	**N/A** inches	(Eqn 14)

Case 2A - PDM 1

LEACHATE HEAD COMPUTATIONS FOR LANDFILLS WITH BOTTOM LINER SYSTEM

Reference: Giroud, J.P., Zhao, A., Tomlinson, H.M., and Zornberg, J.G., 2004, "Liquid Flow Equations for Drainage Systems Composed of Two Layers Including a Geocomposite", Geosynthetics International, Vo. 11, No. 1.
(The indicated equation numbers correspond to the equation number in this paper)

Assumptions:
1. Drainage systems consists of two layers, with the bottom layer being a geocomposite;
2. Hydraulic conductivity of the bottom drainage layer is greater than that of the top drainage layer;
3. The drainage system is underlain by a geomembrane with no defects;
4. Length of drainage layer is measured horizontally;
5. Liquid impingement rate is uniform and constant (steady-state flow conditions); and
6. Liquid impingement rate is smaller than the hydraulic conductivity of top drainage layer.

Manually input numbers in RED

For "Top Drainage Layer" using subscript "t" (same as "2" in the paper)
For "Bottom Drainage Layer" using subscript "b" (same as "1" in the paper)

Geocomposite Permeability (k1) = (kb) =		0.328 ft/sec		Geocomposite Transmissivity (θ1) = (θb) =		7.20E-04 m^2/sec		0.0077 ft^2/sec
Geocomposite Thickness (t1) = (tb) =		0.283 inches						
Sand Permeability (k2) = (kt) =		3.3E-05 ft/sec		0.001 cm/sec	Check k1 or kb > k2 or kt			
Slope angle = β =	0.859 degrees	0.015 radians	Slope (%) =	1.5	Check =	0.015		
Drainage Length = L =		400 ft						
Liquid Impingement Rate = qh =		4.36E-08 ft/sec		164 ft^3/ac/day	Check qh < k2 or kt < k1 or kb			
Length of Upstream Section = Lu =		2,666.1 ft	(Eqn 18)					
Characteristic Parameter = λ1 = λb		0.001	(Eqn 7)					
Characteristic Parameter = λ2 = λt		5.903	(Eqn 17)					

Maximum Liquid Thickness: Top Layer = t maxt; Bottom Layer = t maxb; Combined = t max
Maximum Head: Top Layer = h maxt; Bottom Layer = h maxb; Combined = h max

Conservative Approach:

Cont'd (Case 2A - PDM 1)

Is applicable when $\lambda < 0.01$; Is an acceptable approximation when t max < one tenth the height of the drainage layer; and
Is rarely valid for granular drainage layers on a relatively flat slope.

For bottom drainage layer:		For top drainage layer:		
t maxb = (qh x L)/(kb x sinβ) =	0.04 inches	t maxt = qh (L-Lu)/(kt x sinβ) =	N/A inches	(Eqns 20 & 29)
h maxb = (t maxb) cosβ =	0.04 inches	h maxt = (t maxt) cosβ =	N/A inches	(Eqn 14)

Rigorous Approach:

Modifying Factor = j2 = jt =	0.917	(Eqn 26)
t max (top) = t max2 =	N/A inches	(Eqn 25)

For Lu > L, flow is in the bottom drainage layer (geocomposite) only and the conservative approach is applicable.

Is conservative approach applicable	Yes	Therefore,	t max = t maxb =	**0.04** inches	(Eqn 20)
for the bottom drainage layer?		and	h max = (t max)cosβ =	**0.04** inches	(Eqn 14)

For Lu < L and $\lambda t < 0.01$, flow is in both the drainage layers and the conservative approach is applicable.

Is conservative approach applicable	No	Therefore,	t max = tb + t maxt =	**N/A** inches	(Eqn 32)
for the top drainage layer?		and	h max = (t max)cosβ =	**N/A** inches	(Eqn 14)

For Lu < L and $\lambda t > 0.01$, flow is in both the drainage layers and the rigorous approach is applicable.

Is rigorous approach applicable	No	Therefore,	t max = tb + t max2 =	**N/A** inches	(Eqn 32)
for the top drainage layer?		and	h max = (t max)cosβ =	**N/A** inches	(Eqn 14)

Case 2B - PDM 1

LEACHATE HEAD COMPUTATIONS FOR LANDFILLS WITH BOTTOM LINER SYSTEM

Reference: Giroud, J.P., Zhao, A., Tomlinson, H.M., and Zornberg, J.G., 2004, "Liquid Flow Equations for Drainage Systems Composed of Two Layers Including a Geocomposite", Geosynthetics International, Vo. 11, No. 1.
(The indicated equation numbers correspond to the equation number in this paper)

Assumptions:
1. Drainage systems consists of two layers, with the bottom layer being a geocomposite;
2. Hydraulic conductivity of the bottom drainage layer is greater than that of the top drainage layer;
3. The drainage system is underlain by a geomembrane with no defects;
4. Length of drainage layer is measured horizontally;
5. Liquid impingement rate is uniform and constant (steady-state flow conditions); and
6. Liquid impingement rate is smaller than the hydraulic conductivity of top drainage layer.

Manually input numbers in RED

For "Top Drainage Layer" using subscript "t" (same as "2" in the paper)
For "Bottom Drainage Layer" using subscript "b" (same as "1" in the paper)

Geocomposite Permeability (k1) = (kb) =		0.311 ft/sec		Geocomposite Transmissivity (θ1) = (θb) =		6.78E-04 m^2/sec	0.0073 ft^2/sec
Geocomposite Thickness (t1) = (tb) =		0.281 inches					
Sand Permeability (k2) = (kt) =		3.3E-05 ft/sec		0.001 cm/sec	Check k1 or kb > k2 or kt		
Slope angle = β =	0.859 degrees	0.015 radians	Slope (%) =	1.5	Check =	0.015	
Drainage Length = L =		400 ft					
Liquid Impingement Rate = qh =		3.75E-08 ft/sec		141 ft^3/ac/day	Check qh < k2 or kt < k1 or kb		
Length of Upstream Section = Lu =		2,920.1 ft	(Eqn 18)				
Characteristic Parameter = λ1 = λb		0.001	(Eqn 7)				
Characteristic Parameter = λ2 = λt		5.075	(Eqn 17)				

Maximum Liquid Thickness: Top Layer = t maxt; Bottom Layer = t maxb; Combined = t max
Maximum Head: Top Layer = h maxt; Bottom Layer = h maxb; Combined = h max

Conservative Approach:

Cont'd (Case 2B - PDM 1)

Is applicable when $\lambda < 0.01$; Is an acceptable approximation when t max < one tenth the height of the drainage layer; and
Is rarely valid for granular drainage layers on a relatively flat slope.

For bottom drainage layer:		For top drainage layer:		
t maxb = (qh x L)/(kb x sinβ) =	0.04 inches	t maxt = qh (L-Lu)/(kt x sinβ) =	N/A inches	(Eqns 20 & 29)
h maxb = (t maxb) cosβ =	0.04 inches	h maxt = (t maxt) cosβ =	N/A inches	(Eqn 14)

Rigorous Approach:

Modifying Factor = j2 = jt =	0.913	(Eqn 26)
t max (top) = t max2 =	N/A inches	(Eqn 25)

For Lu > L, flow is in the bottom drainage layer (geocomposite) only and the conservative approach is applicable.

Is conservative approach applicable	Yes	Therefore,	t max = t maxb =	**0.04** inches	(Eqn 20)
for the bottom drainage layer?		and	h max = (t max)cosβ =	**0.04** inches	(Eqn 14)

For Lu < L and $\lambda t < 0.01$, flow is in both the drainage layers and the conservative approach is applicable.

Is conservative approach applicable	No	Therefore,	t max = tb + t maxt =	**N/A** inches	(Eqn 32)
for the top drainage layer?		and	h max = (t max)cosβ =	**N/A** inches	(Eqn 14)

For Lu < L and $\lambda t > 0.01$, flow is in both the drainage layers and the rigorous approach is applicable.

Is rigorous approach applicable	No	Therefore,	t max = tb + t max2 =	**N/A** inches	(Eqn 32)
for the top drainage layer?		and	h max = (t max)cosβ =	**N/A** inches	(Eqn 14)

Case 2C - PDM 1

LEACHATE HEAD COMPUTATIONS FOR LANDFILLS WITH BOTTOM LINER SYSTEM

Reference: Giroud, J.P., Zhao, A., Tomlinson, H.M., and Zornberg, J.G., 2004, "Liquid Flow Equations for Drainage Systems Composed of Two Layers Including a Geocomposite", Geosynthetics International, Vo. 11, No. 1.
(The indicated equation numbers correspond to the equation number in this paper)

Assumptions:
1. Drainage systems consists of two layers, with the bottom layer being a geocomposite;
2. Hydraulic conductivity of the bottom drainage layer is greater than that of the top drainage layer;
3. The drainage system is underlain by a geomembrane with no defects;
4. Length of drainage layer is measured horizontally;
5. Liquid impingement rate is uniform and constant (steady-state flow conditions); and
6. Liquid impingement rate is smaller than the hydraulic conductivity of top drainage layer.

Manually input numbers in RED

For "Top Drainage Layer" using subscript "t" (same as "2" in the paper)
For "Bottom Drainage Layer" using subscript "b" (same as "1" in the paper)

Geocomposite Permeability (k1) = (kb) =		0.295	ft/sec		Geocomposite Transmissivity (θ1) = (θb) =	6.36E-04	m^2/sec	0.0068 ft^2/sec
Geocomposite Thickness (t1) = (tb) =		0.278	inches					
Sand Permeability (k2) = (kt) =		3.3E-05	ft/sec	0.001	cm/sec	Check k1 or kb > k2 or kt		
Slope angle = β =	0.573	0.010		Slope (%) =	1	Check =	0.010	
	degrees	radians						
Drainage Length = L =		400	ft					
Liquid Impingement Rate = qh =		4.54E-08	ft/sec	171	ft^3/ac/day	Check qh < k2 or kt < k1 or kb		
Length of Upstream Section = Lu =		1,505.9	ft	(Eqn 18)				
Characteristic Parameter = λ1 = λb		0.002		(Eqn 7)				
Characteristic Parameter = λ2 = λt		13.849		(Eqn 17)				

Maximum Liquid Thickness: Top Layer = t maxt; Bottom Layer = t maxb; Combined = t max
Maximum Head: Top Layer = h maxt; Bottom Layer = h maxb; Combined = h max

Conservative Approach:

Cont'd (Case 2C - PDM 1)

Is applicable when $\lambda < 0.01$; Is an acceptable approximation when t max < one tenth the height of the drainage layer; and
Is rarely valid for granular drainage layers on a relatively flat slope.

For bottom drainage layer:		For top drainage layer:		
t maxb = (qh x L)/(kb x sinβ) =	0.07 inches	t maxt = qh (L-Lu)/(kt x sinβ) =	N/A inches	(Eqns 20 & 29)
h maxb = (t maxb) cosβ =	0.07 inches	h maxt = (t maxt) cosβ =	N/A inches	(Eqn 14)

Rigorous Approach:

Modifying Factor = j2 = jt =	0.941	(Eqn 26)
t max (top) = t max2 =	N/A inches	(Eqn 25)

For Lu > L, flow is in the bottom drainage layer (geocomposite) only and the conservative approach is applicable.

Is conservative approach applicable	Yes	Therefore,	t max = t maxb =	**0.07** inches	(Eqn 20)
for the bottom drainage layer?		and	h max = (t max)cosβ =	**0.07** inches	(Eqn 14)

For Lu < L and λt < 0.01, flow is in both the drainage layers and the conservative approach is applicable.

Is conservative approach applicable	No	Therefore,	t max = tb + t maxt =	**N/A** inches	(Eqn 32)
for the top drainage layer?		and	h max = (t max)cosβ =	**N/A** inches	(Eqn 14)

For Lu < L and λt > 0.01, flow is in both the drainage layers and the rigorous approach is applicable.

Is rigorous approach applicable	No	Therefore,	t max = tb + t max2 =	**N/A** inches	(Eqn 32)
for the top drainage layer?		and	h max = (t max)cosβ =	**N/A** inches	(Eqn 14)

Case 2D - PDM 1

LEACHATE HEAD COMPUTATIONS FOR LANDFILLS WITH BOTTOM LINER SYSTEM

Reference: Giroud, J.P., Zhao, A., Tomlinson, H.M., and Zornberg, J.G., 2004, "Liquid Flow Equations for Drainage Systems Composed of Two Layers Including a Geocomposite", Geosynthetics International, Vo. 11, No. 1.
(The indicated equation numbers correspond to the equation number in this paper)

Assumptions:
1. Drainage systems consists of two layers, with the bottom layer being a geocomposite;
2. Hydraulic conductivity of the bottom drainage layer is greater than that of the top drainage layer;
3. The drainage system is underlain by a geomembrane with no defects;
4. Length of drainage layer is measured horizontally;
5. Liquid impingement rate is uniform and constant (steady-state flow conditions); and
6. Liquid impingement rate is smaller than the hydraulic conductivity of top drainage layer.

Manually input numbers in RED

For "Top Drainage Layer" using subscript "t" (same as "2" in the paper)
For "Bottom Drainage Layer" using subscript "b" (same as "1" in the paper)

Geocomposite Permeability (k1) = (kb) =		0.169 ft/sec		Geocomposite Transmissivity (θ1) = (θb) =		3.58E-04 m^2/sec		0.0039 ft^2/sec
Geocomposite Thickness (t1) = (tb) =		0.273 inches						
Sand Permeability (k2) = (kt) =		3.3E-05 ft/sec	0.001 cm/sec		Check k1 or kb > k2 or kt			
Slope angle = β =	0.573 degrees	0.010 radians	Slope (%) = 1		Check =	0.010		
Drainage Length = L =		400 ft						
Liquid Impingement Rate = qh =		3.35E-08 ft/sec	126 ft^3/ac/day		Check qh < k2 or kt < k1 or kb			

Length of Upstream Section = Lu =	1,150.4 ft	(Eqn 18)
Characteristic Parameter = λ1 = λb	0.002	(Eqn 7)
Characteristic Parameter = λ2 = λt	10.204	(Eqn 17)

Maximum Liquid Thickness: Top Layer = t maxt; Bottom Layer = t maxb; Combined = t max
Maximum Head: Top Layer = h maxt; Bottom Layer = h maxb; Combined = h max

Conservative Approach:

Cont'd (Case 2D - PDM1)

Is applicable when $\lambda < 0.01$; Is an acceptable approximation when t max < one tenth the height of the drainage layer; and
Is rarely valid for granular drainage layers on a relatively flat slope.

For bottom drainage layer:		For top drainage layer:		
t maxb = (qh x L)/(kb x sinβ) =	0.09 inches	t maxt = qh (L-Lu)/(kt x sinβ) =	N/A inches	(Eqns 20 & 29)
h maxb = (t maxb) cosβ =	0.09 inches	h maxt = (t maxt) cosβ =	N/A inches	(Eqn 14)

Rigorous Approach:

Modifying Factor = j2 = jt =	0.932	(Eqn 26)
t max (top) = t max2 =	N/A inches	(Eqn 25)

For Lu > L, flow is in the bottom drainage layer (geocomposite) only and the conservative approach is applicable.

Is conservative approach applicable	Yes	Therefore,	t max = t maxb =	**0.09** inches	(Eqn 20)
for the bottom drainage layer?		and	h max = (t max)cosβ =	**0.09** inches	(Eqn 14)

For Lu < L and $\lambda t < 0.01$, flow is in both the drainage layers and the conservative approach is applicable.

Is conservative approach applicable	No	Therefore,	t max = tb + t maxt =	**N/A** inches	(Eqn 32)
for the top drainage layer?		and	h max = (t max)cosβ =	**N/A** inches	(Eqn 14)

For Lu < L and $\lambda t > 0.01$, flow is in both the drainage layers and the rigorous approach is applicable.

Is rigorous approach applicable	No	Therefore,	t max = tb + t max2 =	**N/A** inches	(Eqn 32)
for the top drainage layer?		and	h max = (t max)cosβ =	**N/A** inches	(Eqn 14)

Attachment 4

MINIMUM PRIMARY GEOCOMPOSITE TRANSMISSIVITY COMPUTATIONS USING GIROUD'S METHOD

Case 1 - PPM 2

LEACHATE HEAD COMPUTATIONS FOR LANDFILLS WITH BOTTOM LINER SYSTEM

Reference: Giroud, J.P., Zhao, A., Tomlinson, H.M., and Zornberg, J.G., 2004, "Liquid Flow Equations for Drainage Systems Composed of Two Layers Including a Geocomposite", Geosynthetics International, Vo. 11, No. 1.
(The indicated equation numbers correspond to the equation number in this paper)

Assumptions:
1. Drainage systems consists of two layers, with the bottom layer being a geocomposite;
2. Hydraulic conductivity of the bottom drainage layer is greater than that of the top drainage layer;
3. The drainage system is underlain by a geomembrane with no defects;
4. Length of drainage layer is measured horizontally;
5. Liquid impingement rate is uniform and constant (steady-state flow conditions); and
6. Liquid impingement rate is smaller than the hydraulic conductivity of top drainage layer.

Manually input numbers in RED

For "Top Drainage Layer" using subscript "t" (same as "2" in the paper)
For "Bottom Drainage Layer" using subscript "b" (same as "1" in the paper)

Geocomposite Permeability (k1) = (kb) =		0.060 ft/sec		Geocomposite Transmissivity (θ1) = (θb) =	1.33E-04 m^2/sec	0.0014
Geocomposite Thickness (t1) = (tb) =		0.285 inches				
Sand Permeability (k2) = (kt) =		3.3E-05 ft/sec	0.001 cm/sec	Check k1 or kb > k2 or kt		
Slope angle = β =	1.146 degrees	0.020 radians	Slope (%) = 2	Check = 0.020		
Drainage Length = L =		400 ft				
Liquid Impingement Rate = qh =		7.63E-08 ft/sec	287 ft^3/ac/day	Check qh < k2 or kt < k1 or kb		
Length of Upstream Section = Lu =		375.2 ft	(Eqn 18)			
Characteristic Parameter = λ1 = λb		0.003	(Eqn 7)			
Characteristic Parameter = λ2 = λt		5.811	(Eqn 17)			

Maximum Liquid Thickness: Top Layer = t maxt; Bottom Layer = t maxb; Combined = t max
Maximum Head: Top Layer = h maxt; Bottom Layer = h maxb; Combined = h max

CASE 1 – PDM 2 (CONT'D)

Conservative Approach:

Is applicable when $\lambda < 0.01$; Is an acceptable approximation when t max < one tenth the height of the drainage layer; and Is rarely valid for granular drainage layers on a relatively flat slope.

For bottom drainage layer:		For top drainage layer:		
t maxb = (qh x L)/(kb x sinβ) =	N/A inches	t maxt = qh (L-Lu)/(kt x sinβ) =	34.59 inches	(Eqns 20 & 29)
h maxb = (t maxb) cosβ =	N/A inches	h maxt = (t maxt) cosβ =	34.59 inches	(Eqn 14)

Rigorous Approach:

Modifying Factor = j2 = jt =	0.917	(Eqn 26)
t max (top) = t max2 =	10.708 inches	(Eqn 25)

For Lu > L, flow is in the bottom drainage layer (geocomposite) only and the conservative approach is applicable.

Is conservative approach applicable	No	Therefore,	t max = t maxb =	**N/A** inches	(Eqn 20)
for the bottom drainage layer?		and	h max = (t max)cosβ =	**N/A** inches	(Eqn 14)

For Lu < L and λt < 0.01, flow is in both the drainage layers and the conservative approach is applicable.

Is conservative approach applicable	No	Therefore,	t max = tb + t maxt =	**N/A** inches	(Eqn 32)
for the top drainage layer?		and	h max = (t max)cosβ =	**N/A** inches	(Eqn 14)

For Lu < L and λt > 0.01, flow is in both the drainage layers and the rigorous approach is applicable.

Is rigorous approach applicable	Yes	Therefore,	t max = tb + t max2 =	**11.0** inches	(Eqn 32)
for the top drainage layer?		and	h max = (t max)cosβ =	**11.0** inches	(Eqn 14)

Case 2C - PDM 2

LEACHATE HEAD COMPUTATIONS FOR LANDFILLS WITH BOTTOM LINER SYSTEM

Reference: Giroud, J.P., Zhao, A., Tomlinson, H.M., and Zornberg, J.G., 2004, "Liquid Flow Equations for Drainage Systems Composed of Two Layers Including a Geocomposite", Geosynthetics International, Vo. 11, No. 1.
(The indicated equation numbers correspond to the equation number in this paper)

Assumptions:
1. Drainage systems consists of two layers, with the bottom layer being a geocomposite;
2. Hydraulic conductivity of the bottom drainage layer is greater than that of the top drainage layer;
3. The drainage system is underlain by a geomembrane with no defects;
4. Length of drainage layer is measured horizontally;
5. Liquid impingement rate is uniform and constant (steady-state flow conditions); and
6. Liquid impingement rate is smaller than the hydraulic conductivity of top drainage layer.

Manually input numbers in RED

For "Top Drainage Layer" using subscript "t" (same as "2" in the paper)
For "Bottom Drainage Layer" using subscript "b" (same as "1" in the paper)

Geocomposite Permeability (k1) = (kb) =		0.072 ft/sec		Geocomposite Transmissivity (θ1) = (θb) =		1.56E-04 m^2/sec	0.0017
Geocomposite Thickness (t1) = (tb) =		0.278 inches					
Sand Permeability (k2) = (kt) =		3.3E-05 ft/sec	0.001 cm/sec	Check k1 or kb > k2 or kt			
Slope angle = β =	0.573 degrees	0.010 radians	Slope (%) = 1	Check =	0.010		
Drainage Length = L =		400 ft					
Liquid Impingement Rate = qh =		4.54E-08 ft/sec	171 ft^3/ac/day	Check qh < k2 or kt < k1 or kb			
Length of Upstream Section = Lu =		369.4 ft	(Eqn 18)				
Characteristic Parameter = λ1 = λb		0.006	(Eqn 7)				
Characteristic Parameter = λ2 = λt		13.849	(Eqn 17)				

Maximum Liquid Thickness: Top Layer = t maxt; Bottom Layer = t maxb; Combined = t max
Maximum Head: Top Layer = h maxt; Bottom Layer = h maxb; Combined = h max

CASE 2C - PDM 2 (CONT'D)

Conservative Approach:

Is applicable when $\lambda < 0.01$; Is an acceptable approximation when t max < one tenth the height of the drainage layer; and Is rarely valid for granular drainage layers on a relatively flat slope.

For bottom drainage layer:		For top drainage layer:		
t maxb = (qh x L)/(kb x sinβ) =	N/A inches	t maxt = qh (L-Lu)/(kt x sinβ) =	50.91 inches	(Eqns 20 & 29)
h maxb = (t maxb) cosβ =	N/A inches	h maxt = (t maxt) cosβ =	50.91 inches	(Eqn 14)

Rigorous Approach:

Modifying Factor = j2 = jt =	0.941	(Eqn 26)
t max (top) = t max2 =	11.258 inches	(Eqn 25)

For Lu > L, flow is in the bottom drainage layer (geocomposite) only and the conservative approach is applicable.

Is conservative approach applicable	No	Therefore,	t max = t maxb =	**N/A** inches	(Eqn 20)
for the bottom drainage layer?		and	h max = (t max)cosβ =	**N/A** inches	(Eqn 14)

For Lu < L and λt < 0.01, flow is in both the drainage layers and the conservative approach is applicable.

Is conservative approach applicable	No	Therefore,	t max = tb + t maxt =	**N/A** inches	(Eqn 32)
for the top drainage layer?		and	h max = (t max)cosβ =	**N/A** inches	(Eqn 14)

For Lu < L and λt > 0.01, flow is in both the drainage layers and the rigorous approach is applicable.

Is rigorous approach applicable	Yes	Therefore,	t max = tb + t max2 =	**11.54** inches	(Eqn 32)
for the top drainage layer?		and	h max = (t max)cosβ =	**11.54** inches	(Eqn 14)

Case 2D - PPM 2

LEACHATE HEAD COMPUTATIONS FOR LANDFILLS WITH BOTTOM LINER SYSTEM

Reference: Giroud, J.P., Zhao, A., Tomlinson, H.M., and Zornberg, J.G., 2004, "Liquid Flow Equations for Drainage Systems Composed of Two Layers Including a Geocomposite", Geosynthetics International, Vo. 11, No. 1.
(The indicated equation numbers correspond to the equation number in this paper)

Assumptions:
1. Drainage systems consists of two layers, with the bottom layer being a geocomposite;
2. Hydraulic conductivity of the bottom drainage layer is greater than that of the top drainage layer;
3. The drainage system is underlain by a geomembrane with no defects;
4. Length of drainage layer is measured horizontally;
5. Liquid impingement rate is uniform and constant (steady-state flow conditions); and
6. Liquid impingement rate is smaller than the hydraulic conductivity of top drainage layer.

Manually input numbers in RED

For "Top Drainage Layer" using subscript "t" (same as "2" in the paper)
For "Bottom Drainage Layer" using subscript "b" (same as "1" in the paper)

Geocomposite Permeability (k1) = (kb) =		0.053	ft/sec	Geocomposite Transmissivity (θ1) = (θb) =			1.13E-04	m^2/sec	0.0012
Geocomposite Thickness (t1) = (tb) =		0.273	inches						
Sand Permeability (k2) = (kt) =		3.3E-05	ft/sec	0.001	cm/sec	Check k1 or kb > k2 or kt			
Slope angle = β =	0.573	0.010		Slope (%) =	1	Check =	0.010		
	degrees	radians							
Drainage Length = L =		400	ft						
Liquid Impingement Rate = qh =		3.35E-08	ft/sec	126	ft^3/ac/day	Check qh < k2 or kt < k1 or kb			
Length of Upstream Section = Lu =		363.1	ft	(Eqn 18)					
Characteristic Parameter = λ1 = λb		0.006		(Eqn 7)					
Characteristic Parameter = λ2 = λt		10.204		(Eqn 17)					

Maximum Liquid Thickness: Top Layer = t maxt; Bottom Layer = t maxb; Combined = t max
Maximum Head: Top Layer = h maxt; Bottom Layer = h maxb; Combined = h max

CASE 2D - PDM 2 (CONT'D)

Conservative Approach:

Is applicable when $\lambda < 0.01$; Is an acceptable approximation when t max < one tenth the height of the drainage layer; and Is rarely valid for granular drainage layers on a relatively flat slope.

For bottom drainage layer:		For top drainage layer:		
t maxb = (qh x L)/(kb x sinβ) =	N/A inches	t maxt = qh (L-Lu)/(kt x sinβ) =	45.18 inches	(Eqns 20 & 29)
h maxb = (t maxb) cosβ =	N/A inches	h maxt = (t maxt) cosβ =	45.18 inches	(Eqn 14)

Rigorous Approach:

Modifying Factor = j2 = jt =	0.932	(Eqn 26)
t max (top) = t max2 =	11.284 inches	(Eqn 25)

For Lu > L, flow is in the bottom drainage layer (geocomposite) only and the conservative approach is applicable.

Is conservative approach applicable	No	Therefore,	t max = t maxb =	**N/A** inches	(Eqn 20)
for the bottom drainage layer?		and	h max = (t max)cosβ =	**N/A** inches	(Eqn 14)

For Lu < L and $\lambda t < 0.01$, flow is in both the drainage layers and the conservative approach is applicable.

Is conservative approach applicable	No	Therefore,	t max = tb + t maxt =	**N/A** inches	(Eqn 32)
for the top drainage layer?		and	h max = (t max)cosβ =	**N/A** inches	(Eqn 14)

For Lu < L and $\lambda t > 0.01$, flow is in both the drainage layers and the rigorous approach is applicable.

Is rigorous approach applicable	Yes	Therefore,	t max = tb + t max2 =	**11.56** inches	(Eqn 32)
for the top drainage layer?		and	h max = (t max)cosβ =	**11.56** inches	(Eqn 14)

Appendix D

REVISED TECHNICAL SPECIFICATIONS FOR CELL 3 PRIMARY GEOCOMPOSITE

TABLE 02740-1
PRIMARY AND FINAL COVER GEOCOMPOSITE PROPERTY VALUES

PROPERTIES	QUALIFIER	UNITS	SPECIFIED VALUES (1)	TEST METHOD
Geonet Component:				
Polymer composition	Minimum	%	95 polyethylene by weight	--
Polymer density	Minimum	g/cm^3	0.93	ASTM D 1505
Carbon black content	Range	%	2 - 3	ASTM D 1603
Nominal thickness	Minimum	Mil	200	ASTM D 1777
Geotextile Component:				
Type	None	none	needlepunched nonwoven	--
Polymer composition	Minimum	%	95 polyester or polypropylene	
Mass per unit area	Minimum	oz/yd^2	8	ASTM D 5261
Apparent opening size	Maximum	mm	$O_{95} \leq 0.21$ mm	ASTM D 4751
Permittivity	Minimum	sec^{-1}	0.5	ASTM D 4491
Grab strength	Minimum	lb	180	ASTM D 4632 (2)
Tear strength	Minimum	Lb	75	ASTM D 4533 (2)
Puncture strength	Minimum	Lb	75	ASTM D 4833 (3)
Geocomposite				
Transmissivity	Minimum	m^2/s	See notes 4, 5, and 6	ASTM D 4716
Peel strength	Minimum	g/in.	500	ASTM F 904

Notes:
1. All values represent minimum average roll values.
2. Minimum value measured in machine and cross-machine direction.
3. Tension testing machine with a 1.75-inch diameter ring clamp, the steel ball being replaced with 0.31-inch diameter solid steel cylinder with flat tip centered within the ring clamp.
4. The design transmissivity of the geocomposite drainage layer used for the primary leachate collection layer is measured using water at 68°F with a gradient of 0.02 under compressive stresses of 500 psf and of 10,000 psf for 100 hours. For the test, the geocomposite shall be sandwiched between 60-mil textured HDPE geomembrane and soil actually used for the liner protective layer. The minimum required transmissivities are 3.0×10^{-3} m^2/s and 1.0×10^{-3} m^2/s under the compressive stresses of 500 psf and 10,000 psf, respectively.

TABLE 02740-1 (Continued)

5. The design transmissivity of the geocomposite drainage layer used for the secondary leachate collection layer is measured using water at 68°F with a gradient of 0.02 under compressive stresses of 500 psf and 13,500 psf for 100 hours. For the test, the geocomposite shall be sandwiched between geosynthetic clay liner (GCL) and 60-mil textured HDPE geomembrane. The minimum required transmissivities are 2.4 x 10^{-3} m^2/s and 3.5 x 10^{-4} m^2/s under the compressive stresses of 500 psf and 25,000 psf, respectively.
6. The design transmissivity of the geocomposite drainage layer used for the final cover drainage layer is measured using water at 68°F with gradient of 0.25 under a compressive stress of 500 psf for 100 hours. For the test, the geocomposite shall be sandwiched between 40-mil textured PE geomembrane and soil actually used for the cap protective layer. The minimum required transmissivity is 4.5 x 10^{-3} m^2/s under the compressive stress of 500 psf.

[END OF SECTION]