Environmental Consultants
and Contractors

4041 Park Oaks Boulevard
Suite 100
Tampa, FL 33610

813 621-0080
FAX 813 623-6757
www.scsengineers.com

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March 4, 2009
File No. 09207049.02

Mr. Richard Tedder
Director of the Division of Waste Management
Florida Department of Environmental Protection (FDEP)
2600 Blair Stone Road
Twin Tower Office Building
Tallahassee, Florida 32399-2400

Subject: Request for Approval of Alternate Procedure
Landfill Sideslope Subbase Design
Citrus County Central Landfill Phase 3 Expansion

Dear Mr. Tedder:

In response to the Florida Department of Environmental Protection (FDEP) items 36, 37, and 38 of the request for additional information for the Phase 3 Expansion Construction Permit Application, SCS has revised the calculations submitted with request for approval of an alternate procedure for landfill sideslope subbase design dated October 30, 2008. The following summarizes the changes made to the request for approval by repeating and responding to the specific requests of items 36, 37, and 38.

36. Please revise the information, calculations and analyses, and conclusions presented in the alternate procedure request based on your responses and revised calculations and analyses provided in response to this letter.

Response: The HELP Model runs were revised to consider the proposed recirculation of leachate using an assumed unit weight for waste after leachate recirculation. SCS used information developed by Tim Townsend, PhD, PE to obtain the recirculation waste unit weights. This reference has been added to the list of references for following the HELP Model runs and outputs and is included in Attachment A. The summary of these revised calculations are included in Attachment A.

FDEP Item 17 of the request for additional information for the Phase 3 Expansion Construction Permit Application requested that a hydraulic conductivity be specified for the liner protective layer as part of the liner system and adequate CQA testing be provided to ensure the soils of the specified hydraulic conductivity be installed whether it occurs during initial cell construction or on the side slopes during phased operation of the facility. The County is requesting that the hydraulic conductivity of the protective sand layer not be specified in the Specifications or CQA Plan since the protective soil cover is not being used as the drainage layer. The County will select sand from the cover soil stockpile that is of average consistency; not overly clayey or overly sandy.

In response to Item 17, three scenarios were developed, based on different hydraulic conductivity of the drainage material ranging from $1x10^{-3}$ cm/sec to $1x10^{-5}$ cm/sec with and without GCL to demonstrate that the hydraulic conductivity of the protective sand layer has negligible effect on the HELP Model Results. The summary of these model runs and model outputs are located in Attachment A.

In accordance with Rule 62-701.400(3)(c)1, F.A.C. the hydraulic head on the upper liner must not exceed one foot or the thickness of the drainage layer during normal landfill operations. Based upon the results from the HELP Model and the assumptions made in the modeling, the leachate collection system will maintain the leachate head to be within the thickness of the geocomposite layer.

On October 30, 2008, SCS prepared a letter on behalf of Citrus County to request approval for the landfill side slope sub-base design, in accordance with the criteria set forth in Rule 62-701.310(2), Florida Administrative Code, F.A.C. Based on the analysis described above the expected flow through natural soils and through the GCL subbase will be the same.

Thus, we can conclude that the effect of hydraulic conductivity of the protective material on top of the primary leachate collection and removal system is insignificant and that the need for the clay subbase or GCL is not warranted.

37. Rule 62-701.310(2) (d), F.A.C.: It does not appear that the HELP Model analysis provided in Attachment A considered the proposed recirculation of leachate and the worst case geocomposite transmissivity based on increased waste unit weight. Please verify and revise the HELP Model analyses, as applicable.

Response: The HELP Model analysis was revised to consider the proposed recirculation of leachate. Please refer to Attachment A for the revised HELP Model runs and outputs.

38. Rule 62-701.310(2) (e), F.A.C.:

a. Please revise the liner stress analysis in Attachment B based on the comments provided for Attachment H-9.

Response: The liner stress analysis guidance from Robert Koerner is based on a recent 10 ft lift of waste, therefore no revisions to the calculations are needed based on the proposed recirculation option.

b. Please revise the anchor trench calculations in Attachment C based on the comments provided for Attachment H-2. The geogrid anchor trench calculations should also be included in Attachment C.

Response: The anchor trench calculations were inadvertently submitted with the letter request for approval of an alternate procedure for landfill sideslope subbase design dated October 30, 2008 and replaced with the geogrid reinforcing calculations.

Please do not hesitate to contact SCS if you have any questions or need additional information to assist in your review process.

Sincerely,

3/4/09

Dominique H. Bramlett, P.E.
Senior Project Engineer
SCS ENGINEERS

John A. Banks, P.E.
Project Director
SCS ENGINEERS

DHB/JAB:dhb

cc: Susan Pelz, P.E., FDEP Tampa
Susan Metcalfe, P.G., Citrus County

Attachment A HELP Model Analysis
Attachment C Anchor Trench Calculations

ATTACHMENT A

HELP MODEL ANALYSIS

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SHEET 1 of 8

CLIENT	PROJECT	JOB NO.
Citrus County	Citrus County Landfill - Phase 3	09207049.02

SUBJECT	BY	DATE
HELP Model Summary - RAI No. 2 Peak Daily Values 2:1 Side Slope with various K for protective cover soil	DHB	3/4/2009
	CHECKED	DATE 3/4/09

Summary is on a per acre basis, Phase 3 Expansion area is 6.65 acres

No GCL

Sand Sat. Hyd. Cond. = 1x10^{-3}cm/sec

	Collection System, K = 8 cm/sec				Detection System, K = 2.5 cm/sec				
	Thickness (inches)	Max. Head on Liner (inches)	Leachate Collected (ft^3/day)	Leachate Collected (gal/min)	Thickness at 100 hr (inches)	Max. Head on Liner (inches)	Leachate Collected (ft^3/day)	Leachate Collected (gal/min)	Expected Flow through natural soils (ft^3/yr/acre)
L_{total} = 140ft S = 45%	0.273[1]	0.056	2,195	11.40	0.227[2]	0.043	9.125	0.05	0.00433

No GCL

Sand Sat. Hyd. Cond. = 5.2x10^{-4}cm/sec

	Collection System, K = 8 cm/sec				Detection System, K = 2.5 cm/sec				
	Thickness (inches)	Max. Head on Liner (inches)	Leachate Collected (ft^3/day)	Leachate Collected (gal/min)	Thickness at 100 hr (inches)	Max. Head on Liner (inches)	Leachate Collected (ft^3/day)	Leachate Collected (gal/min)	Expected Flow through natural soils (ft^3/yr/acre)
L_{total} = 140ft S = 45%	0.273[1]	0.075	2,204	11.45	0.227[2]	0.040	9.146	0.05	0.00433

No GCL

Sand Sat. Hyd. Cond. = 1x10^{-5}cm/sec

	Collection System, K = 8 cm/sec				Detection System, K = 2.5 cm/sec				
	Thickness (inches)	Max. Head on Liner (inches)	Leachate Collected (ft^3/day)	Leachate Collected (gal/min)	Thickness at 100 hr (inches)	Max. Head on Liner (inches)	Leachate Collected (ft^3/day)	Leachate Collected (gal/min)	Expected Flow through natural soils (ft^3/yr/acre)
L_{total} = 140ft S = 45%	0.273[1]	0.060	1,233	6.41	0.227[2]	0.036	1.409	0.01	0.00433

WITH GCL

Sand Sat. Hyd. Cond. = 1x10^{-3}cm/sec

	Collection System, K = 8 cm/sec				Detection System, K = 2.5 cm/sec				
	Thickness (inches)	Max. Head on Liner (inches)	Leachate Collected (ft^3/day)	Leachate Collected (gal/min)	Thickness at 100 hr (inches)	Max. Head on Liner (inches)	Leachate Collected (ft^3/day)	Leachate Collected (gal/min)	Expected Flow through a GCL subbase (ft^3/yr/acre)
L_{total} = 140ft S = 45%	0.273[1]	0.008	2,187	11.36	0.227[2]	0.044	9.111	0.05	0.00433

WITH GCL

Sand Sat. Hyd. Cond. = 5.2x10^{-4}cm/sec

	Collection System, K = 8 cm/sec				Detection System, K = 2.5 cm/sec				
	Thickness (inches)	Max. Head on Liner (inches)	Leachate Collected (ft^3/day)	Leachate Collected (gal/min)	Thickness at 100 hr (inches)	Max. Head on Liner (inches)	Leachate Collected (ft^3/day)	Leachate Collected (gal/min)	Expected Flow through a GCL subbase (ft^3/yr/acre)
L_{total} = 140ft S = 45%	0.273[1]	0.036	2,216	11.51	0.227[2]	0.037	9.170	0.05	0.00433

WITH GCL

Sand Sat. Hyd. Cond. = 1x10^{-5}cm/sec

	Collection System, K = 8 cm/sec				Detection System, K = 2.5 cm/sec				
	Thickness (inches)	Max. Head on Liner (inches)	Leachate Collected (ft^3/day)	Leachate Collected (gal/min)	Thickness at 100 hr (inches)	Max. Head on Liner (inches)	Leachate Collected (ft^3/day)	Leachate Collected (gal/min)	Expected Flow through a GCL subbase (ft^3/yr/acre)
L_{total} = 140ft S = 45%	0.273[1]	0.060	1,233	6.41	0.227[2]	0.036	1.409	0.01	0.00433

Note:
1. Thickness of 300-mil Tri-Planar Geocomposite at 100 hrs & loaded.
2. Thickness of 250-mil Bi-Planar Geocomposite at 100 hrs & loaded.

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CLIENT	PROJECT	JOB NO.	
Citrus County	Citrus County Landfill - Phase 3	09207049.02	
SUBJECT		**BY**	**DATE**
HELP Model Summary - RAI No. 2		DHB	3/4/2009
Average Daily Values		**CHECKED**	**DATE**
2:1 Side Slope with various K for protective cover soil		DB	3/4/09

Summary is on a per acre basis, Phase 3 Expansion area is 6.65 acres

No GCL

Sand Sat. Hyd. Cond. = 1x10-3cm/sec

		Collection System, K = 8 cm/sec			Detection System, K = 2.5 cm/sec				
	Thickness (inches)	Avg. Head on Liner (inches)	Leachate Collected (ft^3/yr)	Leachate Collected (gal/min)	Thickness at 100 hr (inches)	Avg. Head on Liner (inches)	Leachate Collected (ft^3/yr)	Leachate Collected (gal/min)	Expected Flow through natural soils (ft^3/yr/acre)
L_{total} = 140ft S = 45%	0.273[1]	0.000	78,239	1.11	0.227[2]	0.000	836.684	0.01	0.002

No GCL

Sand Sat. Hyd. Cond. = 5.2x10-4cm/sec

		Collection System, K = 8 cm/sec			Detection System, K = 2.5 cm/sec				
	Thickness (inches)	Avg. Head on Liner (inches)	Leachate Collected (ft^3/yr)	Leachate Collected (gal/min)	Thickness at 100 hr (inches)	Avg. Head on Liner (inches)	Leachate Collected (ft^3/yr)	Leachate Collected (gal/min)	Expected Flow through natural soils (ft^3/yr/acre)
L_{total} = 140ft S = 45%	0.273[1]	0.000	78,198	1.11	0.227[2]	0.000	847.348	0.01	0.003

No GCL

Sand Sat. Hyd. Cond. = 1x10-5cm/sec

		Collection System, K = 8 cm/sec			Detection System, K = 2.5 cm/sec				
	Thickness (inches)	Avg. Head on Liner (inches)	Leachate Collected (ft^3/yr)	Leachate Collected (gal/min)	Thickness at 100 hr (inches)	Avg. Head on Liner (inches)	Leachate Collected (ft^3/yr)	Leachate Collected (gal/min)	Expected Flow through natural soils (ft^3/yr/acre)
L_{total} = 140ft S = 45%	0.273[1]	0.005	62,700	0.89	0.227[2]	0.000	156.003	0.00	0.002

WITH GCL

Sand Sat. Hyd. Cond. = 1x10-3cm/sec

		Collection System, K = 8 cm/sec			Detection System, K = 2.5 cm/sec				
	Thickness (inches)	Avg. Head on Liner (inches)	Leachate Collected (ft^3/yr)	Leachate Collected (gal/min)	Thickness at 100 hr (inches)	Avg. Head on Liner (inches)	Leachate Collected (ft^3/yr)	Leachate Collected (gal/min)	Expected Flow through a GCL subbase (ft^3/yr/acre)
L_{total} = 140ft S = 45%	0.273[1]	0.000	77,843	1.11	0.227[2]	0.000	833.726	0.01	0.001

WITH GCL

Sand Sat. Hyd. Cond. = 5.2x10-4cm/sec

		Collection System, K = 8 cm/sec			Detection System, K = 2.5 cm/sec				
	Thickness (inches)	Avg. Head on Liner (inches)	Leachate Collected (ft^3/yr)	Leachate Collected (gal/min)	Thickness at 100 hr (inches)	Avg. Head on Liner (inches)	Leachate Collected (ft^3/yr)	Leachate Collected (gal/min)	Expected Flow through a GCL subbase (ft^3/yr/acre)
L_{total} = 140ft S = 45%	0.273[1]	0.000	78,576	1.12	0.227[2]	0.000	845.466	0.01	0.001

WITH GCL

Sand Sat. Hyd. Cond. = 1x10-5cm/sec

		Collection System, K = 8 cm/sec			Detection System, K = 2.5 cm/sec				
	Thickness (inches)	Avg. Head on Liner (inches)	Leachate Collected (ft^3/yr)	Leachate Collected (gal/min)	Thickness at 100 hr (inches)	Avg. Head on Liner (inches)	Leachate Collected (ft^3/yr)	Leachate Collected (gal/min)	Expected Flow through a GCL subbase (ft^3/yr/acre)
L_{total} = 140ft S = 45%	0.273[1]	0.004	60,113	0.86	0.227[2]	0.001	152.949	0.00	0.001

Note:
1. Thickness of 300-mil Tri-Planar Geocomposite at 100 hrs & loaded.
2. Thickness of 250-mil Bi-Planar Geocomposite at 100 hrs & loaded.
3. $L_{total} = L_{upstream} + L_{downstream}$

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SHEET 3 OF 8			
CLIENT Citrus County	PROJECT Phase 3 - Alternate Procedure	JOB NO. 09207049.02	
SUBJECT Transmissivity/Hydraulic Conductivity Calculations RAI No. 2		BY DHB	DATE 3/4/2009
		CHECKED	DATE 3/4/09

OBJECTIVE:

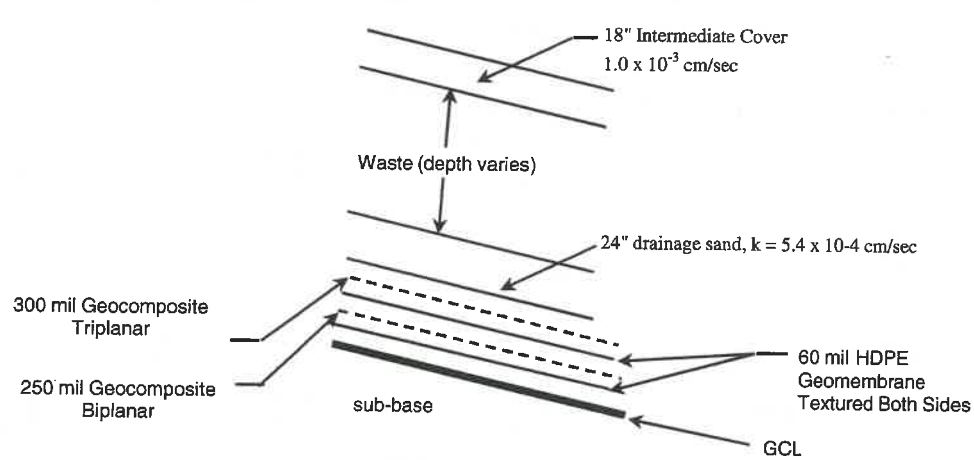
To determine the hydraulic conductivity for the geocomposite used in the leachate collection and removal system (LCRS) and leak detection system.

REFERENCES:

1. GRI Standard - GC8 Technical Release, April 17, 2001
2. Hydrologic Evaluation of Landfill Performance (HELP Model), ver 3.07
3. Triplanar Material Properties (Tendrain 770-2 Double sided Geocomposite)
4. Biplanar Material Properties (GSE 250 mil Double sided Composite)
5. "Table 4 - Default Soil, Waste, and Geosynthetic Characteristics" for HELP Model.
6. Selection of Densities for Use in Landfill Design Calculations, Dr. Tim Townsend, Nov. 8, 2004.

PROCEDURE:

1. Geocomposite properties are dependent on landfill load, landfill leachate and other conditions. Determine loads on geocomposite.
2. GRI Standard - GC8 is a way to determine geocomposite allowable flow rates based on specific landfill conditions.
3. Use Excel spreadsheet to calculate the downstream hydraulic conductivity (k) for various landfill conditions.
4. Use Table 4 - "Default Soil, Waste, and Geosynthetic Characteristics" for soil texture within the HELP Model.
5. Use calculated values in step 3 to run the HELP Model.



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SHEET 4 of 8

CLIENT	PROJECT	JOB NO.
Citrus County	Citrus County Landfill - Phase 3	09207049.02

SUBJECT	BY	DATE
Bioreactor Waste Unit Weights	DHB	3/2/2009
Phase 3 Expansion	CHECKED DB	DATE 3/4/09

Landfill Depth (ft)	Average Landfilled Material Density (pcf)		
	Traditional Landfill (no added water, no decomposition)	New Bioreactor Landfill (water added to field capacity, no mass loss)	Old Bioreactor Landfill (water added to field capacity, waste degraded)
50	60.7	71.1	73.7
100	60.7	72.2	74.9
150	61.8	74.5	77.2
200	63.6	76.6	79.3
250	65.6	78.5	81.2
300	67.1	80.2	82.9

(ref. 6)

35 ft Landfill Depth (with recirculation)
Use 71.1 pcf (conservative)

70 ft Landfill Depth (with recirculation)
Interpolate waste unit weight for old Bioreactor for Landfill (conservative)

$$y_2 = \frac{(x_2 - x_1)(y_3 - y_1)}{(x_3 - x_1)} + y_1$$

$$y_2 = \frac{(70-50)(74.9-73.7)}{(100-50)} + 73.7$$

y_2 = 74.18

135 ft Landfill Depth (with recirculation)
Interpolate waste unit weight for old Bioreactor Landfill

$$y_2 = \frac{(x_2 - x_1)(y_3 - y_1)}{(x_3 - x_1)} + y_1$$

$$y_2 = \frac{(135-100)(77.2-74.9)}{(150-100)} + 74.9$$

y_2 = 76.51

175 ft Landfill Depth (with recirculation)
Interpolate waste unit weight for Old Bioreactor Landfill

$$y_2 = \frac{(x_2 - x_1)(y_3 - y_1)}{(x_3 - x_1)} + y_1$$

$$y_2 = \frac{(175-150)(79.3-77.2)}{(200-150)} + 77.2$$

y_2 = 78.25

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SHEET 5 OF 8

CLIENT	PROJECT	JOB NO.	
Citrus County	Phase 3 - Alternate Procedure	09207049.02	
SUBJECT HELP Model Load Calculations RAI No. 2		BY: DHB	DATE: 3/4/2009
		CHECKED: DB	DATE: 3/4/09

Open Cell, 35 ft waste

Material	Material Density (pcf)	Depth of material (ft)	Load (psf)	
Sand	110	2.0	220	
Solid Waste	71.1	35.0	2,489	
Soil Cover	110	0.5	55	
		Total	**2,764**	**=> 3,000**

Notes:

For this analysis, the average depth of waste to the LCRS is 35 ft. Thus 3,000 psf is used for determining the thickness and conductivity of the geocomposite drainage layers.

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SHEET 6 OF 8

CLIENT	PROJECT	JOB NO.
Citrus County	Phase 3 - Alternate Procedure	09207049.02

SUBJECT	BY	DATE
Transmissivity/Hydraulic Conductivity Calculations RAI No. 2	DHB	3/4/2009
	CHECKED: DB	DATE: 3/4/09

EQUATIONS:

From Attachment 2

$$T_{allow} = \frac{T_{ultimate}}{RF_{IN} * RF_{CC} * RF_{BC} * RF_{CR} * FS}$$

Where,

RF_{IN} = Intrusion reduction factors (accounted for in RF_{CR})

RF_{CC} = Chemical clogging reduction factor

RF_{BC} = Biological clogging reduction factor

RF_{CR} = Creep reduction factor

$$RF_{CR} = \left[\frac{(t'/t) - (1 - n_{original})}{(t_{CR}/t) - (1 - n_{original})}\right]^3$$

Where,

t' = Thickness at 100 hours

t = Virgin thickness

HELP Model. Thickness at >> 100 hours

$n_{original}$ = Original porosity $= \frac{1 - \text{mass unit area}}{\text{density x thickness}}$

FS = Factor of Safety = 2 (Industry Standard)

$$k = \frac{T_{allow}}{t'}$$

Where,

k = Hydraulic conductivity, cm/sec

NOTE:

RF_{IN} accounts for the geotextile encroaching on the geonet under a constant loading. A 100-hour transmissivity test accounts for intrusion. After the 100-hour seat time, the geotextile has already begun to intrude into the geonet, therefore, the transmissivity value reflects the intrusion. The transmissivity values for these calculations are all based on the 100-hour test, therefore, RF_{IN} = 1.0.

TRIPLANAR (PRIMARY COLLECTION SYSTEM)

Purpose

Calculate the design transmissivity, k, of a 300-mil triplanar geocomposite under soil/geocomposite/geomembrane boundary conditions for various loading conditions.

From the TENAX technical department, the following Transmissivity (T) values are known:
(Based on TENDRAIN 770-2 geocomposite specifications). Refer to product specifications in HELP Model references.

@ 45% Gradient		(2H:1V)
Load (psf)	T (m^2/sec)	
3,000	2.00E-03	

Reduction Factors

RF-Intrusion, RF_{IN}
RF-Chemical Clogging, RF_{CC}
RF-Biological Clogging, RF_{BC}
RF-Creep, RF_{CR}
FS - Factor of Safety

thickness, t = 300 mil
0.3 inches
0.762 cm

Equations

$$T_{allow} = \frac{T_{ultimate}}{RF_{IN} * RF_{CC} * RF_{BC} * RF_{CR} * FS}$$

$$t' = \frac{t}{RF_{CR}}$$

$$k = \frac{T_{allow}}{t'}$$

Leachate Collection System

Chemical Clogging RF_{CC} = 1.5 to 2.0
Biological Clogging RF_{BC} = 1.1 to 1.3
} Obtained from GRI Standard GC8 page GC8-9 provided in reference.

Leachate Detection System

Chemical Clogging RF_{CC} = 1.1 to 1.5
Biological Clogging RF_{BC} = 1.1 to 1.3
} Obtained from GRI Standard GC8 page GC8-9 provided in reference.

WASTE LOAD 3,000 PSF ≈ 35' of waste

Reduction Factors

RF_{IN} = 1.0
RF_{CC} = 1.5
RF_{BC} = 1.1
RF_{CR} = 1.1
FS = 2.0

thickness, t = 300 mil
0.3 inches
0.762 cm

2H:1V					
Load (psf)	T (m^2/sec)	T_{allow} (m^2/sec)	T_{allow} (cm^2/sec)	t' (cm)	k (cm/sec)
3,000	2.00E-03	5.51E-04	5.5	0.693	8.0

t' = 0.273 inches

BIPLANAR (SECONDARY COLLECTION SYSTEM)

Purpose

Calculate the design transmissivity, k, of a 250-mil biplanar geocomposite under geomembrane/geocomposite/geomembrane boundary conditions for various loading conditions.

From the GSE technical department, the following Transmissivity (T) values are known: (Based on GSE Drainage Design Manual). Refer to graph in references.

@ 45% Gradient		(2H:1V)
Load (psf)	T (m^2/sec)	
1,000	4.10E-04	
3,000	3.77E-04	(interpolated value)
10,000	2.60E-04	

Reduction Factors

RF-Intrusion, RF_{IN}

RF-Chemical Clogging, RF_{CC}

RF-Biological Clogging, RF_{BC}

RF-Creep, RF_{CR}

FS - Factor of Safety

thickness, t = 250 mil

0.25 inches

0.635 cm

Equations

$$T_{allow} = \frac{T_{ultimate}}{RF_{IN} * RF_{CC} * RF_{BC} * RF_{CR} * FS}$$

$$t' = \frac{t}{RF_{CR}}$$

$$k = \frac{T_{allow}}{t'}$$

Leachate Collection System

Chemical Clogging RF_{CC} = 1.5 to 2.0
Biological Clogging RF_{BC} = 1.1 to 1.3

Obtained from GRI Standard GC8 page GC8-9 provided in reference.

Leachate Detection System

Chemical Clogging RF_{CC} = 1.1 to 1.5
Biological Clogging RF_{BC} = 1.1 to 1.3

Obtained from GRI Standard GC8 page GC8-9 provided in reference.

WASTE LOAD 3,000 PSF

Reduction Factors

RF_{IN} = 1.0

RF_{CC} = 1.1

RF_{BC} = 1.1

RF_{CR} = 1.1

FS = 2.0

thickness, t = 250 mil

0.25 inches

0.635 cm

2H:1V					
Load (psf)	T (m^2/sec)	T_{allow} (m^2/sec)	T_{allow} (cm^2/sec)	t' (cm)	k (cm/sec)
3,000	3.77E-04	1.41E-04	1.4	0.577	2.5

t' = 0.227 inches

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**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07   (1 NOVEMBER 1997)               **
**                 DEVELOPED BY ENVIRONMENTAL LABORATORY                    **
**                   USAE WATERWAYS EXPERIMENT STATION                      **
**           FOR USEPA RISK REDUCTION ENGINEERING LABORATORY                **
**                                                                          **
**                                                                          **
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PRECIPITATION DATA FILE:    P:\HELP\CITRUS.D4
TEMPERATURE DATA FILE:      P:\HELP\CITRUS.D7
SOLAR RADIATION DATA FILE:  P:\HELP\CITRUS.D13
EVAPOTRANSPIRATION DATA:    P:\HELP\CITRUS.D11
SOIL AND DESIGN DATA FILE:  p:\HELP\CIT35ALN.D10
OUTPUT DATA FILE:           P:\HELP\CIT35ALN.OUT


TIME:  14:49     DATE:   2/11/2009


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

     TITLE:  Citrus County Alternate Procedure Request
     No GCL, Sand Sat. Hydr. Cond. = 1x10-3 cm/sec

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


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


                            LAYER  1    (6-inch daily cover)
                            --------

               TYPE 1 - VERTICAL PERCOLATION LAYER
                  MATERIAL TEXTURE NUMBER   5
          THICKNESS                    =      6.00   INCHES
          POROSITY                     =      0.4570 VOL/VOL
          FIELD CAPACITY               =      0.1310 VOL/VOL
          WILTING POINT                =      0.0580 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.0554 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.100000005000E-02 CM/SEC
        NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  1.80
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               FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.


                            LAYER  2    (10 ft waste)
                            --------

               TYPE 1 - VERTICAL PERCOLATION LAYER
                  MATERIAL TEXTURE NUMBER  19
          THICKNESS                    =    120.00   INCHES
          POROSITY                     =      0.1680 VOL/VOL
          FIELD CAPACITY               =      0.0730 VOL/VOL
          WILTING POINT                =      0.0190 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.0713 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.100000005000E-02 CM/SEC


                            LAYER  3    (10 ft waste)
                            --------

               TYPE 1 - VERTICAL PERCOLATION LAYER
                  MATERIAL TEXTURE NUMBER  19
          THICKNESS                    =    120.00   INCHES
          POROSITY                     =      0.1680 VOL/VOL
          FIELD CAPACITY               =      0.0730 VOL/VOL
          WILTING POINT                =      0.0190 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.0730 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.100000005000E-02 CM/SEC


                            LAYER  4    (10 ft waste)
                            --------

               TYPE 1 - VERTICAL PERCOLATION LAYER
                  MATERIAL TEXTURE NUMBER  19
          THICKNESS                    =    120.00   INCHES
          POROSITY                     =      0.1680 VOL/VOL
          FIELD CAPACITY               =      0.0730 VOL/VOL
          WILTING POINT                =      0.0190 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.0730 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.100000005000E-02 CM/SEC


                            LAYER  5    (5 ft waste)
                            --------

               TYPE 1 - VERTICAL PERCOLATION LAYER
                  MATERIAL TEXTURE NUMBER  19
          THICKNESS                    =     60.00   INCHES
          POROSITY                     =      0.1680 VOL/VOL
```

```
FIELD CAPACITY             =      0.0730 VOL/VOL
WILTING POINT              =      0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.0730 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC


                      LAYER  6     (24-inch drainage sand)
                      --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   0
THICKNESS                  =     24.00   INCHES
POROSITY                   =      0.4730 VOL/VOL
FIELD CAPACITY             =      0.2220 VOL/VOL
WILTING POINT              =      0.1040 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.2455 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC


                      LAYER  7     (300-mil triplanar geocomposite)
                      --------

            TYPE 2 - LATERAL DRAINAGE LAYER
              MATERIAL TEXTURE NUMBER   0
THICKNESS                  =      0.27   INCHES
POROSITY                   =      0.8500 VOL/VOL
FIELD CAPACITY             =      0.0100 VOL/VOL
WILTING POINT              =      0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.0107 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =   8.00000000000      CM/SEC
SLOPE                      =     45.00   PERCENT
DRAINAGE LENGTH            =    140.0    FEET


                      LAYER  8     (60-mil HDPE geomembrane)
                      --------

            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        =      0.50   HOLES/ACRE
FML INSTALLATION DEFECTS   =      1.00   HOLES/ACRE
FML PLACEMENT QUALITY      =  5 - BAD
```



```
                      LAYER  9     (250-mil biplanar geocomposite)
                      --------

            TYPE 2 - LATERAL DRAINAGE LAYER
              MATERIAL TEXTURE NUMBER   0
THICKNESS                  =      0.23   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.  =   2.50000000000      CM/SEC
SLOPE                      =     45.00   PERCENT
DRAINAGE LENGTH            =    140.0    FEET


                      LAYER 10     (60-mil HDPE geomembrane)
                      --------

            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        =      0.50   HOLES/ACRE
FML INSTALLATION DEFECTS   =      1.00   HOLES/ACRE
FML PLACEMENT QUALITY      =  3 - GOOD


                      LAYER 11     (Drainage Sand)
                      --------

            TYPE 3 - BARRIER SOIL LINER
              MATERIAL TEXTURE NUMBER   0
THICKNESS                  =      0.25   INCHES
POROSITY                   =      0.4570 VOL/VOL
FIELD CAPACITY             =      0.1310 VOL/VOL
WILTING POINT              =      0.0580 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.4570 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.299999992000E-04 CM/SEC


                      LAYER 12     (Subbase)
                      --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   0
THICKNESS                  =     24.00   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.          =  0.299999992000E-04 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 BARE
         GROUND CONDITIONS, A SURFACE SLOPE OF  4.% AND
         A SLOPE LENGTH OF  140. FEET.

SCS RUNOFF CURVE NUMBER                 =      84.40
FRACTION OF AREA ALLOWING RUNOFF        =     100.0    PERCENT
AREA PROJECTED ON HORIZONTAL PLANE      =       1.000  ACRES
EVAPORATIVE ZONE DEPTH                  =      10.0    INCHES
INITIAL WATER IN EVAPORATIVE ZONE       =       0.424  INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE      =       3.414  INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE      =       0.424  INCHES
INITIAL SNOW WATER                      =       0.000  INCHES
INITIAL WATER IN LAYER MATERIALS        =      39.947  INCHES
TOTAL INITIAL WATER                     =      39.947  INCHES
TOTAL SUBSURFACE INFLOW                 =       0.00   INCHES/YEAR
```

EVAPOTRANSPIRATION AND WEATHER DATA

```
NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
         TAMPA                      FLORIDA

      STATION LATITUDE                           =  27.58 DEGREES
      MAXIMUM LEAF AREA INDEX                    =   1.00
      START OF GROWING SEASON (JULIAN DATE)      =     0
      END OF GROWING SEASON (JULIAN DATE)        =   367
      EVAPORATIVE ZONE DEPTH                     =  10.0  INCHES
      AVERAGE ANNUAL WIND SPEED                  =   8.60 MPH
      AVERAGE 1ST QUARTER RELATIVE HUMIDITY      =  74.00 %
      AVERAGE 2ND QUARTER RELATIVE HUMIDITY      =  72.00 %
      AVERAGE 3RD QUARTER RELATIVE HUMIDITY      =  78.00 %
      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
2.94	3.26	2.35	0.68	1.38	8.20
13.13	8.40	20.26	1.27	0.70	3.15

```
NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
         COEFFICIENTS FOR     TAMPA                FLORIDA
```

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
59.80	60.80	66.20	71.60	77.10	80.90
82.20	82.20	80.90	74.50	66.70	61.30

```
NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
         COEFFICIENTS FOR     TAMPA                FLORIDA
           AND STATION LATITUDE  =  27.58 DEGREES

WARNING:  TEMPERATURE FOR YEAR      1 USED WITH PRECIPITATION FOR YEAR 2003

WARNING:  SOLAR RADIATION FOR YEAR      1 USED WITH PRECIPITATION FOR YEAR 2003

WARNING:  TEMPERATURE FOR YEAR      2 USED WITH PRECIPITATION FOR YEAR 2004

WARNING:  SOLAR RADIATION FOR YEAR      2 USED WITH PRECIPITATION FOR YEAR 2004

WARNING:  TEMPERATURE FOR YEAR      3 USED WITH PRECIPITATION FOR YEAR 2005

WARNING:  SOLAR RADIATION FOR YEAR      3 USED WITH PRECIPITATION FOR YEAR 2005

WARNING:  TEMPERATURE FOR YEAR      4 USED WITH PRECIPITATION FOR YEAR 2006

WARNING:  SOLAR RADIATION FOR YEAR      4 USED WITH PRECIPITATION FOR YEAR 2006

WARNING:  TEMPERATURE FOR YEAR      5 USED WITH PRECIPITATION FOR YEAR 2007

WARNING:  SOLAR RADIATION FOR YEAR      5 USED WITH PRECIPITATION FOR YEAR 2007
```

****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 2003 THROUGH 2007

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	1.73	3.58	3.16	2.50	3.25	10.36
	10.75	6.83	6.87	3.18	1.88	3.01
STD. DEVIATIONS	1.00	1.67	2.61	2.89	2.97	8.03
	2.46	1.27	7.65	3.23	1.54	1.29
RUNOFF						
TOTALS	0.069	0.218	0.262	0.221	0.226	1.985
	1.393	0.374	1.820	0.267	0.163	0.106
STD. DEVIATIONS	0.154	0.229	0.323	0.474	0.424	3.285
	0.776	0.336	3.732	0.598	0.363	0.075
EVAPOTRANSPIRATION						
TOTALS	1.254	1.675	1.860	1.205	1.474	4.251
	5.352	4.311	3.074	1.688	0.604	1.263
STD. DEVIATIONS	0.298	0.672	1.398	1.329	1.046	1.706
	0.815	0.533	1.087	1.250	0.325	0.800
LATERAL DRAINAGE COLLECTED FROM LAYER 7						
TOTALS	1.3229	0.9146	1.3834	1.3341	1.2229	1.5655
	4.3576	3.7889	1.8380	1.8691	0.9223	1.0343
STD. DEVIATIONS	0.6618	0.3237	1.4762	1.5858	1.1531	1.2569
	2.4752	2.0142	1.8206	1.4826	0.4736	1.0727
PERCOLATION/LEAKAGE THROUGH LAYER 8						
TOTALS	0.0175	0.0141	0.0170	0.0155	0.0156	0.0175
	0.0327	0.0312	0.0198	0.0202	0.0149	0.0144
STD. DEVIATIONS	0.0030	0.0023	0.0090	0.0107	0.0092	0.0074
	0.0099	0.0086	0.0084	0.0080	0.0041	0.0062
LATERAL DRAINAGE COLLECTED FROM LAYER 9						
TOTALS	0.0175	0.0141	0.0170	0.0155	0.0156	0.0175
	0.0327	0.0312	0.0198	0.0202	0.0149	0.0144
STD. DEVIATIONS	0.0030	0.0023	0.0090	0.0107	0.0092	0.0074
	0.0099	0.0086	0.0084	0.0080	0.0041	0.0062
PERCOLATION/LEAKAGE THROUGH LAYER 11						

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 12						
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 8						
AVERAGES	0.0004	0.0003	0.0004	0.0004	0.0003	0.0004
	0.0012	0.0010	0.0005	0.0005	0.0003	0.0003
STD. DEVIATIONS	0.0002	0.0001	0.0004	0.0004	0.0003	0.0003
	0.0007	0.0005	0.0005	0.0004	0.0001	0.0003
DAILY AVERAGE HEAD ON TOP OF LAYER 10						
AVERAGES	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

****

****

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 2003 THROUGH 2007

	INCHES		CU. FEET	PERCENT
PRECIPITATION	57.11	(11.991)	207309.3	100.00
RUNOFF	7.103	(3.8178)	25785.54	12.438
EVAPOTRANSPIRATION	28.011	(5.0695)	101679.97	49.047
LATERAL DRAINAGE COLLECTED FROM LAYER 7	21.55333	(5.25937)	78238.586	37.74003
PERCOLATION/LEAKAGE THROUGH	0.23049	(0.03154)	836.685	0.40359

LAYER 8

AVERAGE HEAD ON TOP OF LAYER 8	0.000 (	0.000) <0.173 ✓		
LATERAL DRAINAGE COLLECTED FROM LAYER 9	0.23049 (	0.03154)	836.684	0.40359
PERCOLATION/LEAKAGE THROUGH LAYER 11	0.00000 (	0.00000)	0.000	0.00000
AVERAGE HEAD ON TOP OF LAYER 10	0.000 (	0.000) <0.227 ✓		
PERCOLATION/LEAKAGE THROUGH LAYER 12	0.00000 (	0.00000)	0.002	0.00000
CHANGE IN WATER STORAGE	0.212 (	1.4649)	768.53	0.371

Expected flow through

****

****

PEAK DAILY VALUES FOR YEARS 2003 THROUGH 2007

	(INCHES)	(CU. FT.)
PRECIPITATION	6.00	21780.000
RUNOFF	3.388	12299.8027
DRAINAGE COLLECTED FROM LAYER 7	0.60475	2195.25073
PERCOLATION/LEAKAGE THROUGH LAYER 8	0.002514	9.12500
AVERAGE HEAD ON TOP OF LAYER 8	0.005	
MAXIMUM HEAD ON TOP OF LAYER 8	0.056 <0.27 ✓	
LOCATION OF MAXIMUM HEAD IN LAYER 7 (DISTANCE FROM DRAIN)	0.0 FEET	
DRAINAGE COLLECTED FROM LAYER 9	0.00251	9.12498
PERCOLATION/LEAKAGE THROUGH LAYER 11	0.000000	0.00003
AVERAGE HEAD ON TOP OF LAYER 10	0.000	
MAXIMUM HEAD ON TOP OF LAYER 10	0.043 <0.227 ✓	
LOCATION OF MAXIMUM HEAD IN LAYER 9 (DISTANCE FROM DRAIN)	0.0 FEET	
PERCOLATION/LEAKAGE THROUGH LAYER 12	0.000001	0.00433 ← Expected Flow through natural soils
SNOW WATER	0.00	0.0000
MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.2450	
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0424	

*** 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 2007

LAYER	(INCHES)	(VOL/VOL)
1	0.5390	0.0898
2	8.7311	0.0728
3	8.7600	0.0730
4	8.7600	0.0730
5	4.3800	0.0730
6	6.5711	0.2738
7	0.0035	0.0128
8	0.0000	0.0000
9	0.0023	0.0100
10	0.0000	0.0000
11	0.1142	0.4570
12	3.1440	0.1310
SNOW WATER	0.000	

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              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:     P:\HELP\CITRUS.D4
TEMPERATURE DATA FILE:       P:\HELP\CITRUS.D7
SOLAR RADIATION DATA FILE:   P:\HELP\CITRUS.D13
EVAPOTRANSPIRATION DATA:     P:\HELP\CITRUS.D11
SOIL AND DESIGN DATA FILE:   p:\HELP\CIT35ALN.D10
OUTPUT DATA FILE:            P:\HELP\CIT35ALN.OUT


TIME:  15: 0     DATE:   2/11/2009


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

     TITLE:  Citrus County Alternate Procedure Request
     No GCL, Sand Sat. Hydr. Cond. = 5.2x10-4cm/sec

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


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


                                  LAYER  1    (6-inch daily)
                                  --------

                  TYPE 1 - VERTICAL PERCOLATION LAYER
                      MATERIAL TEXTURE NUMBER   5
          THICKNESS                  =      6.00    INCHES
          POROSITY                   =      0.4570 VOL/VOL
          FIELD CAPACITY             =      0.1310 VOL/VOL
          WILTING POINT              =      0.0580 VOL/VOL
          INITIAL SOIL WATER CONTENT =      0.0554 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    (10 ft waste)
                                  --------

                  TYPE 1 - VERTICAL PERCOLATION LAYER
                      MATERIAL TEXTURE NUMBER  19
          THICKNESS                  =    120.00    INCHES
          POROSITY                   =      0.1680 VOL/VOL
          FIELD CAPACITY             =      0.0730 VOL/VOL
          WILTING POINT              =      0.0190 VOL/VOL
          INITIAL SOIL WATER CONTENT =      0.0713 VOL/VOL
          EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC


                                  LAYER  3    (10 ft waste)
                                  --------

                  TYPE 1 - VERTICAL PERCOLATION LAYER
                      MATERIAL TEXTURE NUMBER  19
          THICKNESS                  =    120.00    INCHES
          POROSITY                   =      0.1680 VOL/VOL
          FIELD CAPACITY             =      0.0730 VOL/VOL
          WILTING POINT              =      0.0190 VOL/VOL
          INITIAL SOIL WATER CONTENT =      0.0730 VOL/VOL
          EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC


                                  LAYER  4    (10 ft waste)
                                  --------

                  TYPE 1 - VERTICAL PERCOLATION LAYER
                      MATERIAL TEXTURE NUMBER  19
          THICKNESS                  =    120.00    INCHES
          POROSITY                   =      0.1680 VOL/VOL
          FIELD CAPACITY             =      0.0730 VOL/VOL
          WILTING POINT              =      0.0190 VOL/VOL
          INITIAL SOIL WATER CONTENT =      0.0730 VOL/VOL
          EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC


                                  LAYER  5    (5 ft waste)
                                  --------

                  TYPE 1 - VERTICAL PERCOLATION LAYER
                      MATERIAL TEXTURE NUMBER  19
          THICKNESS                  =     60.00    INCHES
          POROSITY                   =      0.1680 VOL/VOL
```

```
FIELD CAPACITY              =      0.0730 VOL/VOL
WILTING POINT               =      0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0730 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC


                  LAYER  6     (24-inch drainage sand)
                  --------

         TYPE 1 - VERTICAL PERCOLATION LAYER
            MATERIAL TEXTURE NUMBER   0
THICKNESS                   =     24.00    INCHES
POROSITY                    =      0.4730 VOL/VOL
FIELD CAPACITY              =      0.2220 VOL/VOL
WILTING POINT               =      0.1040 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.2591 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.520000001000E-03 CM/SEC


                  LAYER  7     (300-mil triplanar geocomposite)
                  --------

          TYPE 2 - LATERAL DRAINAGE LAYER
            MATERIAL TEXTURE NUMBER   0
THICKNESS                   =      0.27    INCHES
POROSITY                    =      0.8500 VOL/VOL
FIELD CAPACITY              =      0.0100 VOL/VOL
WILTING POINT               =      0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0107 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =   8.00000000000      CM/SEC
SLOPE                       =     45.00    PERCENT
DRAINAGE LENGTH             =    140.0     FEET


                  LAYER  8     (60-mil HDPE geomembrane)
                  --------

          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         =      0.50    HOLES/ACRE
FML INSTALLATION DEFECTS    =      1.00    HOLES/ACRE
FML PLACEMENT QUALITY       =  5 - BAD
```



```
                  LAYER  9     (250-mil biplanar geocomposite)
                  --------

          TYPE 2 - LATERAL DRAINAGE LAYER
            MATERIAL TEXTURE NUMBER   0
THICKNESS                   =      0.23    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.   =   2.50000000000      CM/SEC
SLOPE                       =     45.00    PERCENT
DRAINAGE LENGTH             =    140.0     FEET


                  LAYER 10     (60-mil HDPE geomembrane)
                  --------

          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         =      0.50    HOLES/ACRE
FML INSTALLATION DEFECTS    =      1.00    HOLES/ACRE
FML PLACEMENT QUALITY       =  3 - GOOD


                  LAYER 11     (Drainage Sand)
                  --------

           TYPE 3 - BARRIER SOIL LINER
            MATERIAL TEXTURE NUMBER   0
THICKNESS                   =      0.25    INCHES
POROSITY                    =      0.4570 VOL/VOL
FIELD CAPACITY              =      0.1310 VOL/VOL
WILTING POINT               =      0.0580 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.4570 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.299999992000E-04 CM/SEC


                  LAYER 12     (subbase)
                  --------

         TYPE 1 - VERTICAL PERCOLATION LAYER
            MATERIAL TEXTURE NUMBER   0
THICKNESS                   =     24.00    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.       =  0.299999992000E-04 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 BARE GROUND CONDITIONS, A SURFACE SLOPE OF 4.% AND A SLOPE LENGTH OF 140. FEET.

```
SCS RUNOFF CURVE NUMBER              =     84.40
FRACTION OF AREA ALLOWING RUNOFF     =    100.0     PERCENT
AREA PROJECTED ON HORIZONTAL PLANE   =      1.000   ACRES
EVAPORATIVE ZONE DEPTH               =     10.0     INCHES
INITIAL WATER IN EVAPORATIVE ZONE    =      0.424   INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE   =      3.414   INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE   =      0.424   INCHES
INITIAL SNOW WATER                   =      0.000   INCHES
INITIAL WATER IN LAYER MATERIALS     =     40.274   INCHES
TOTAL INITIAL WATER                  =     40.274   INCHES
TOTAL SUBSURFACE INFLOW              =      0.00    INCHES/YEAR
```

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM TAMPA FLORIDA

```
STATION LATITUDE                          =  27.58 DEGREES
MAXIMUM LEAF AREA INDEX                   =   1.00
START OF GROWING SEASON (JULIAN DATE)     =      0
END OF GROWING SEASON (JULIAN DATE)       =    367
EVAPORATIVE ZONE DEPTH                    =  10.0  INCHES
AVERAGE ANNUAL WIND SPEED                 =   8.60 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY     =  74.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY     =  72.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY     =  78.00 %
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
2.94	3.26	2.35	0.68	1.38	8.20
13.13	8.40	20.26	1.27	0.70	3.15

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

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
59.80	60.80	66.20	71.60	77.10	80.90
82.20	82.20	80.90	74.50	66.70	61.30

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR TAMPA FLORIDA AND STATION LATITUDE = 27.58 DEGREES

WARNING: TEMPERATURE FOR YEAR 1 USED WITH PRECIPITATION FOR YEAR 2003

WARNING: SOLAR RADIATION FOR YEAR 1 USED WITH PRECIPITATION FOR YEAR 2003

WARNING: TEMPERATURE FOR YEAR 2 USED WITH PRECIPITATION FOR YEAR 2004

WARNING: SOLAR RADIATION FOR YEAR 2 USED WITH PRECIPITATION FOR YEAR 2004

WARNING: TEMPERATURE FOR YEAR 3 USED WITH PRECIPITATION FOR YEAR 2005

WARNING: SOLAR RADIATION FOR YEAR 3 USED WITH PRECIPITATION FOR YEAR 2005

WARNING: TEMPERATURE FOR YEAR 4 USED WITH PRECIPITATION FOR YEAR 2006

WARNING: SOLAR RADIATION FOR YEAR 4 USED WITH PRECIPITATION FOR YEAR 2006

WARNING: TEMPERATURE FOR YEAR 5 USED WITH PRECIPITATION FOR YEAR 2007

WARNING: SOLAR RADIATION FOR YEAR 5 USED WITH PRECIPITATION FOR YEAR 2007

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 2003 THROUGH 2007

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	1.73	3.58	3.16	2.50	3.25	10.36
	10.75	6.83	6.87	3.18	1.88	3.01
STD. DEVIATIONS	1.00	1.67	2.61	2.89	2.97	8.03
	2.46	1.27	7.65	3.23	1.54	1.29
RUNOFF						
TOTALS	0.069	0.218	0.262	0.221	0.226	1.985
	1.393	0.374	1.820	0.267	0.163	0.106
STD. DEVIATIONS	0.154	0.229	0.323	0.474	0.424	3.285
	0.776	0.336	3.732	0.598	0.363	0.075
EVAPOTRANSPIRATION						
TOTALS	1.254	1.675	1.860	1.205	1.474	4.251
	5.352	4.311	3.074	1.688	0.604	1.263
STD. DEVIATIONS	0.298	0.672	1.398	1.329	1.046	1.706
	0.815	0.533	1.087	1.250	0.325	0.800
LATERAL DRAINAGE COLLECTED FROM LAYER 7						
TOTALS	1.3060	0.9037	1.3941	1.3797	1.2202	1.4912
	4.3265	3.8227	1.8583	1.8720	0.9333	1.0344
STD. DEVIATIONS	0.6335	0.3197	1.4586	1.4847	1.1652	1.2597
	2.4965	1.9829	1.8097	1.4677	0.4916	1.0422
PERCOLATION/LEAKAGE THROUGH LAYER 8						
TOTALS	0.0176	0.0142	0.0174	0.0173	0.0158	0.0170
	0.0325	0.0314	0.0201	0.0204	0.0151	0.0147
STD. DEVIATIONS	0.0028	0.0022	0.0085	0.0079	0.0091	0.0077
	0.0100	0.0084	0.0084	0.0078	0.0042	0.0058
LATERAL DRAINAGE COLLECTED FROM LAYER 9						
TOTALS	0.0176	0.0142	0.0174	0.0173	0.0158	0.0170
	0.0325	0.0314	0.0201	0.0204	0.0151	0.0147
STD. DEVIATIONS	0.0028	0.0022	0.0085	0.0079	0.0091	0.0077
	0.0100	0.0084	0.0084	0.0078	0.0042	0.0058
PERCOLATION/LEAKAGE THROUGH LAYER 11						

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 12						
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 8						
AVERAGES	0.0003	0.0003	0.0004	0.0004	0.0003	0.0004
	0.0012	0.0010	0.0005	0.0005	0.0003	0.0003
STD. DEVIATIONS	0.0002	0.0001	0.0004	0.0004	0.0003	0.0003
	0.0007	0.0005	0.0005	0.0004	0.0001	0.0003
DAILY AVERAGE HEAD ON TOP OF LAYER 10						
AVERAGES	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
	0.0002	0.0002	0.0001	0.0001	0.0001	0.0001
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 2003 THROUGH 2007

	INCHES		CU. FEET	PERCENT
PRECIPITATION	57.11	(11.991)	207309.3	100.00
RUNOFF	7.103	(3.8178)	25785.54	12.438
EVAPOTRANSPIRATION	28.011	(5.0695)	101679.97	49.047
LATERAL DRAINAGE COLLECTED FROM LAYER 7	21.54208	(5.21947)	78197.766	37.72034
PERCOLATION/LEAKAGE THROUGH	0.23343	(0.02859)	847.352	0.40874

LAYER 8				
AVERAGE HEAD ON TOP OF LAYER 8	0.000 (	0.000)		
LATERAL DRAINAGE COLLECTED FROM LAYER 9	0.23343 (	0.02859)	847.348	0.40874
PERCOLATION/LEAKAGE THROUGH LAYER 11	0.00000 (	0.00000)	0.003	0.00000
AVERAGE HEAD ON TOP OF LAYER 10	0.000 (	0.000)		
PERCOLATION/LEAKAGE THROUGH LAYER 12	0.00000 (	0.00000)	0.003	0.00000
CHANGE IN WATER STORAGE	0.220 (	1.4013)	798.66	0.385

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PEAK DAILY VALUES FOR YEARS 2003 THROUGH 2007

	(INCHES)	(CU. FT.)
PRECIPITATION	6.00	21780.000
RUNOFF	3.388	12299.8027
DRAINAGE COLLECTED FROM LAYER 7	0.60728	2204.44312
PERCOLATION/LEAKAGE THROUGH LAYER 8	0.002519	9.14578
AVERAGE HEAD ON TOP OF LAYER 8	0.005	
MAXIMUM HEAD ON TOP OF LAYER 8	0.075	
LOCATION OF MAXIMUM HEAD IN LAYER 7 (DISTANCE FROM DRAIN)	0.0 FEET	
DRAINAGE COLLECTED FROM LAYER 9	0.00252	9.14575
PERCOLATION/LEAKAGE THROUGH LAYER 11	0.000000	0.00003
AVERAGE HEAD ON TOP OF LAYER 10	0.000	
MAXIMUM HEAD ON TOP OF LAYER 10	0.040	
LOCATION OF MAXIMUM HEAD IN LAYER 9 (DISTANCE FROM DRAIN)	0.0 FEET	
PERCOLATION/LEAKAGE THROUGH LAYER 12	0.000001	0.00433
SNOW WATER	0.00	0.0000
MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.2450	
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0424	

*** 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 2007

LAYER	(INCHES)	(VOL/VOL)
1	0.5390	0.0898
2	8.7311	0.0728
3	8.7600	0.0730
4	8.7600	0.0730
5	4.3800	0.0730
6	6.9399	0.2892
7	0.0034	0.0125
8	0.0000	0.0000
9	0.0023	0.0100
10	0.0000	0.0000
11	0.1142	0.4570
12	3.1440	0.1310
SNOW WATER	0.000	

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

PRECIPITATION DATA FILE:      P:\HELP\CITRUS.D4
TEMPERATURE DATA FILE:        P:\HELP\CITRUS.D7
SOLAR RADIATION DATA FILE:    P:\HELP\CITRUS.D13
EVAPOTRANSPIRATION DATA:      P:\HELP\CITRUS.D11
SOIL AND DESIGN DATA FILE:    p:\HELP\CIT35ALN.D10
OUTPUT DATA FILE:             P:\HELP\CIT35ALN.OUT

TIME:  15:19     DATE:   2/11/2009

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

    TITLE:  Citrus County Alternate Procedure Request
    No GCL, Sand Sat. Hydr. Cond. = 1x10-5 cm/sec

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

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

                           LAYER  1    (6-inch daily)
                           --------

               TYPE 1 - VERTICAL PERCOLATION LAYER
                  MATERIAL TEXTURE NUMBER   5
         THICKNESS                    =      6.00   INCHES
         POROSITY                     =      0.4570 VOL/VOL
         FIELD CAPACITY               =      0.1310 VOL/VOL
         WILTING POINT                =      0.0580 VOL/VOL
         INITIAL SOIL WATER CONTENT   =      0.0554 VOL/VOL
         EFFECTIVE SAT. HYD. COND.    =  0.100000005000E-02 CM/SEC
       NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  1.80
```



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               FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.

                           LAYER  2    (10 ft waste)
                           --------

               TYPE 1 - VERTICAL PERCOLATION LAYER
                  MATERIAL TEXTURE NUMBER  19
         THICKNESS                    =    120.00   INCHES
         POROSITY                     =      0.1680 VOL/VOL
         FIELD CAPACITY               =      0.0730 VOL/VOL
         WILTING POINT                =      0.0190 VOL/VOL
         INITIAL SOIL WATER CONTENT   =      0.0713 VOL/VOL
         EFFECTIVE SAT. HYD. COND.    =  0.100000005000E-02 CM/SEC

                           LAYER  3    (10 ft waste)
                           --------

               TYPE 1 - VERTICAL PERCOLATION LAYER
                  MATERIAL TEXTURE NUMBER  19
         THICKNESS                    =    120.00   INCHES
         POROSITY                     =      0.1680 VOL/VOL
         FIELD CAPACITY               =      0.0730 VOL/VOL
         WILTING POINT                =      0.0190 VOL/VOL
         INITIAL SOIL WATER CONTENT   =      0.0730 VOL/VOL
         EFFECTIVE SAT. HYD. COND.    =  0.100000005000E-02 CM/SEC

                           LAYER  4    (10 ft waste)
                           --------

               TYPE 1 - VERTICAL PERCOLATION LAYER
                  MATERIAL TEXTURE NUMBER  19
         THICKNESS                    =    120.00   INCHES
         POROSITY                     =      0.1680 VOL/VOL
         FIELD CAPACITY               =      0.0730 VOL/VOL
         WILTING POINT                =      0.0190 VOL/VOL
         INITIAL SOIL WATER CONTENT   =      0.0730 VOL/VOL
         EFFECTIVE SAT. HYD. COND.    =  0.100000005000E-02 CM/SEC

                           LAYER  5    (5 ft waste)
                           --------

               TYPE 1 - VERTICAL PERCOLATION LAYER
                  MATERIAL TEXTURE NUMBER  19
         THICKNESS                    =     60.00   INCHES
         POROSITY                     =      0.1680 VOL/VOL
```

```
FIELD CAPACITY              =     0.0730 VOL/VOL
WILTING POINT               =     0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT  =     0.0730 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC


                 LAYER  6    (24-inch drainage sand)
                 --------

        TYPE 1 - VERTICAL PERCOLATION LAYER
           MATERIAL TEXTURE NUMBER   0
THICKNESS                   =    24.00   INCHES
POROSITY                    =     0.4730 VOL/VOL
FIELD CAPACITY              =     0.2220 VOL/VOL
WILTING POINT               =     0.1040 VOL/VOL
INITIAL SOIL WATER CONTENT  =     0.3202 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.999999975000E-05 CM/SEC


                 LAYER  7    (300-mil triplanar geocomposite)
                 --------

        TYPE 2 - LATERAL DRAINAGE LAYER
           MATERIAL TEXTURE NUMBER   0
THICKNESS                   =     0.27   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.   =   8.00000000000      CM/SEC
SLOPE                       =    45.00   PERCENT
DRAINAGE LENGTH             =   140.0    FEET


                 LAYER  8    (60-mil HDPE geomembrane)
                 --------

        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         =     0.50   HOLES/ACRE
FML INSTALLATION DEFECTS    =     1.00   HOLES/ACRE
FML PLACEMENT QUALITY       =  5 - BAD
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                 LAYER  9    (250-mil biplanar geocomposite)
                 --------

        TYPE 2 - LATERAL DRAINAGE LAYER
           MATERIAL TEXTURE NUMBER   0
THICKNESS                   =     0.23   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.   =   2.50000000000      CM/SEC
SLOPE                       =    45.00   PERCENT
DRAINAGE LENGTH             =   140.0    FEET


                 LAYER 10    (60-mil HDPE geomembrane)
                 --------

        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         =     0.50   HOLES/ACRE
FML INSTALLATION DEFECTS    =     1.00   HOLES/ACRE
FML PLACEMENT QUALITY       =  3 - GOOD


                 LAYER 11    (Drainage Sand)
                 --------

        TYPE 3 - BARRIER SOIL LINER
           MATERIAL TEXTURE NUMBER   0
THICKNESS                   =     0.25   INCHES
POROSITY                    =     0.4570 VOL/VOL
FIELD CAPACITY              =     0.1310 VOL/VOL
WILTING POINT               =     0.0580 VOL/VOL
INITIAL SOIL WATER CONTENT  =     0.4570 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.299999992000E-04 CM/SEC


                 LAYER 12    (Subbase)
                 --------

        TYPE 1 - VERTICAL PERCOLATION LAYER
           MATERIAL TEXTURE NUMBER   0
THICKNESS                   =    24.00   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.          =  0.299999992000E-04 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 BARE GROUND CONDITIONS, A SURFACE SLOPE OF 4.% AND A SLOPE LENGTH OF 140. FEET.

```
SCS RUNOFF CURVE NUMBER               =     84.40
FRACTION OF AREA ALLOWING RUNOFF      =    100.0     PERCENT
AREA PROJECTED ON HORIZONTAL PLANE    =      1.000   ACRES
EVAPORATIVE ZONE DEPTH                =     10.0     INCHES
INITIAL WATER IN EVAPORATIVE ZONE     =      0.424   INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE    =      3.414   INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE    =      0.424   INCHES
INITIAL SNOW WATER                    =      0.000   INCHES
INITIAL WATER IN LAYER MATERIALS      =     41.741   INCHES
TOTAL INITIAL WATER                   =     41.741   INCHES
TOTAL SUBSURFACE INFLOW               =      0.00    INCHES/YEAR
```

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM TAMPA FLORIDA

```
STATION LATITUDE                           =  27.58 DEGREES
MAXIMUM LEAF AREA INDEX                    =   1.00
START OF GROWING SEASON (JULIAN DATE)      =     0
END OF GROWING SEASON (JULIAN DATE)        =   367
EVAPORATIVE ZONE DEPTH                     =  10.0  INCHES
AVERAGE ANNUAL WIND SPEED                  =   8.60 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY      =  74.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY      =  72.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY      =  78.00 %
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
2.94	3.26	2.35	0.68	1.38	8.20
13.13	8.40	20.26	1.27	0.70	3.15

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

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
59.80	60.80	66.20	71.60	77.10	80.90
82.20	82.20	80.90	74.50	66.70	61.30

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR TAMPA FLORIDA AND STATION LATITUDE = 27.58 DEGREES

WARNING: TEMPERATURE FOR YEAR 1 USED WITH PRECIPITATION FOR YEAR 2003

WARNING: SOLAR RADIATION FOR YEAR 1 USED WITH PRECIPITATION FOR YEAR 2003

WARNING: TEMPERATURE FOR YEAR 2 USED WITH PRECIPITATION FOR YEAR 2004

WARNING: SOLAR RADIATION FOR YEAR 2 USED WITH PRECIPITATION FOR YEAR 2004

WARNING: TEMPERATURE FOR YEAR 3 USED WITH PRECIPITATION FOR YEAR 2005

WARNING: SOLAR RADIATION FOR YEAR 3 USED WITH PRECIPITATION FOR YEAR 2005

WARNING: TEMPERATURE FOR YEAR 4 USED WITH PRECIPITATION FOR YEAR 2006

WARNING: SOLAR RADIATION FOR YEAR 4 USED WITH PRECIPITATION FOR YEAR 2006

WARNING: TEMPERATURE FOR YEAR 5 USED WITH PRECIPITATION FOR YEAR 2007

WARNING: SOLAR RADIATION FOR YEAR 5 USED WITH PRECIPITATION FOR YEAR 2007

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 2003 THROUGH 2007

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	1.73	3.58	3.16	2.50	3.25	10.36
	10.75	6.83	6.87	3.18	1.88	3.01
STD. DEVIATIONS	1.00	1.67	2.61	2.89	2.97	8.03
	2.46	1.27	7.65	3.23	1.54	1.29
RUNOFF						
TOTALS	0.069	0.247	0.279	0.233	0.271	2.011
	1.524	0.388	1.909	0.304	0.187	0.130
STD. DEVIATIONS	0.154	0.241	0.364	0.502	0.493	3.211
	0.887	0.347	3.798	0.681	0.417	0.102
EVAPOTRANSPIRATION						
TOTALS	1.486	1.843	2.081	1.732	1.944	4.546
	5.828	4.693	3.193	2.028	1.027	1.510
STD. DEVIATIONS	0.515	0.862	1.365	1.534	0.847	1.452
	0.636	0.535	1.072	1.360	0.740	0.758
LATERAL DRAINAGE COLLECTED FROM LAYER 7						
TOTALS	0.8204	0.6045	1.2323	1.1578	0.7995	0.9927
	3.3453	3.4229	1.7771	1.7534	0.7002	0.6666
STD. DEVIATIONS	0.6226	0.3818	1.2862	0.9542	0.9020	0.8876
	3.1673	1.7630	1.5621	1.4695	0.5967	0.7014
PERCOLATION/LEAKAGE THROUGH LAYER 8						
TOTALS	0.0028	0.0023	0.0034	0.0033	0.0029	0.0028
	0.0056	0.0062	0.0042	0.0041	0.0028	0.0024
STD. DEVIATIONS	0.0014	0.0010	0.0016	0.0011	0.0014	0.0012
	0.0030	0.0016	0.0015	0.0017	0.0011	0.0008
LATERAL DRAINAGE COLLECTED FROM LAYER 9						
TOTALS	0.0028	0.0023	0.0034	0.0033	0.0029	0.0028
	0.0056	0.0062	0.0042	0.0041	0.0028	0.0024
STD. DEVIATIONS	0.0014	0.0010	0.0016	0.0011	0.0014	0.0012
	0.0030	0.0016	0.0015	0.0017	0.0011	0.0008
PERCOLATION/LEAKAGE THROUGH LAYER 11						

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 12						
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 8						
AVERAGES	0.0026	0.0022	0.0040	0.0039	0.0026	0.0033
	0.0107	0.0110	0.0059	0.0056	0.0023	0.0022
STD. DEVIATIONS	0.0020	0.0014	0.0041	0.0032	0.0029	0.0030
	0.0101	0.0056	0.0052	0.0047	0.0020	0.0023
DAILY AVERAGE HEAD ON TOP OF LAYER 10						
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 2003 THROUGH 2007

	INCHES		CU. FEET	PERCENT
PRECIPITATION	57.11	(11.991)	207309.3	100.00
RUNOFF	7.553	(3.9183)	27415.83	13.225
EVAPOTRANSPIRATION	31.911	(4.9522)	115838.42	55.877
LATERAL DRAINAGE COLLECTED FROM LAYER 7	17.27271	(4.99903)	62699.918	30.24463
PERCOLATION/LEAKAGE THROUGH	0.04298	(0.00518)	156.005	0.07525

LAYER 8

AVERAGE HEAD ON TOP OF LAYER 8	0.005 (	0.001)		
LATERAL DRAINAGE COLLECTED FROM LAYER 9	0.04298 (	0.00518)	156.003	0.07525
PERCOLATION/LEAKAGE THROUGH LAYER 11	0.00000 (	0.00000)	0.001	0.00000
AVERAGE HEAD ON TOP OF LAYER 10	0.000 (	0.000)		
PERCOLATION/LEAKAGE THROUGH LAYER 12	0.00000 (	0.00000)	0.002	0.00000
CHANGE IN WATER STORAGE	0.330 (	1.6000)	1199.13	0.578

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PEAK DAILY VALUES FOR YEARS 2003 THROUGH 2007

	(INCHES)	(CU. FT.)
PRECIPITATION	6.00	21780.000
RUNOFF	3.667	13311.1494
DRAINAGE COLLECTED FROM LAYER 7	0.33976	1233.34265
PERCOLATION/LEAKAGE THROUGH LAYER 8	0.000388	1.40930
AVERAGE HEAD ON TOP OF LAYER 8	0.034	
MAXIMUM HEAD ON TOP OF LAYER 8	0.060	
LOCATION OF MAXIMUM HEAD IN LAYER 7 (DISTANCE FROM DRAIN)	0.0 FEET	
DRAINAGE COLLECTED FROM LAYER 9	0.00039	1.40929
PERCOLATION/LEAKAGE THROUGH LAYER 11	0.000000	0.00001
AVERAGE HEAD ON TOP OF LAYER 10	0.000	
MAXIMUM HEAD ON TOP OF LAYER 10	0.036	
LOCATION OF MAXIMUM HEAD IN LAYER 9 (DISTANCE FROM DRAIN)	0.0 FEET	
PERCOLATION/LEAKAGE THROUGH LAYER 12	0.000001	0.00433
SNOW WATER	0.00	0.0000

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.2528
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0424

*** 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 2007

LAYER	(INCHES)	(VOL/VOL)
1	0.7697	0.1283
2	8.6549	0.0721
3	8.7600	0.0730
4	8.7600	0.0730
5	4.3800	0.0730
6	8.8040	0.3668
7	0.0032	0.0117
8	0.0000	0.0000
9	0.0023	0.0100
10	0.0000	0.0000
11	0.1142	0.4570
12	3.1440	0.1310
SNOW WATER	0.000	

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**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**             HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                   **
**              DEVELOPED BY ENVIRONMENTAL LABORATORY                       **
**                USAE WATERWAYS EXPERIMENT STATION                         **
**          FOR USEPA RISK REDUCTION ENGINEERING LABORATORY                 **
**                                                                          **
**                                                                          **
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PRECIPITATION DATA FILE:     P:\HELP\CITRUS.D4
TEMPERATURE DATA FILE:       P:\HELP\CITRUS.D7
SOLAR RADIATION DATA FILE:   P:\HELP\CITRUS.D13
EVAPOTRANSPIRATION DATA:     P:\HELP\CITRUS.D11
SOIL AND DESIGN DATA FILE:   p:\HELP\CIT35ALT.D10
OUTPUT DATA FILE:            P:\HELP\CIT35ALT.OUT


TIME:  11: 9     DATE:   1/15/2009


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     TITLE:  Citrus County Alternate Procedure Request
     With GCL, Sand Sat. Hyd. Conductivity = 1x10-3cm/sec

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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     (6-inch daily cover)
                              --------

                TYPE 1 - VERTICAL PERCOLATION LAYER
                    MATERIAL TEXTURE NUMBER   5
          THICKNESS                    =      6.00   INCHES
          POROSITY                     =      0.4570  VOL/VOL
          FIELD CAPACITY               =      0.1310  VOL/VOL
          WILTING POINT                =      0.0580  VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.0554  VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.100000005000E-02 CM/SEC
        NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  1.80
```



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               FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.


                              LAYER  2     (10 ft waste)
                              --------

                TYPE 1 - VERTICAL PERCOLATION LAYER
                    MATERIAL TEXTURE NUMBER  19
          THICKNESS                    =    120.00   INCHES
          POROSITY                     =      0.1680  VOL/VOL
          FIELD CAPACITY               =      0.0730  VOL/VOL
          WILTING POINT                =      0.0190  VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.0713  VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.100000005000E-02 CM/SEC


                              LAYER  3     (10 ft waste)
                              --------

                TYPE 1 - VERTICAL PERCOLATION LAYER
                    MATERIAL TEXTURE NUMBER  19
          THICKNESS                    =    120.00   INCHES
          POROSITY                     =      0.1680  VOL/VOL
          FIELD CAPACITY               =      0.0730  VOL/VOL
          WILTING POINT                =      0.0190  VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.0730  VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.100000005000E-02 CM/SEC


                              LAYER  4     (10 ft waste)
                              --------

                TYPE 1 - VERTICAL PERCOLATION LAYER
                    MATERIAL TEXTURE NUMBER  19
          THICKNESS                    =    120.00   INCHES
          POROSITY                     =      0.1680  VOL/VOL
          FIELD CAPACITY               =      0.0730  VOL/VOL
          WILTING POINT                =      0.0190  VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.0730  VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.100000005000E-02 CM/SEC


                              LAYER  5     (5 ft waste)
                              --------

                TYPE 1 - VERTICAL PERCOLATION LAYER
                    MATERIAL TEXTURE NUMBER  19
          THICKNESS                    =     60.00   INCHES
          POROSITY                     =      0.1680  VOL/VOL
```

```
FIELD CAPACITY             =      0.0730 VOL/VOL
WILTING POINT              =      0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.0730 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC


                 LAYER  6    (24-inch drainage sand)
                 --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
             MATERIAL TEXTURE NUMBER   0
THICKNESS                  =     24.00    INCHES
POROSITY                   =      0.4730 VOL/VOL
FIELD CAPACITY             =      0.2220 VOL/VOL
WILTING POINT              =      0.1040 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.2449 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC


                 LAYER  7    (300-mil triplanar geocomposite)
                 --------

            TYPE 2 - LATERAL DRAINAGE LAYER
             MATERIAL TEXTURE NUMBER   0
THICKNESS                  =      0.27    INCHES
POROSITY                   =      0.8500 VOL/VOL
FIELD CAPACITY             =      0.0100 VOL/VOL
WILTING POINT              =      0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.0107 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =   8.00000000000      CM/SEC
SLOPE                      =     45.00    PERCENT
DRAINAGE LENGTH            =    140.0     FEET


                 LAYER  8    (60-mil HDPE geomembrane)
                 --------

            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        =      0.50    HOLES/ACRE
FML INSTALLATION DEFECTS   =      1.00    HOLES/ACRE
FML PLACEMENT QUALITY      =  5 - BAD
```



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                 LAYER  9    (250-mil biplanar geocomposite)
                 --------

            TYPE 2 - LATERAL DRAINAGE LAYER
             MATERIAL TEXTURE NUMBER   0
THICKNESS                  =      0.23    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.  =   2.50000000000      CM/SEC
SLOPE                      =     45.00    PERCENT
DRAINAGE LENGTH            =    140.0     FEET


                 LAYER 10    (60-mil HDPE geomembrane)
                 --------

            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        =      0.50    HOLES/ACRE
FML INSTALLATION DEFECTS   =      1.00    HOLES/ACRE
FML PLACEMENT QUALITY      =  3 - GOOD


                 LAYER 11    (GCL)
                 --------

             TYPE 3 - BARRIER SOIL LINER
             MATERIAL TEXTURE NUMBER   0
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.  =  0.499999997000E-08 CM/SEC


                 LAYER 12    (subbase)
                 --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
             MATERIAL TEXTURE NUMBER   0
THICKNESS                  =     24.00    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.         =  0.299999992000E-04 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 BARE GROUND CONDITIONS, A SURFACE SLOPE OF 45.% AND A SLOPE LENGTH OF 140. FEET.

```
SCS RUNOFF CURVE NUMBER             =    85.40
FRACTION OF AREA ALLOWING RUNOFF    =   100.0     PERCENT
AREA PROJECTED ON HORIZONTAL PLANE  =     1.000   ACRES
EVAPORATIVE ZONE DEPTH              =    10.0     INCHES
INITIAL WATER IN EVAPORATIVE ZONE   =     0.424   INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE  =     3.414   INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE  =     0.424   INCHES
INITIAL SNOW WATER                  =     0.000   INCHES
INITIAL WATER IN LAYER MATERIALS    =    40.006   INCHES
TOTAL INITIAL WATER                 =    40.006   INCHES
TOTAL SUBSURFACE INFLOW             =     0.00    INCHES/YEAR
```

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM TAMPA FLORIDA

```
STATION LATITUDE                          =  27.58 DEGREES
MAXIMUM LEAF AREA INDEX                   =   1.00
START OF GROWING SEASON (JULIAN DATE)     =      0
END OF GROWING SEASON (JULIAN DATE)       =    367
EVAPORATIVE ZONE DEPTH                    =  10.0  INCHES
AVERAGE ANNUAL WIND SPEED                 =   8.60 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY     =  74.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY     =  72.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY     =  78.00 %
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
2.94	3.26	2.35	0.68	1.38	8.20
13.13	8.40	20.26	1.27	0.70	3.15

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

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
59.80	60.80	66.20	71.60	77.10	80.90
82.20	82.20	80.90	74.50	66.70	61.30

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR TAMPA FLORIDA AND STATION LATITUDE = 27.58 DEGREES

WARNING: TEMPERATURE FOR YEAR 1 USED WITH PRECIPITATION FOR YEAR 2003

WARNING: SOLAR RADIATION FOR YEAR 1 USED WITH PRECIPITATION FOR YEAR 2003

WARNING: TEMPERATURE FOR YEAR 2 USED WITH PRECIPITATION FOR YEAR 2004

WARNING: SOLAR RADIATION FOR YEAR 2 USED WITH PRECIPITATION FOR YEAR 2004

WARNING: TEMPERATURE FOR YEAR 3 USED WITH PRECIPITATION FOR YEAR 2005

WARNING: SOLAR RADIATION FOR YEAR 3 USED WITH PRECIPITATION FOR YEAR 2005

WARNING: TEMPERATURE FOR YEAR 4 USED WITH PRECIPITATION FOR YEAR 2006

WARNING: SOLAR RADIATION FOR YEAR 4 USED WITH PRECIPITATION FOR YEAR 2006

WARNING: TEMPERATURE FOR YEAR 5 USED WITH PRECIPITATION FOR YEAR 2007

WARNING: SOLAR RADIATION FOR YEAR 5 USED WITH PRECIPITATION FOR YEAR 2007

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 2003 THROUGH 2007

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	1.73	3.58	3.16	2.50	3.25	10.36
	10.75	6.83	6.87	3.18	1.88	3.01
STD. DEVIATIONS	1.00	1.67	2.61	2.89	2.97	8.03
	2.46	1.27	7.65	3.23	1.54	1.29
RUNOFF						
TOTALS	0.080	0.257	0.277	0.253	0.275	2.154
	1.600	0.423	1.927	0.233	0.182	0.134
STD. DEVIATIONS	0.178	0.253	0.367	0.538	0.512	3.450
	0.842	0.329	3.919	0.519	0.403	0.096
EVAPOTRANSPIRATION						
TOTALS	1.183	1.627	1.841	1.295	1.408	4.060
	5.546	3.994	2.833	1.732	0.591	1.356
STD. DEVIATIONS	0.271	0.660	1.377	1.451	1.070	1.501
	0.752	0.565	1.030	1.221	0.301	0.759
LATERAL DRAINAGE COLLECTED FROM LAYER 7						
TOTALS	1.3244	0.8744	1.4660	1.2649	1.1334	1.6388
	4.1200	3.6762	2.0755	1.9971	0.8727	1.0012
STD. DEVIATIONS	0.7399	0.3639	1.5184	1.4900	0.9709	1.1960
	2.5594	1.6451	1.8325	1.7434	0.4824	1.0339
PERCOLATION/LEAKAGE THROUGH LAYER 8						
TOTALS	0.0174	0.0132	0.0177	0.0151	0.0153	0.0181
	0.0315	0.0306	0.0212	0.0210	0.0144	0.0142
STD. DEVIATIONS	0.0045	0.0029	0.0091	0.0103	0.0078	0.0071
	0.0109	0.0071	0.0086	0.0092	0.0040	0.0062
LATERAL DRAINAGE COLLECTED FROM LAYER 9						
TOTALS	0.0174	0.0132	0.0177	0.0151	0.0153	0.0181
	0.0315	0.0306	0.0212	0.0210	0.0144	0.0142
STD. DEVIATIONS	0.0045	0.0029	0.0091	0.0103	0.0078	0.0071
	0.0109	0.0071	0.0086	0.0092	0.0040	0.0062
PERCOLATION/LEAKAGE THROUGH LAYER 11						

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 12						
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 8						
AVERAGES	0.0004	0.0003	0.0004	0.0003	0.0003	0.0005
	0.0011	0.0010	0.0006	0.0005	0.0002	0.0003
STD. DEVIATIONS	0.0002	0.0001	0.0004	0.0004	0.0003	0.0003
	0.0007	0.0004	0.0005	0.0005	0.0001	0.0003
DAILY AVERAGE HEAD ON TOP OF LAYER 10						
AVERAGES	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000
	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 2003 THROUGH 2007

	INCHES		CU. FEET	PERCENT
PRECIPITATION	57.11	(11.991)	207309.3	100.00
RUNOFF	7.794	(4.1183)	28293.92	13.648
EVAPOTRANSPIRATION	27.467	(5.1535)	99704.72	48.095
LATERAL DRAINAGE COLLECTED FROM LAYER 7	21.44446	(4.91080)	77843.375	37.54939
PERCOLATION/LEAKAGE THROUGH	0.22968	(0.02992)	833.727	0.40217

LAYER 8

AVERAGE HEAD ON TOP OF LAYER 8	0.000 (	0.000)		
LATERAL DRAINAGE COLLECTED FROM LAYER 9	0.22968 (	0.02992)	833.726	0.40217
PERCOLATION/LEAKAGE THROUGH LAYER 11	0.00000 (	0.00000)	0.001	0.00000
AVERAGE HEAD ON TOP OF LAYER 10	0.000 (	0.000)		
PERCOLATION/LEAKAGE THROUGH LAYER 12	0.00000 (	0.00000)	0.001	0.00000
CHANGE IN WATER STORAGE	0.175 (	1.5648)	633.58	0.306

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PEAK DAILY VALUES FOR YEARS 2003 THROUGH 2007

	(INCHES)	(CU. FT.)
PRECIPITATION	6.00	21780.000
RUNOFF	3.474	12610.9023
DRAINAGE COLLECTED FROM LAYER 7	0.60253	2187.19092
PERCOLATION/LEAKAGE THROUGH LAYER 8	0.002510	9.11134
AVERAGE HEAD ON TOP OF LAYER 8	0.005	
MAXIMUM HEAD ON TOP OF LAYER 8	0.008	
LOCATION OF MAXIMUM HEAD IN LAYER 7 (DISTANCE FROM DRAIN)	0.0 FEET	
DRAINAGE COLLECTED FROM LAYER 9	0.00251	9.11133
PERCOLATION/LEAKAGE THROUGH LAYER 11	0.000000	0.00000
AVERAGE HEAD ON TOP OF LAYER 10	0.000	
MAXIMUM HEAD ON TOP OF LAYER 10	0.044	
LOCATION OF MAXIMUM HEAD IN LAYER 9 (DISTANCE FROM DRAIN)	0.0 FEET	
PERCOLATION/LEAKAGE THROUGH LAYER 12	0.000001	0.00433
SNOW WATER	0.00	0.0000

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.2435

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.0424

*** 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 2007

LAYER	(INCHES)	(VOL/VOL)
1	0.5340	0.0890
2	8.7356	0.0728
3	8.7600	0.0730
4	8.7600	0.0730
5	4.3800	0.0730
6	6.3725	0.2655
7	0.0032	0.0118
8	0.0000	0.0000
9	0.0023	0.0100
10	0.0000	0.0000
11	0.1875	0.7500
12	3.1440	0.1310
SNOW WATER	0.000	

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**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                 DEVELOPED BY ENVIRONMENTAL LABORATORY                    **
**                   USAE WATERWAYS EXPERIMENT STATION                      **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
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PRECIPITATION DATA FILE:      P:\HELP\CITRUS.D4
TEMPERATURE DATA FILE:        P:\HELP\CITRUS.D7
SOLAR RADIATION DATA FILE:    P:\HELP\CITRUS.D13
EVAPOTRANSPIRATION DATA:      P:\HELP\CITRUS.D11
SOIL AND DESIGN DATA FILE:    p:\HELP\CIT35ALT.D10
OUTPUT DATA FILE:             P:\HELP\CIT35ALT.OUT

TIME:  10:53      DATE:  10/28/2008

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TITLE: Citrus County Alternate Procedure Request
With GCL, Drainage Sand Hydr. Conductivity = 5.2×10^{-4} cm/sec

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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    (6-inch daily cover)
                          --------

              TYPE 1 - VERTICAL PERCOLATION LAYER
                   MATERIAL TEXTURE NUMBER   5
        THICKNESS                    =      6.00  INCHES
        POROSITY                     =      0.4570 VOL/VOL
        FIELD CAPACITY               =      0.1310 VOL/VOL
        WILTING POINT                =      0.0580 VOL/VOL
        INITIAL SOIL WATER CONTENT   =      0.0554 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    (10 ft waste)
                          --------

              TYPE 1 - VERTICAL PERCOLATION LAYER
                   MATERIAL TEXTURE NUMBER  19
        THICKNESS                    =    120.00  INCHES
        POROSITY                     =      0.1680 VOL/VOL
        FIELD CAPACITY               =      0.0730 VOL/VOL
        WILTING POINT                =      0.0190 VOL/VOL
        INITIAL SOIL WATER CONTENT   =      0.0713 VOL/VOL
        EFFECTIVE SAT. HYD. COND.    =  0.100000005000E-02 CM/SEC

                          LAYER  3    (10 ft waste)
                          --------

              TYPE 1 - VERTICAL PERCOLATION LAYER
                   MATERIAL TEXTURE NUMBER  19
        THICKNESS                    =    120.00  INCHES
        POROSITY                     =      0.1680 VOL/VOL
        FIELD CAPACITY               =      0.0730 VOL/VOL
        WILTING POINT                =      0.0190 VOL/VOL
        INITIAL SOIL WATER CONTENT   =      0.0730 VOL/VOL
        EFFECTIVE SAT. HYD. COND.    =  0.100000005000E-02 CM/SEC

                          LAYER  4    (10 ft waste)
                          --------

              TYPE 1 - VERTICAL PERCOLATION LAYER
                   MATERIAL TEXTURE NUMBER  19
        THICKNESS                    =    120.00  INCHES
        POROSITY                     =      0.1680 VOL/VOL
        FIELD CAPACITY               =      0.0730 VOL/VOL
        WILTING POINT                =      0.0190 VOL/VOL
        INITIAL SOIL WATER CONTENT   =      0.0730 VOL/VOL
        EFFECTIVE SAT. HYD. COND.    =  0.100000005000E-02 CM/SEC

                          LAYER  5    (5 ft waste)
                          --------

              TYPE 1 - VERTICAL PERCOLATION LAYER
                   MATERIAL TEXTURE NUMBER  19
        THICKNESS                    =     60.00  INCHES
        POROSITY                     =      0.1680 VOL/VOL
```

```
FIELD CAPACITY              =      0.0730 VOL/VOL
WILTING POINT               =      0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0730 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC


                      LAYER  6    (24-inch drainage sand)
                      --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
             MATERIAL TEXTURE NUMBER   7
THICKNESS                   =     24.00    INCHES
POROSITY                    =      0.4730 VOL/VOL
FIELD CAPACITY              =      0.2220 VOL/VOL
WILTING POINT               =      0.1040 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.2590 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.520000001000E-03 CM/SEC


                      LAYER  7    (300-mil triplanar geocomposite)
                      --------

          TYPE 2 - LATERAL DRAINAGE LAYER
             MATERIAL TEXTURE NUMBER   0
THICKNESS                   =      0.27    INCHES
POROSITY                    =      0.8500 VOL/VOL
FIELD CAPACITY              =      0.0100 VOL/VOL
WILTING POINT               =      0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0106 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =   8.00000000000      CM/SEC
SLOPE                       =     45.00    PERCENT
DRAINAGE LENGTH             =    140.0     FEET


                      LAYER  8    (60-mil HDPE geomembrane)
                      --------

          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         =      0.50    HOLES/ACRE
FML INSTALLATION DEFECTS    =      1.00    HOLES/ACRE
FML PLACEMENT QUALITY       =  5 - BAD
```



```
                      LAYER  9    (250-mil biplanar geocomposite)
                      --------

          TYPE 2 - LATERAL DRAINAGE LAYER
             MATERIAL TEXTURE NUMBER   0
THICKNESS                   =      0.23    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.   =   2.50000000000      CM/SEC
SLOPE                       =     45.00    PERCENT
DRAINAGE LENGTH             =    140.0     FEET


                      LAYER 10    (60-mil HDPE geomembrane)
                      --------

          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         =      0.50    HOLES/ACRE
FML INSTALLATION DEFECTS    =      1.00    HOLES/ACRE
FML PLACEMENT QUALITY       =  3 - GOOD


                      LAYER 11    (GCL)
                      --------

          TYPE 3 - BARRIER SOIL LINER
             MATERIAL TEXTURE NUMBER   0
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.   =  0.499999997000E-08 CM/SEC


                      LAYER 12    (sub-base)
                      --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
             MATERIAL TEXTURE NUMBER   0
THICKNESS                   =     24.00    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.         =  0.299999992000E-04 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 BARE
       GROUND CONDITIONS, A SURFACE SLOPE OF  4.% AND
       A SLOPE LENGTH OF  121. FEET.

SCS RUNOFF CURVE NUMBER                =    84.60
FRACTION OF AREA ALLOWING RUNOFF       =   100.0    PERCENT
AREA PROJECTED ON HORIZONTAL PLANE     =     1.000  ACRES
EVAPORATIVE ZONE DEPTH                 =    10.0    INCHES
INITIAL WATER IN EVAPORATIVE ZONE      =     0.424  INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE     =     3.414  INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE     =     0.424  INCHES
INITIAL SNOW WATER                     =     0.000  INCHES
INITIAL WATER IN LAYER MATERIALS       =    40.345  INCHES
TOTAL INITIAL WATER                    =    40.345  INCHES
TOTAL SUBSURFACE INFLOW                =     0.00   INCHES/YEAR
```

EVAPOTRANSPIRATION AND WEATHER DATA

```
NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
       TAMPA                FLORIDA

    STATION LATITUDE                          =  27.58 DEGREES
    MAXIMUM LEAF AREA INDEX                   =   1.00
    START OF GROWING SEASON (JULIAN DATE)     =     0
    END OF GROWING SEASON (JULIAN DATE)       =   367
    EVAPORATIVE ZONE DEPTH                    =  10.0  INCHES
    AVERAGE ANNUAL WIND SPEED                 =   8.60 MPH
    AVERAGE 1ST QUARTER RELATIVE HUMIDITY     =  74.00 %
    AVERAGE 2ND QUARTER RELATIVE HUMIDITY     =  72.00 %
    AVERAGE 3RD QUARTER RELATIVE HUMIDITY     =  78.00 %
    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
2.94	3.26	2.35	0.68	1.38	8.20
13.13	8.40	20.26	1.27	0.70	3.15

```
NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
       COEFFICIENTS FOR    TAMPA              FLORIDA
```

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
59.80	60.80	66.20	71.60	77.10	80.90
82.20	82.20	80.90	74.50	66.70	61.30

```
NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
       COEFFICIENTS FOR    TAMPA              FLORIDA
         AND STATION LATITUDE  =  27.58 DEGREES

WARNING:  TEMPERATURE FOR YEAR     1 USED WITH PRECIPITATION FOR YEAR 2003

WARNING:  SOLAR RADIATION FOR YEAR     1 USED WITH PRECIPITATION FOR YEAR 2003

WARNING:  TEMPERATURE FOR YEAR     2 USED WITH PRECIPITATION FOR YEAR 2004

WARNING:  SOLAR RADIATION FOR YEAR     2 USED WITH PRECIPITATION FOR YEAR 2004

WARNING:  TEMPERATURE FOR YEAR     3 USED WITH PRECIPITATION FOR YEAR 2005

WARNING:  SOLAR RADIATION FOR YEAR     3 USED WITH PRECIPITATION FOR YEAR 2005

WARNING:  TEMPERATURE FOR YEAR     4 USED WITH PRECIPITATION FOR YEAR 2006

WARNING:  SOLAR RADIATION FOR YEAR     4 USED WITH PRECIPITATION FOR YEAR 2006

WARNING:  TEMPERATURE FOR YEAR     5 USED WITH PRECIPITATION FOR YEAR 2007

WARNING:  SOLAR RADIATION FOR YEAR     5 USED WITH PRECIPITATION FOR YEAR 2007
```

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 2003 THROUGH 2007

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	1.73	3.58	3.16	2.50	3.25	10.36
	10.75	6.83	6.87	3.18	1.88	3.01
STD. DEVIATIONS	1.00	1.67	2.61	2.89	2.97	8.03
	2.46	1.27	7.65	3.23	1.54	1.29
RUNOFF						
TOTALS	0.071	0.225	0.271	0.227	0.233	2.026
	1.360	0.368	1.860	0.215	0.167	0.107
STD. DEVIATIONS	0.158	0.234	0.332	0.486	0.436	3.256
	0.881	0.321	3.756	0.481	0.371	0.073
EVAPOTRANSPIRATION						
TOTALS	1.303	1.663	1.788	1.318	1.437	4.160
	5.316	4.165	3.004	1.770	0.649	1.306
STD. DEVIATIONS	0.449	0.659	1.304	1.556	1.084	1.480
	0.790	0.703	0.950	1.214	0.464	0.813
LATERAL DRAINAGE COLLECTED FROM LAYER 7						
TOTALS	1.1924	0.8924	1.4767	1.3908	1.1121	1.6498
	4.3406	3.8660	2.0324	1.9203	0.8394	0.9333
STD. DEVIATIONS	0.4865	0.3185	1.3986	1.4312	0.9319	1.2912
	2.5911	1.8751	1.7168	1.6257	0.6508	1.0348
PERCOLATION/LEAKAGE THROUGH LAYER 8						
TOTALS	0.0169	0.0140	0.0180	0.0174	0.0154	0.0180
	0.0325	0.0317	0.0211	0.0206	0.0136	0.0136
STD. DEVIATIONS	0.0029	0.0024	0.0081	0.0078	0.0078	0.0074
	0.0105	0.0079	0.0080	0.0090	0.0063	0.0059
LATERAL DRAINAGE COLLECTED FROM LAYER 9						
TOTALS	0.0169	0.0140	0.0180	0.0174	0.0154	0.0180
	0.0325	0.0317	0.0211	0.0206	0.0136	0.0136
STD. DEVIATIONS	0.0029	0.0024	0.0081	0.0078	0.0078	0.0074
	0.0105	0.0079	0.0080	0.0090	0.0063	0.0059
PERCOLATION/LEAKAGE THROUGH LAYER 11						

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 12						
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 8						
AVERAGES	0.0003	0.0003	0.0004	0.0004	0.0003	0.0005
	0.0012	0.0010	0.0006	0.0005	0.0002	0.0002
STD. DEVIATIONS	0.0001	0.0001	0.0004	0.0004	0.0002	0.0004
	0.0007	0.0005	0.0005	0.0004	0.0002	0.0003
DAILY AVERAGE HEAD ON TOP OF LAYER 10						
AVERAGES	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
	0.0002	0.0002	0.0001	0.0001	0.0001	0.0001
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 2003 THROUGH 2007

	INCHES		CU. FEET	PERCENT
PRECIPITATION	57.11	(11.991)	207309.3	100.00
RUNOFF	7.129	(4.0139)	25879.55	12.484
EVAPOTRANSPIRATION	27.878	(4.8985)	101198.62	48.815
LATERAL DRAINAGE COLLECTED FROM LAYER 7	21.64618	(5.30189)	78575.648	37.90262
PERCOLATION/LEAKAGE THROUGH	0.23291	(0.02785)	845.466	0.40783

LAYER 8				
AVERAGE HEAD ON TOP OF LAYER 8	0.000 (	0.000)		
LATERAL DRAINAGE COLLECTED FROM LAYER 9	0.23291 (	0.02785)	845.466	0.40783
PERCOLATION/LEAKAGE THROUGH LAYER 11	0.00000 (	0.00000)	0.001	0.00000
AVERAGE HEAD ON TOP OF LAYER 10	0.000 (	0.000)		
PERCOLATION/LEAKAGE THROUGH LAYER 12	0.00000 (	0.00000)	0.001	0.00000
CHANGE IN WATER STORAGE	0.223 (	1.4310)	810.02	0.391

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****

PEAK DAILY VALUES FOR YEARS 2003 THROUGH 2007

	(INCHES)	(CU. FT.)
PRECIPITATION	6.00	21780.000
RUNOFF	3.403	12352.9492
DRAINAGE COLLECTED FROM LAYER 7	0.61036	2215.59985
PERCOLATION/LEAKAGE THROUGH LAYER 8	0.002526	9.17016
AVERAGE HEAD ON TOP OF LAYER 8	0.005	
MAXIMUM HEAD ON TOP OF LAYER 8	0.036	
LOCATION OF MAXIMUM HEAD IN LAYER 7 (DISTANCE FROM DRAIN)	0.0 FEET	
DRAINAGE COLLECTED FROM LAYER 9	0.00253	9.17016
PERCOLATION/LEAKAGE THROUGH LAYER 11	0.000000	0.00000
AVERAGE HEAD ON TOP OF LAYER 10	0.000	
MAXIMUM HEAD ON TOP OF LAYER 10	0.037	
LOCATION OF MAXIMUM HEAD IN LAYER 9 (DISTANCE FROM DRAIN)	0.0 FEET	
PERCOLATION/LEAKAGE THROUGH LAYER 12	0.000001	0.00433
SNOW WATER	0.00	0.0000

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.2445
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0424

*** 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 2007

LAYER	(INCHES)	(VOL/VOL)
1	0.5392	0.0899
2	8.7295	0.0727
3	8.7600	0.0730
4	8.7600	0.0730
5	4.3800	0.0730
6	6.9554	0.2898
7	0.0032	0.0118
8	0.0000	0.0000
9	0.0023	0.0100
10	0.0000	0.0000
11	0.1875	0.7500
12	3.1440	0.1310
SNOW WATER	0.000	

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              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:     P:\HELP\CITRUS.D4
TEMPERATURE DATA FILE:       P:\HELP\CITRUS.D7
SOLAR RADIATION DATA FILE:   P:\HELP\CITRUS.D13
EVAPOTRANSPIRATION DATA:     P:\HELP\CITRUS.D11
SOIL AND DESIGN DATA FILE:   p:\HELP\cit.D10
OUTPUT DATA FILE:            P:\HELP\cit.OUT


TIME:  11:18     DATE:   1/15/2009


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

     TITLE:  Citrus County Alternate Procedure Request
     With GCL, Sand Sat. Hyd. Conductivity = 1x10^-5 cm/sec

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


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


                            LAYER  1     (6-inch daily cover)
                            --------

                  TYPE 1 - VERTICAL PERCOLATION LAYER
                       MATERIAL TEXTURE NUMBER   5
           THICKNESS                  =      6.00    INCHES
           POROSITY                   =      0.4570 VOL/VOL
           FIELD CAPACITY             =      0.1310 VOL/VOL
           WILTING POINT              =      0.0580 VOL/VOL
           INITIAL SOIL WATER CONTENT =      0.0554 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     (10 ft waste)
                            --------

                  TYPE 1 - VERTICAL PERCOLATION LAYER
                       MATERIAL TEXTURE NUMBER  19
           THICKNESS                  =    120.00    INCHES
           POROSITY                   =      0.1680 VOL/VOL
           FIELD CAPACITY             =      0.0730 VOL/VOL
           WILTING POINT              =      0.0190 VOL/VOL
           INITIAL SOIL WATER CONTENT =      0.0713 VOL/VOL
           EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC


                            LAYER  3     (10 ft waste)
                            --------

                  TYPE 1 - VERTICAL PERCOLATION LAYER
                       MATERIAL TEXTURE NUMBER  19
           THICKNESS                  =    120.00    INCHES
           POROSITY                   =      0.1680 VOL/VOL
           FIELD CAPACITY             =      0.0730 VOL/VOL
           WILTING POINT              =      0.0190 VOL/VOL
           INITIAL SOIL WATER CONTENT =      0.0730 VOL/VOL
           EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC


                            LAYER  4     (10 ft waste)
                            --------

                  TYPE 1 - VERTICAL PERCOLATION LAYER
                       MATERIAL TEXTURE NUMBER  19
           THICKNESS                  =    120.00    INCHES
           POROSITY                   =      0.1680 VOL/VOL
           FIELD CAPACITY             =      0.0730 VOL/VOL
           WILTING POINT              =      0.0190 VOL/VOL
           INITIAL SOIL WATER CONTENT =      0.0730 VOL/VOL
           EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC


                            LAYER  5     (5 ft waste)
                            --------

                  TYPE 1 - VERTICAL PERCOLATION LAYER
                       MATERIAL TEXTURE NUMBER  19
           THICKNESS                  =     60.00    INCHES
           POROSITY                   =      0.1680 VOL/VOL
```

```
FIELD CAPACITY              =     0.0730 VOL/VOL
WILTING POINT               =     0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT  =     0.0730 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.100000005000E-02 CM/SEC


              LAYER  6    (24-in drainage sand)
              --------

       TYPE 1 - VERTICAL PERCOLATION LAYER
         MATERIAL TEXTURE NUMBER   0
THICKNESS                   =    24.00   INCHES
POROSITY                    =     0.4730 VOL/VOL
FIELD CAPACITY              =     0.2220 VOL/VOL
WILTING POINT               =     0.1040 VOL/VOL
INITIAL SOIL WATER CONTENT  =     0.3200 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =  0.999999975000E-05 CM/SEC


              LAYER  7    (300-mil triplanar geocomposite)
              --------

        TYPE 2 - LATERAL DRAINAGE LAYER
         MATERIAL TEXTURE NUMBER   0
THICKNESS                   =     0.27   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.   =   8.00000000000     CM/SEC
SLOPE                       =    45.00   PERCENT
DRAINAGE LENGTH             =   140.0    FEET


              LAYER  8    (60-mil HDPE geomembrane)
              --------

        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         =     0.50   HOLES/ACRE
FML INSTALLATION DEFECTS    =     1.00   HOLES/ACRE
FML PLACEMENT QUALITY       =  5 - BAD
```



```
              LAYER  9    (250-mil biplanar geocomposite)
              --------

        TYPE 2 - LATERAL DRAINAGE LAYER
         MATERIAL TEXTURE NUMBER   0
THICKNESS                   =     0.23   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.   =   2.50000000000     CM/SEC
SLOPE                       =    45.00   PERCENT
DRAINAGE LENGTH             =   140.0    FEET


              LAYER 10    (60-mil HDPE geomembrane)
              --------

        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         =     0.50   HOLES/ACRE
FML INSTALLATION DEFECTS    =     1.00   HOLES/ACRE
FML PLACEMENT QUALITY       =  3 - GOOD


              LAYER 11    (GCL)
              --------

         TYPE 3 - BARRIER SOIL LINER
         MATERIAL TEXTURE NUMBER   0
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.   =  0.499999997000E-08 CM/SEC


              LAYER 12    (subbase)
              --------

       TYPE 1 - VERTICAL PERCOLATION LAYER
         MATERIAL TEXTURE NUMBER   0
THICKNESS                   =    24.00   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.         =  0.299999992000E-04 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 BARE GROUND CONDITIONS, A SURFACE SLOPE OF 45.% AND A SLOPE LENGTH OF 140. FEET.

```
SCS RUNOFF CURVE NUMBER               =     85.40
FRACTION OF AREA ALLOWING RUNOFF      =    100.0     PERCENT
AREA PROJECTED ON HORIZONTAL PLANE    =      1.000   ACRES
EVAPORATIVE ZONE DEPTH                =     10.0     INCHES
INITIAL WATER IN EVAPORATIVE ZONE     =      0.424   INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE    =      3.414   INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE    =      0.424   INCHES
INITIAL SNOW WATER                    =      0.000   INCHES
INITIAL WATER IN LAYER MATERIALS      =     41.808   INCHES
TOTAL INITIAL WATER                   =     41.808   INCHES
TOTAL SUBSURFACE INFLOW               =      0.00    INCHES/YEAR
```

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM TAMPA FLORIDA

```
STATION LATITUDE                          =  27.58 DEGREES
MAXIMUM LEAF AREA INDEX                   =   1.00
START OF GROWING SEASON (JULIAN DATE)     =      0
END OF GROWING SEASON (JULIAN DATE)       =    367
EVAPORATIVE ZONE DEPTH                    =  10.0  INCHES
AVERAGE ANNUAL WIND SPEED                 =   8.60 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY     =  74.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY     =  72.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY     =  78.00 %
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
2.94	3.26	2.35	0.68	1.38	8.20
13.13	8.40	20.26	1.27	0.70	3.15

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

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
59.80	60.80	66.20	71.60	77.10	80.90
82.20	82.20	80.90	74.50	66.70	61.30

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR TAMPA FLORIDA AND STATION LATITUDE = 27.58 DEGREES

WARNING: TEMPERATURE FOR YEAR 1 USED WITH PRECIPITATION FOR YEAR 2003

WARNING: SOLAR RADIATION FOR YEAR 1 USED WITH PRECIPITATION FOR YEAR 2003

WARNING: TEMPERATURE FOR YEAR 2 USED WITH PRECIPITATION FOR YEAR 2004

WARNING: SOLAR RADIATION FOR YEAR 2 USED WITH PRECIPITATION FOR YEAR 2004

WARNING: TEMPERATURE FOR YEAR 3 USED WITH PRECIPITATION FOR YEAR 2005

WARNING: SOLAR RADIATION FOR YEAR 3 USED WITH PRECIPITATION FOR YEAR 2005

WARNING: TEMPERATURE FOR YEAR 4 USED WITH PRECIPITATION FOR YEAR 2006

WARNING: SOLAR RADIATION FOR YEAR 4 USED WITH PRECIPITATION FOR YEAR 2006

WARNING: TEMPERATURE FOR YEAR 5 USED WITH PRECIPITATION FOR YEAR 2007

WARNING: SOLAR RADIATION FOR YEAR 5 USED WITH PRECIPITATION FOR YEAR 2007

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 2003 THROUGH 2007

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	1.73	3.58	3.16	2.50	3.25	10.36
	10.75	6.83	6.87	3.18	1.88	3.01
STD. DEVIATIONS	1.00	1.67	2.61	2.89	2.97	8.03
	2.46	1.27	7.65	3.23	1.54	1.29
RUNOFF						
TOTALS	0.080	0.292	0.321	0.264	0.309	2.172
	1.694	0.457	2.006	0.327	0.206	0.159
STD. DEVIATIONS	0.178	0.265	0.406	0.561	0.554	3.394
	0.950	0.384	3.954	0.729	0.457	0.123
EVAPOTRANSPIRATION						
TOTALS	1.483	1.837	2.079	1.733	1.945	4.555
	5.815	4.687	3.195	2.028	1.027	1.506
STD. DEVIATIONS	0.514	0.859	1.365	1.539	0.848	1.446
	0.654	0.522	1.073	1.360	0.740	0.756
LATERAL DRAINAGE COLLECTED FROM LAYER 7						
TOTALS	0.7946	0.5875	1.2002	1.1052	0.7717	0.9267
	3.1531	3.3021	1.7161	1.6657	0.6929	0.6442
STD. DEVIATIONS	0.6095	0.3685	1.2537	0.8764	0.8472	0.8119
	3.0388	1.6617	1.5074	1.3804	0.5914	0.6555
PERCOLATION/LEAKAGE THROUGH LAYER 8						
TOTALS	0.0027	0.0023	0.0034	0.0032	0.0028	0.0028
	0.0054	0.0061	0.0042	0.0040	0.0028	0.0024
STD. DEVIATIONS	0.0014	0.0010	0.0016	0.0011	0.0013	0.0013
	0.0030	0.0016	0.0015	0.0016	0.0012	0.0008
LATERAL DRAINAGE COLLECTED FROM LAYER 9						
TOTALS	0.0027	0.0023	0.0034	0.0032	0.0028	0.0028
	0.0054	0.0061	0.0042	0.0040	0.0028	0.0024
STD. DEVIATIONS	0.0014	0.0010	0.0016	0.0011	0.0013	0.0013
	0.0030	0.0016	0.0015	0.0016	0.0012	0.0008
PERCOLATION/LEAKAGE THROUGH LAYER 11						

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 12						
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 8						
AVERAGES	0.0026	0.0021	0.0039	0.0037	0.0025	0.0031
	0.0101	0.0107	0.0057	0.0053	0.0023	0.0021
STD. DEVIATIONS	0.0020	0.0013	0.0040	0.0029	0.0027	0.0027
	0.0096	0.0053	0.0050	0.0044	0.0019	0.0021
DAILY AVERAGE HEAD ON TOP OF LAYER 10						
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 2003 THROUGH 2007

	INCHES	CU. FEET	PERCENT
PRECIPITATION	57.11 (11.991)	207309.3	100.00
RUNOFF	8.288 (4.1131)	30085.55	14.512
EVAPOTRANSPIRATION	31.892 (4.9588)	115767.18	55.843
LATERAL DRAINAGE COLLECTED FROM LAYER 7	16.56004 (4.77367)	60112.930	28.99674
PERCOLATION/LEAKAGE THROUGH	0.04213 (0.00511)	152.950	0.07378

LAYER 8

AVERAGE HEAD ON TOP OF LAYER 8	0.004 (	0.001)		
LATERAL DRAINAGE COLLECTED FROM LAYER 9	0.04213 (	0.00511)	152.949	0.07378
PERCOLATION/LEAKAGE THROUGH LAYER 11	0.00000 (	0.00000)	0.001	0.00000
AVERAGE HEAD ON TOP OF LAYER 10	0.000 (	0.000)		
PERCOLATION/LEAKAGE THROUGH LAYER 12	0.00000 (	0.00000)	0.001	0.00000
CHANGE IN WATER STORAGE	0.328 (	1.5699)	1190.67	0.574

****

****

PEAK DAILY VALUES FOR YEARS 2003 THROUGH 2007

	(INCHES)	(CU. FT.)
PRECIPITATION	6.00	21780.000
RUNOFF	3.687	13382.7529
DRAINAGE COLLECTED FROM LAYER 7	0.33976	1233.34265
PERCOLATION/LEAKAGE THROUGH LAYER 8	0.000388	1.40928
AVERAGE HEAD ON TOP OF LAYER 8	0.034	
MAXIMUM HEAD ON TOP OF LAYER 8	0.060	
LOCATION OF MAXIMUM HEAD IN LAYER 7 (DISTANCE FROM DRAIN)	0.0 FEET	
DRAINAGE COLLECTED FROM LAYER 9	0.00039	1.40928
PERCOLATION/LEAKAGE THROUGH LAYER 11	0.000000	0.00000
AVERAGE HEAD ON TOP OF LAYER 10	0.000	
MAXIMUM HEAD ON TOP OF LAYER 10	0.036	
LOCATION OF MAXIMUM HEAD IN LAYER 9 (DISTANCE FROM DRAIN)	0.0 FEET	
PERCOLATION/LEAKAGE THROUGH LAYER 12	0.000001	0.00433
SNOW WATER	0.00	0.0000
MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.2466	
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0424	

*** 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 2007

LAYER	(INCHES)	(VOL/VOL)
1	0.7711	0.1285
2	8.6584	0.0722
3	8.7600	0.0730
4	8.7600	0.0730
5	4.3800	0.0730
6	8.7810	0.3659
7	0.0035	0.0128
8	0.0000	0.0000
9	0.0023	0.0100
10	0.0000	0.0000
11	0.1875	0.7500
12	3.1440	0.1310
SNOW WATER	0.000	

REFERENCE NO. 6

SELECTION OF DENSITIES FOR USE IN LANDFILL DESIGN CALCULATIONS, DR. TIM TOWNSEND, NOVEMBER 8, 2004

Selection of Densities for Use in Landfill Design Calculations

Timothy G. Townsend, PhD, PE
Department of Environmental Engineering Sciences
University of Florida

November 8, 2004

1.0 Introduction

An estimate of the density of materials disposed in a landfill is necessary for several steps in the design of a municipal solid waste (MSW) landfill. These steps include, but are not limited to:

- Sizing and capacity calculations
- Foundation analysis
- Pipe sizing
- Geonet specification

Selection of an appropriate density is complicated by the fact that landfilled material densities vary as a function of the type of waste, degree of compaction, amount and type of cover soil used, moisture content, and degree of waste decomposition.

The purpose of this design memo is to provide guidance on the selection of densities to use in engineering design calculations for MSW landfills. Included are a fundamental concepts pertaining to density of materials in landfills, densities reported in the literature, and recommended densities for different landfill conditions.

2.0 Fundamental Concepts

2.1 Definition and Units.

The density (ρ) of a material is defined as the mass of the material (M) per unit volume of that material (V).

$$\rho = \frac{M}{V}$$

Several different densities may be referred to depending upon the application. For most soils and wastes, the term density in normally used to describe the "bulk density," which is the combined mass of the solids and the accompanying moisture per total volume of bulk material (including the air or void spaces within the material). In this memo, the bulk density will be defined as follows:

$$\rho_T = \frac{M_T}{V_T}$$

The density of MSW depends highly on compaction effort. MSW densities in a compactor truck are on the order of 500 – 700 pcy, while densities in a well-compacted modern landfill are typically reported in the range of 1,000 to 1,600 pcy.

4.0 Factors Impacting Density

In addition to the amount of cover soil used in a landfill, several other factors also impact the density of the landfilled waste and thus the overall density of the landfilled material. Four such factors are reviewed.

4.1 Compaction Effort

The compaction effort applied to the waste certainly impacts waste decomposition. The compaction effort applied to the waste depends upon the type of equipment used (weight of vehicle, cleat design) and the operating technique (e.g., number of passes). As an example, Figure 1 shows the reported density of MSW achieved using four different pieces of equipment as a function of the number of passes made.

4.2 Overburden Pressure

As the depth of landfilled waste becomes larger, the degree of overburden pressure applied to the lower lifts of waste becomes larger. When the stress resulting from the overburden pressure becomes larger than the stress caused by the initial compact effort, the waste density will increase. Although some research has been conducted on the relationship between overburden stress and density, available data are still limited. Figures 2 and 3 show the results of one such study on MSW from the United Kingdom (figure 2 shows dry density and figure 3 shows density at field capacity). These data were produced in large-scale compression cylinders. The lines presented in the graphs are best fit lines of waste density as a function of average effective stress (e.g., overburden pressure in unsaturated waste). Certainly there is a need to develop additional data of this nature; these data do provide the design engineer some ability to estimate waste density in deep landfills.

4.3 Moisture Content

Moisture content can impact waste density in several manners. First, the presence of water adds to the weight, and thus density, of the waste. The presence of water can also increase waste decomposition (see the next section for this impact). Changes in density can become important when evaluating landfill densities at landfills where water is purposefully added (e.g., bioreactor landfills). If one knows the dry density of waste, the wet density can be calculated as follows:

$$\rho_T = \frac{\rho_d}{1-MC}$$

where MC is the moisture content (mass of water per total (*wet*) mass of material). If one knows the total (wet) density of the material, and density that would occur at a new MC can be determined as follows:

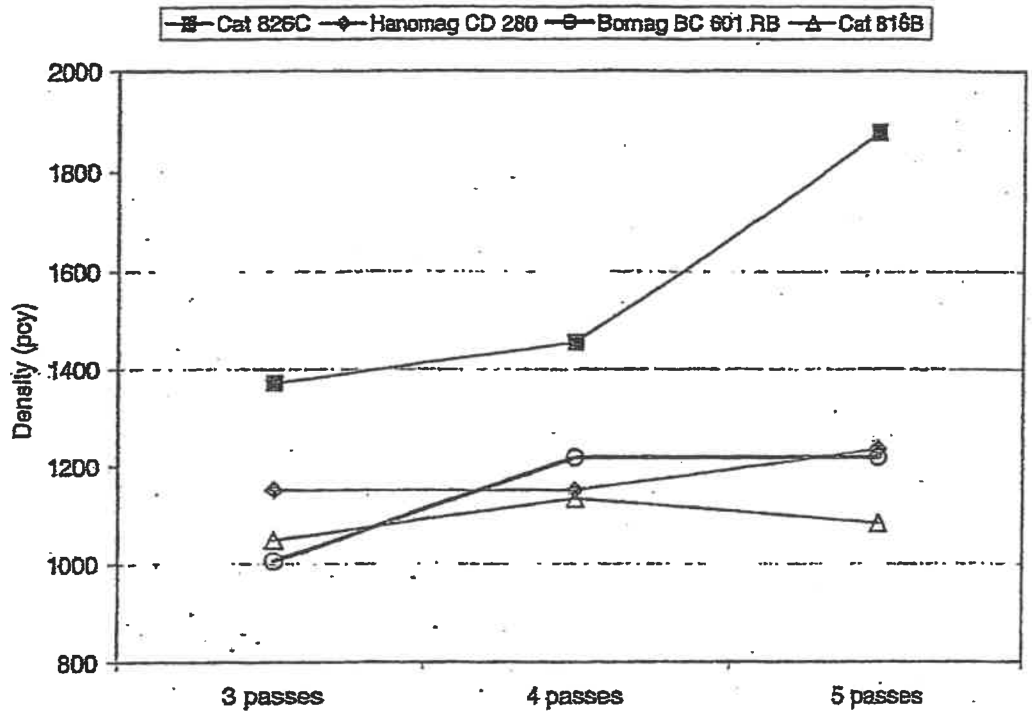


Figure 1. Example of Relationship Between Waste Density and Compaction Effort

Source: Cat 816B & 826C Compaction Study vs Hanomag CD280, Bomag 601 RB (1995). Caterpillar Product Information.

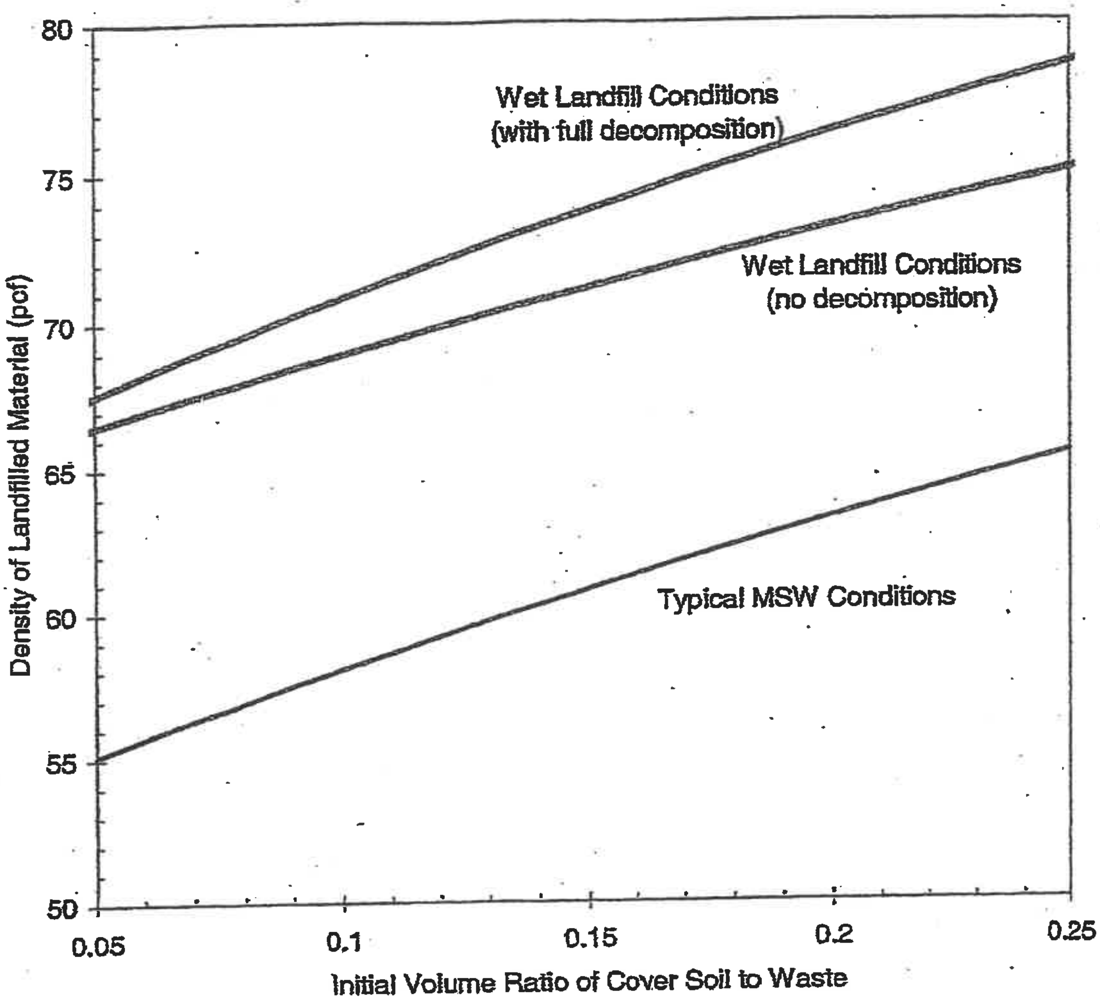


Figure 3. Density of Landfill Material as a Function of CC_V for Three Separate Conditions

I. Typical MSW Conditions

Waste: MC = 20%, $\rho_{T,waste}$ = 1,400 pcy, f_x = 1.0

Soil: $\rho_{T,soil}$ = 120 pcf

II. Wet Landfill Conditions (no decomposition)

Waste: Waste: MC = 35%, Initial $\rho_{T,waste}$ = 1,400 pcy, f_x = 1.0

Soil: $\rho_{T,soil}$ = 120 pcf (assume no change with added moisture)

III. Wet Landfill Conditions (no decomposition)

Waste: Waste: MC = 35%, Initial $\rho_{T,waste}$ = 1,400 pcy, f_x = 0.7

Soil: $\rho_{T,soil}$ = 120 pcf (assume no change with added moisture)

ATTACHMENT C

ANCHOR TRENCH CALCULATIONS

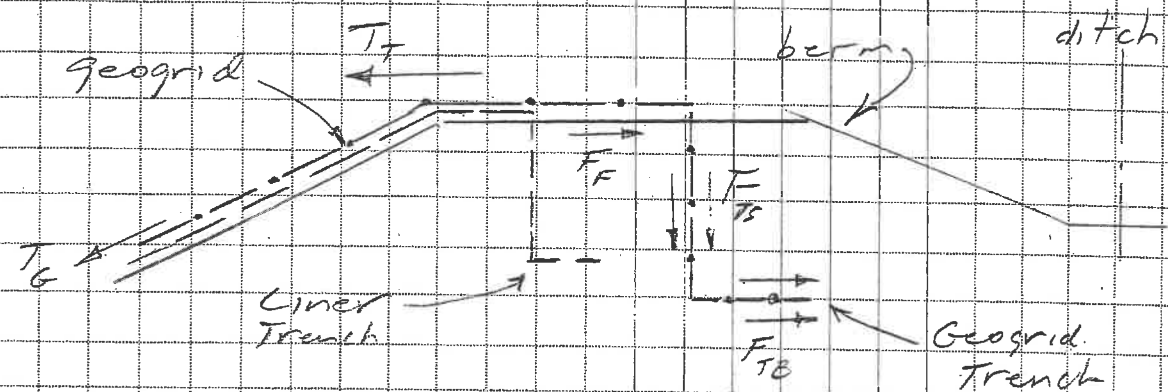
SCS ENGINEERS

SHEET 1 OF 5

CLIENT Citrus	PROJECT Phase 2 Cell	JOB NO. 09199056.02
SUBJECT Anchor Trench for Geogrid Reinforcing	BY BJC	DATE 1/14/03
	CHECKED JB	DATE 1/14/03

Determine necessary anchor trench configuration to hold geogrid reinforcement. (REF: Tensar Design Manual)

Typical Configuration



$T_T = T_G - F_F$

$T_T \leq F_{TS} + F_{TB}$

T_T = resulting force on trench

T_G = force acting on geogrid from waste, equipment, etc.

F_F = Overburden friction force on geogrid

F_{TS} = soil friction on geogrid along sides of trench

F_{TB} = soil friction on geogrid along bottom of trench

$$F_F = \gamma_{soil} Z_{soil} L_1 \tan\phi'_c + 2\left[\gamma_{soil} Z_{soil} L_2 \tan\phi'_f C_i\right]$$

γ_{soil} = unit weight cover soil

Z_{soil} = depth of soil cover

L_1 = length of geogrid over liner

L_2 = length of geogrid beyond liner trench

ϕ'_c = critical interface friction angle

SCS ENGINEERS

SHEET 2 OF 5

CLIENT	PROJECT	JOB NO.
CITRUS	PHASE 2 CELL	

SUBJECT	BY	DATE
ANCHOR TRENCH FOR GEOGRID	BJC	1/14/03
	CHECKED JB	DATE 1/14/03

ϕ'_f = friction angle of base soil = 25° conservative

C_i = soil / geogrid interaction coefficient (Tensar recommends 0.8)

- Friction force acts on both sides of the trench:

$$F_{ST} = 2\left[\gamma_{soil}\left(z_{soil} + \frac{d_{at}}{2}\right)(K_o \tan\phi'_f)(d_{at})(C_i)\right]$$

d_{at} = depth of anchor trench

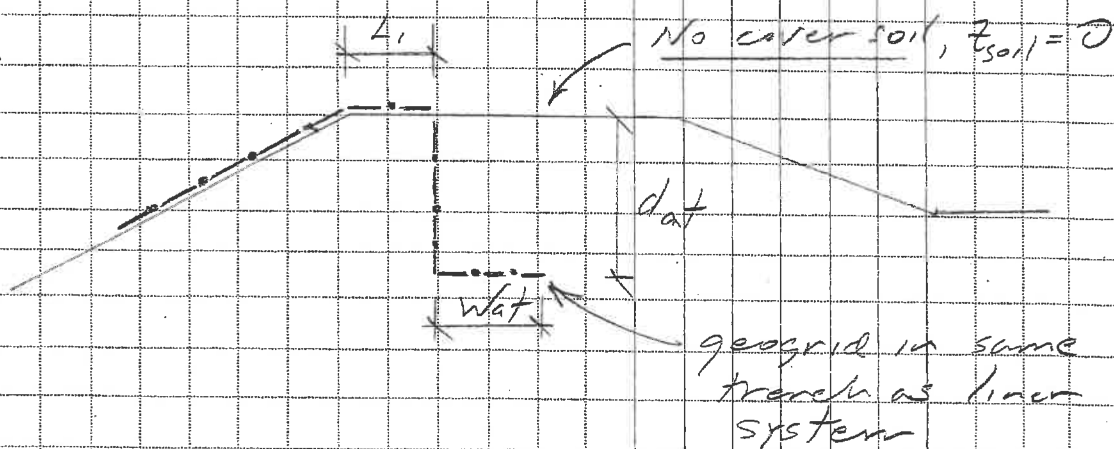
K_o = earth pressure coefficient $(1 - \sin\phi'_f)$

- Friction force at bottom of trench:

$$F_{TB} = 2\left[\gamma_{soil}(z_{soil} + d_{at})(W_{at})(\tan\phi'_f)(C_i)\right]$$

W_{at} = width of anchor trench

Assume $L_2 = 0$ $z_{soil} = 0$



CASE I:

Geogrid in same anchor trench as lining system

$L_1 = 3'$ $W_{at} = 2'$

$d_{at} = 4'$

SCS ENGINEERS

SHEET 3 OF 5

CLIENT: Citrus	PROJECT: Phase 2 Cell	JOB NO.
SUBJECT: Anchor Trench for Geogrid	BY: BJC DATE: 1/14/03	CHECKED: DATE:

If $Z_{soil} = 0$, then $F_F = 0$

$T_F = T_G$

$\therefore T_G \leq 2F_{TS} + 2F_{TB}$ (all of the geogrid pull-out force must be resisted by friction force in anchor trench)

$F_{TS} = 2[105(0 + \frac{4}{2})(1 - \sin 25^\circ)(\tan 25^\circ)(4)(0.8)]$

$= 2[105(2)(0.58)(0.47)(4)(0.8)]$

$= 2(183)$

$= \underline{366 \text{ lb./ft.}}$

$F_{TB} = 2[105(0 + 4)(2)(\tan 25^\circ)(0.8)]$

$= 2[105(4)(2)(0.47)(0.8)]$

$= 2(315)$

$= 632 \text{ lb/ft}$

$T_F = 3{,}400 \text{ lb/ft}$

$T_F > F_{ST} + F_{TB}$

$\therefore$ Must provide separate anchor trench for geogrid

SCS ENGINEERS

SHEET 4 OF 5

CLIENT	PROJECT	JOB NO.
CITRUS	PHASE 2 CELL	

SUBJECT	BY	DATE
ANCHOR TRENCH FOR GEOGRID	BJC	1/14/03
	CHECKED [initials]	DATE 1/14/03

CASE II

Geogrid is anchored in separate trench (see sheet 5).

$F_{TS} = 2[105(0 + 5/2)(1-\sin 25^\circ)(\tan 25^\circ)(5)(0.8)]$

$= 2[105(2.5)(0.58)(0.47)(5)(0.8)]$

$= 2[286]$

$= \underline{572 \text{ lb/ft.}}$

$F_{TB} = 2[105(0+5)(10)(\tan 25^\circ)(0.8)]$

$= 2[1{,}974]$

$= \underline{3{,}948 \text{ lb/ft.}}$

$F_{TS} + F_{TB} = 572 + 3948 = \underline{4{,}520 \text{ lb/ft.}}$

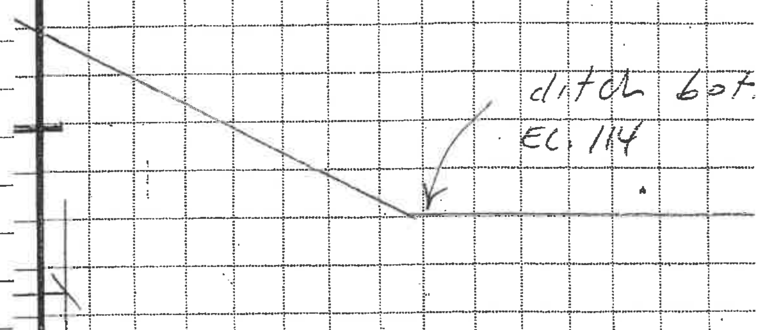
$\therefore T_T = 3{,}400 \text{ lb/ft} < F_{TS} + F_{TB}$ $\underline{\text{o.k.}}$

$FS = \frac{4{,}520}{3{,}400} = \underline{1.33}$ $\underline{\text{o.k.}}$

SHEET 5 OF 5

B. CLARK 1/14/03

[signature] 1/14/03



REFERENCE MATERIAL

DESIGN CONCERNS AND PERFORMANCE OF GEOMEMBRANE ANCHOR TRENCHES, HULLINGS AND SANSONE

DESIGN CONCERNS AND PERFORMANCE OF GEOMEMBRANE ANCHOR TRENCHES

Donald E. Hullings
EMCON

Leonard J. Sansone
EMCON

Proceedings of the GRI-10 Conference on
"Field Performance of Geosynthetics
and Geosynthetic Related Systems"
R.M. Koerner, G.R. Koerner, & Y.G. Hsuan, Eds.
GII Publications, Philadelphia, PA USA 1997

ABSTRACT

The main purpose of the anchor trench is to secure geosynthetics at the top of slopes. As such, the tendency for most designers is to firmly secure the geosynthetics so that movement or pullout does not occur. However, the basic design consideration should be extended to allow pull-out of the geosynthetics from the anchor trench rather than have the geomembrane tear if excess stresses are developed. The emphasis should be placed not on the construction condition, where potential problems may be easily remedied, but on the long-term performance where liner problems may have a greater impact. A realistic design procedure is therefore needed to determine the resistance provided by the anchor trench to check the potential stresses that can be resisted while confirming that the allowable tensile strengths of the geosynthetics are not exceeded.

Following a review of anchor trench designs and methodologies, case studies will be presented to show anchor trenches that have been demonstrated to work. Perhaps more importantly, cases where problems have occurred as a result of poorly designed or constructed anchor trenches will also be presented.

LINER DESIGN

The emphasis of this paper is on anchor trench designs for geomembranes, specifically high density polyethylene (HDPE) geomembrane. In addition to chemical resistance, proper seaming, and other aspects required to assure a relatively impermeable barrier, the basic premise for geomembrane liner design should be to have a relatively "stress-free" material. The ideal "stress-free" geomembrane could not fail, but in actual applications stresses are imposed on the geomembrane along interior sideslopes. Stresses imposed during construction or in exposed applications include self-weight, wind, and contractions due to temperature variation. The anchor trench should be designed to resist these loads either alone or together with sandbags or other restraints. The designer should keep in mind that the anchor trench resistance should not exceed the allowable stress.

In landfill designs, the geomembrane is eventually (preferably quickly) covered. Sideslope systems may consist simply of a layer of operations layer soil but may also include protective geotextiles, drainage geonets, or multiple soil layers. These upper layers, along with settlement of the refuse, may result in downdrag stresses on the geomembrane. By limiting the interface strength above the liner to that of the underside of the geomembrane, the geomembrane will ideally be stress-free. Potential stresses from the weight of the cover soil, potential seepage forces, and downdrag due to waste settlement would not transfer stress into the geomembrane. Such a design strategy is discussed by Von Pein and Prasad (1990), and design methods are discussed more completely by others (Richardson and Koerner, 1987; Druschel and Underwood, 1993; Koerner, 1993; Sharma and Lewis, 1994). Overall slope stability conditions often do not allow low interface strengths, so the interface strengths above the geomembrane cannot be much lower than the interface strength on the underside of the geomembrane. The designer should also consider that variations in interface friction, localized stress concentrations, geomembrane imperfections, and other factors may still result in stresses being imposed on the liner.

TYPES

Different types of anchor trenches may be used depending on required anchorage resistance, available space, access, and available construction equipment (Figure 1). The "workhorse" of the industry is a rectangular trench (typically 0.5 to 0.7 meters wide and a maximum of 1 meter deep) with some runout length. This particular design can result in significant pull-out resistance, does not require a lot of room, and can be constructed with a small backhoe. The trench shown in Figure 1a is recommended, but trenches with the geomembrane run out along the bottom of the trench have also been constructed. A simpler design is the run-out (which is not actually a "trench") that generally requires a large run-out length to produce significant pull-out resistance (Figure 1b). Somewhere between is the V-trench design (Figure 1c). To terminate geomembranes along sideslopes or in confined areas, a narrow trench may be used with "self-compacting" and erosion resistant backfill, often containing cement or bentonite (Figure 1d). Bolted or concreted anchors are usually not recommended but have been used, especially in surface impoundments.

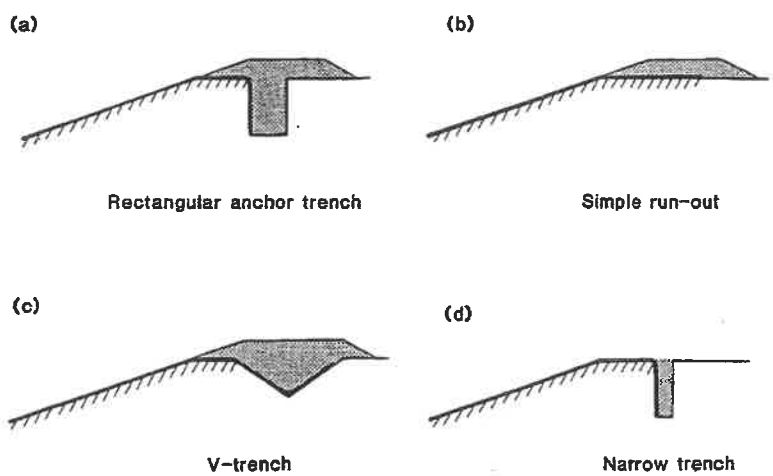


Figure 1. Anchor trench designs

DESIGN EQUATIONS

Run-out. Calculating the anchor trench resistance (T_A) is most straight forward for a simple run-out design. As depicted in Figure 2a, T_A is equal to the weight of the overlying soil multiplied by the tangent of the interface friction angle of the geomembrane. Because the overlying soil may crack and the soil move along with the geomembrane, T_A may be calculated considering only the resistance on the underside of the geomembrane.

$$T_A = L \cdot H \cdot \gamma_{soil} \cdot (\tan \delta_L) \qquad (1)$$

V-trench. Although not ideal, a similar method, as shown in Figure 2b, is used to calculate T_A for a V-trench:

$$T_A = L \cdot H \cdot \gamma_{soil} \cdot (\tan \delta_L) + \left[L_2 \cdot H_1 + \frac{L_2 \cdot D}{2} \right] \cdot \gamma_{soil} \cdot \{ (\tan \delta_L + \tan \delta_U) \} \qquad (2a)$$

The above equation assumes that the soil block remains in place over the V-trench portion so that the friction both above and below the geomembrane is included. Assuming the soil block moves, the upper friction cannot be included but the resistane of the soil is added

$$T_A = L \cdot H \cdot \gamma_{soil} \cdot (\tan \delta_L) + \left[L_2 \cdot H_1 + \frac{L_2 \cdot D}{2} \right] \cdot \gamma_{soil} \cdot \{ \cos\alpha \cdot \tan \delta_L + \sin\alpha \} \qquad (2b)$$

The resistance provided by the V-trench is the lesser of Equation 2a and 2b.

Rectangular trench. A less ideal solution exists for calculating the anchor trench resistance of a rectangular trench. A frictionless pulley assumption is used for estimating resistance, as detailed by Koerner (1995). Calculations are summarized in Figure 2c.

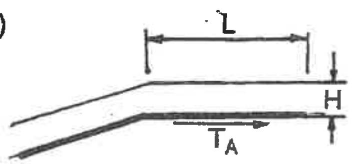
$$T_A = (L \cdot H \cdot \gamma_{soil} \cdot \tan\delta_L) + \left[(1 - \sin\phi) \cdot \gamma_{soil} \cdot \left(H + \frac{D}{2} \right) \right] \cdot (\tan\delta_L + \tan\delta_U) \cdot D + [X \cdot (H + D) \cdot \gamma_{soil} \cdot (\tan\delta_L + \tan\delta_U)] \qquad (3)$$

The frictionless pulley assumption is certainly stretched to include the bottom portion. This is an extension of equations put forth by Koerner (1993) and has not been validated. Also of some question is the use of (1-sinϕ) for K_o. If the backfill is compacted, K_o values could be significantly higher (Sherif, et al., 1984).

In addition to the above stress-based analyses, strain compatibility may also be considered. Geomembrane that exceeds the anchor trench resistance may not pull out, but may slip within the anchor trench. This slippage is not a particular concern and is actually desirable over tearing or pull-out. However, such detailed analyses of stress-strain compatibility requires more sophisticated methods.

It is preferable that the geomembrane slip or pull out of the anchor trench rather than tear (EPA, Sharma and Lewis, Koerner). A geomembrane that slips within in the anchor trench would

(a)



$T_A = W (\tan \delta_L)$

$W = L \cdot H \cdot \gamma_{soil}$

T_A = anchorage resistance

W = weight of soil

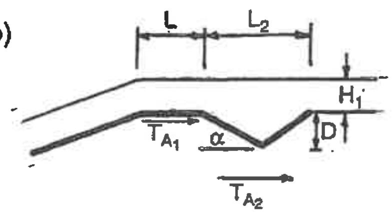
L = length

H = height

γ_{soil} = unit weight of soil

δ_L = interface friction angle lower side of geomembrane

(b)



$T_A = T_{A_1} + T_{A_2}$

$T_{A_1} = L \cdot H \cdot \gamma_{soil} (\tan \delta_L)$ *(from (a))*

Soil block moves:

$T_{A_2} = W \cos\alpha \tan\delta_L + W \sin\alpha$

$$W = \left(L_2 \cdot H_1 + L_2 \cdot \frac{D}{2}\right) \cdot \gamma_{soil}$$

$$T_{A_2} = \left[L_2 H_1 + \frac{L_2 \cdot D}{2}\right] \gamma_{soil} \{\cos\alpha \cdot \tan\delta_L + \sin\alpha\}$$

or

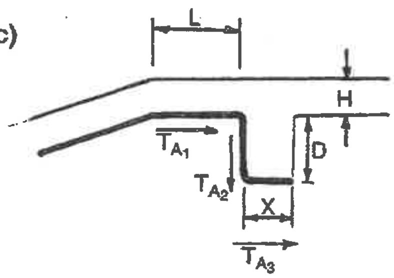
Soil block doesn't move:

$T_{A_2} = W (\tan \delta_L + \tan \delta_U)$

$$T_{A_2} = \left[L_2 H_1 + \frac{L_2 \cdot D}{2}\right] \gamma_{soil} (\tan\delta_L + \tan\delta_u)$$

δ_U = interface friction angle upper side of geomembrane

(c)



$T_A = T_{A_1} + T_{A_2} + T_{A_3}$

$T_{A_1} = L \cdot H \cdot \gamma_{soil} \cdot \tan \delta_L$ *(from (a))*

$T_{A_2} = (\sigma_{h_{avg}}) (\tan \delta_L + \tan \delta_U) \cdot D$

$\sigma_{h_{avg}} = K_O \cdot \gamma_{soil} \cdot H_{avg}$

$K_O = 1 \cdot \sin\phi$ *(estimate)*

$H_{avg} = H + \frac{D}{2}$ *(estimate)*

ϕ = friction angle of backfill

$$T_{A_2} = \left[(1 - \sin\phi)\gamma_{soil}\left(H + \frac{D}{2}\right)\right] (\tan\delta_L + \tan\delta_U) \cdot D$$

$T_{A_3} = X \cdot (H + D) \cdot \gamma_{soil} (\tan \delta_L + \tan \delta_U)$ *(similar to (a))*

Figure 2 - Various calculations used to develop design equations

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probably go unnoticed and is not a concern. A geomembrane that pulls out may be placed back in the anchor trench, or, at worst, repairs may be required at the top of the slope such as adding a strip of geomembrane. Tearing requires repairs that may not be isolated at the top of slopes. The difference may best be explained by a landfill operator who defined a failure as something he could not fix himself.

Parameters. The most significant parameters in the anchor resistance calculations are the interface shear strengths. Other parameters, such as soil density and geometric parameters, can be measured or estimated with some accuracy and controlled. Interface shear strengths, however, can vary greatly, from as little as 5 degrees for smooth geomembrane against clay to above 30 degrees for textured geomembrane and coarse soils (Sharma and Lewis, 1994). A detailed discussion on interface shear strengths is certainly beyond the scope of this paper, but the designer should consider the following regarding interface shear strengths:

- Testing should be conducted under low normal loads (generally no more than 24 kPa). Friction angle values used for the slope stability analyses may not be applicable to anchor trench design, because of different conditions (interfaces, normal loads, compaction, etc.)

- Actual backfill material type and degree of compaction may vary from test conditions.

- Strengths should be measured for both peak and post-peak strengths to give a range of potentially strengths. Under low overburdens peak and post-peak strengths for general backfill material probably do not differ very much.

Along with the parameters required in the anchor resistance calculations, an accurate measure of the tensile strength of the geomembrane is also required. Typical strengths for 1.5 mm-thick HDPE geomembrane are on the order of 25 to 30 kN/m. When determining allowable tensile stresses in the geomembrane, the designer should consider yield stresses from wide width tests (ASTM D 4885) as opposed to smaller strip tests (ASTM D 638). An adequate factor of safety that accounts for installation damage, seams, creep, degradation, etc., should also be applied (Koerner, 1993; Berg and Bonaparte, 1993). Factors of safety against geomembrane failure should be kept relatively low (about 1.5) because an overly conservative factor of safety may result in low anchor trench resistance that may result in pull-outs that were preventable.

The anchor trench resistance (T_A) for various typical anchor designs was calculated and plotted in Figure 3. For simplicity, the anchor trenches are for a geomembrane with only one interface strength assumed on both sides. For lower interface strengths, the resistance is well below the yield strength of the geomembrane. For larger anchorages and higher interface strengths associated with textured geomembranes under low normal loads, the anchorage resistance can exceed the yield strength of the geomembrane.

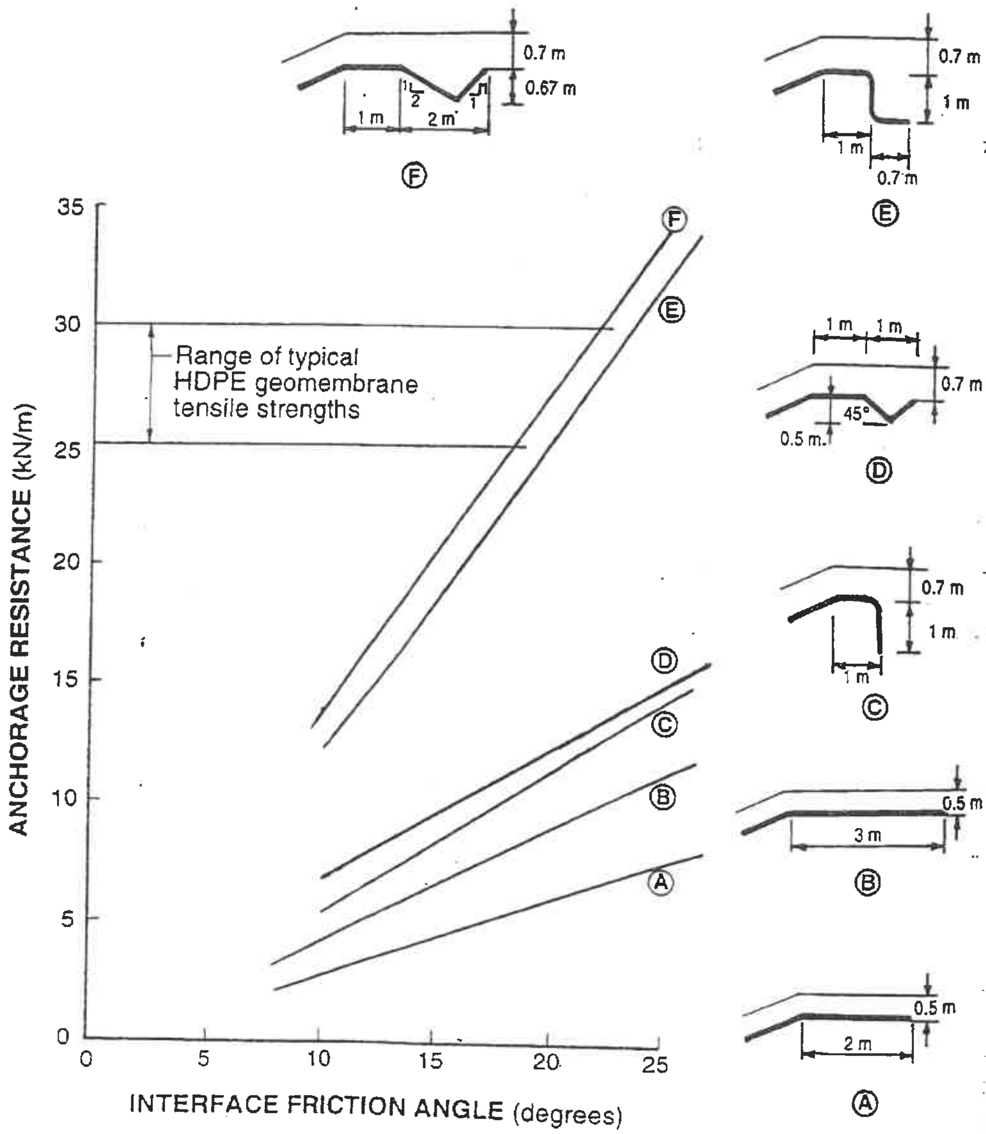

Figure 3 - Typical anchor trench resistance of various designs

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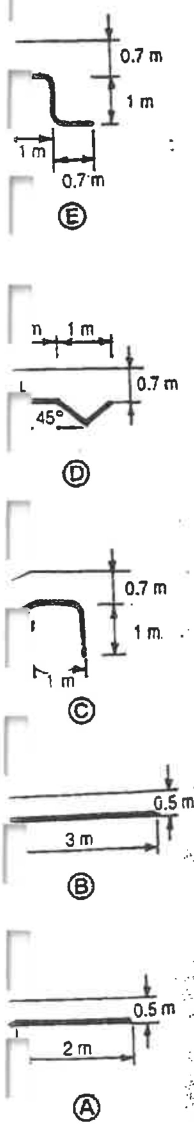

CASE STUDIES

The author is aware of few problems associated with anchor trenches, but the following examples highlight different types of anchors, how design concepts are applied, and a few things that *can* go wrong. Probable causes of problems and potential preventative measures are discussed.

Site A. Canyon sites are often complicated and require consideration of many details including anchor trenches. One such site in California has used different kinds of anchor trenches to successfully retain geomembrane. The typical rectangular anchor trench has been used and is shown in Figure 4 after backfilling.

Figure 4 - Typical anchor trench after backfilling

Simple run-out anchors with small termination trenches have also been used as temporary terminations on benches. Since the landfill in this case is still expanding vertically up the canyon slopes, the run-outs often serve as tie-ins in later expansions. The runout is covered with plywood and geotextile before being covered with soil to protect the geomembrane surface. Seaming near the crest is avoided minimizing the impact of stresses that may concentrate at the top of the slope. The anchor trench run-out is partially uncovered for future seaming and in some cases the geomembrane is actually cut at the trench to relieve potential stresses.

Temporary terminations along sideslopes have employed narrow trenches (Figure 5). In these cases, the geomembrane is not subject to downdrag forces but still must be anchored against windloads. Steep sideslopes do not allow the protective operations soil layer to be placed immediately, but rather in stages as the refuse is placed. The geomembrane is exposed for a few months without the benefit of soil cover. To resist windloads, numerous sand bags would be required. Using the sideslope trench helps resist windloads and prevents surface water from flowing below the liner. Typical soils would be difficult to compact in a narrow trench and would be susceptible to erosion. Soil mixed with bentonite or cement (Figure 5) has been shown to be easily compacted (essentially self-compacting) and resistant to erosion. Where space is tight, such as along existing roads as shown in Figure 6, narrow trenches have also been used at the top of slopes. This particular site has shown that a number of different anchor systems can be used successfully depending on site parameters.

Site B. At this site, conditions allowed the use of a large run-out length instead of an anchor trench. The geomembrane, 1.5 mm-thick HDPE, was simply extended approximately 3 meters beyond the crest of the slope and covered with about 0.5 meter of soil. In this particular design, the geomembrane was covered with a protective nonwoven needle-punched geotextile, which was also extended past the crest and covered. The geotextile protected the geomembrane while the sideslope was exposed and provided a slip plane to handle potential stresses. Assuming an interface friction angle of 10 degrees between the geotextile and geomembrane, this run-out anchor should have provided 4,300 N/m of anchorage resistance for the geotextile. With an interface friction angle of 15 degrees between the geomembrane and soil, the anchorage resistance for the geomembrane should have been 6,500 N/m.

During the wet winter months, the run-out area became an unofficial and unwanted field test for geosynthetic reinforcement of soft soils. Landfill traffic quickly found that it was easier to ride near the edge of the landfill (above the geosynthetics) than over the muddy road. There was some doubt if the full 0.5 meter of cover was constructed as designed, but there was no doubt that whatever soil was constructed was quickly worn away (Figure 7). Without the overlying soil, a small amount of stress on the geotextile resulted in the geotextile pulling out and sliding down slope (Figure 8). The geotextile functioned as intended in protecting the geomembrane, which remained in place, but pulled out at loads much lower than anticipated. While the simple run-out may still be a viable solution for some situations, the cover soil must be maintained for it to function properly.

Site C. The surface impoundment for Site C was constructed using an HDPE geomembrane. Soil placement over the geomembrane resulted in stresses being applied to the geomembrane (Figure 9). The particular placement method employed at this site, i.e., gravel being dumped on

Figure 5 - Sideslope anchor trench

Figure 6 - Narrow anchor trench

Figure 7 - Run-out anchorage with minimal cover

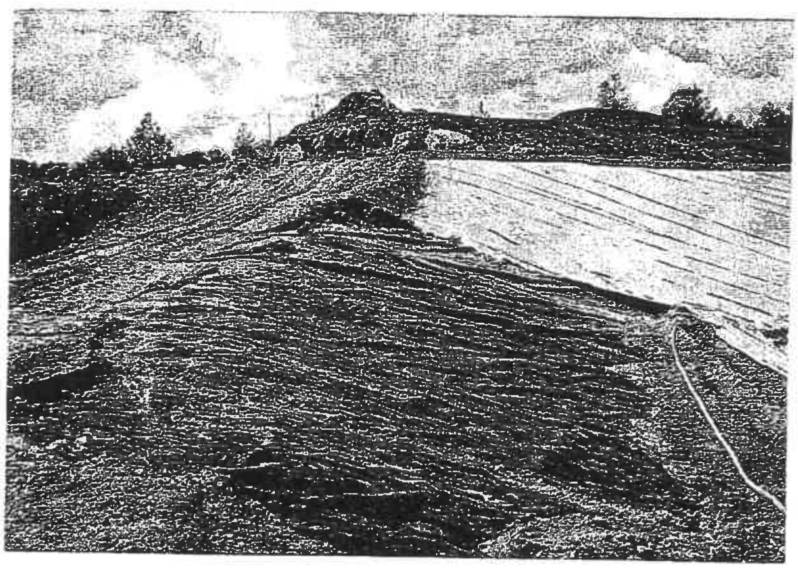

Figure 8 - Geotextile slide due to improper anchorage

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the geomembrane, is certainly not recommended. In addition to the gravel weight, dynamic loads may have added to the geomembrane stresses.

The anchorage design for this site was not really tested, however, since the anchor trenches were not backfilled (Figure 10). The conclusion here is obvious; backfilling is required to mobilize the design anchorage resistance.

Site D. At this particular landfill, stresses at the top of the sideslope resulted in tearing in the geomembrane. The geomembrane was already covered with soil and refuse. It has been summized that the stress was the result of downdrag forces resulting from movement in the refuse mass. While this imposed stress was a concern, the more important concern for the purposes of this paper is the tearing of the geomembrane instead of the geomembrane being pulled out of the anchor trench.

The anchor trench was a 1-meter-deep, 0.67-meter-wide (3-ft by 2-ft) rectangular trench with 300 mm (1 ft) of soil cover above the top of the trench. The estimated resistance (using Equation 3) was 20 kN/m using interface strength data and densities for material obtained from the site. The interface strength for the smooth geomembrane against silty sand ranged from 22 to 24 degrees under low overburden pressures. Field observations indicated that the actual cover soil may have exceeded 300 mm (1 ft). Using 600 mm (2 ft) of soil the estimated anchor trench resistance is 27 kN/m.

Tensile strength testing was conducted on geomembrane retrieved from the site. The actual tensile strength ranged from 19 to 24 MPa depending on the type of test. A calculation of critical stress according to Griffith theory yielded a value of 18 MPa necessary to begin crack propagation. This is a minimum value of about 27 KN/m, which is nearly equal to the maximum anchor resistance of 27 kN/m..

Figures 11 and 12 show the tearing of the geomembrane near the anchor trench. The anchorage strength has exceeded the strength of the geomembrane, otherwise the geomembrane would have pulled-out. It is possible that the anchor trench resistance was greater than anticipated, because either the soil cover was too thick or the methodology underpredicts the resistance. If the anchor trench resistance was too high, however, more tearing would be predicted, and none was seen during examination of other locations.

The tearing is more likely due to isolated stress concentrations and geomembrane imperfections. A careful examination of exhumed geomembrane indicated that a small scratch or crack could have initiated the tear. Tearing occured along a seamed patch, which probably contributed to stress concentrations and potential cracking.

The "failure" at Site D was much less dramatic than pull-out problems discussed in previous case studies, but because refuse was in place the potential impacts at Site D were far greater.

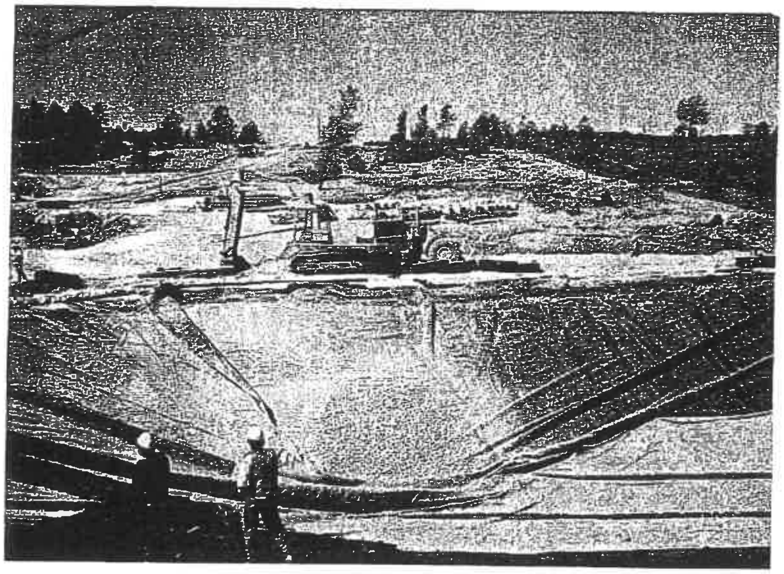

Figure 9 - Geomembrane pull-out during gravel placement

Figure 10 - Anchor trench without backfill

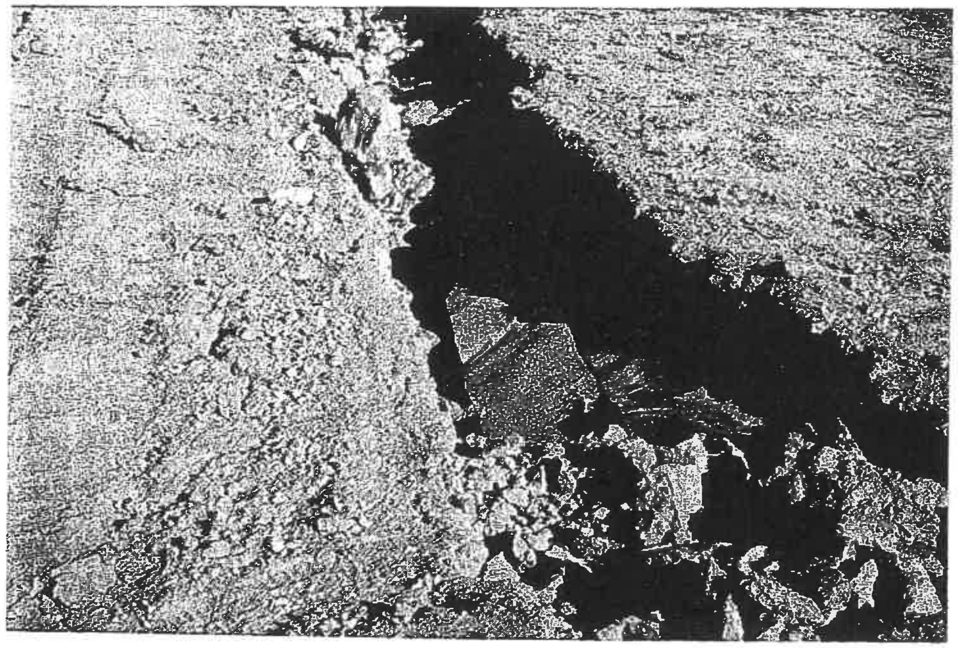

Figure 11 - Geomembrane tear at anchor trench

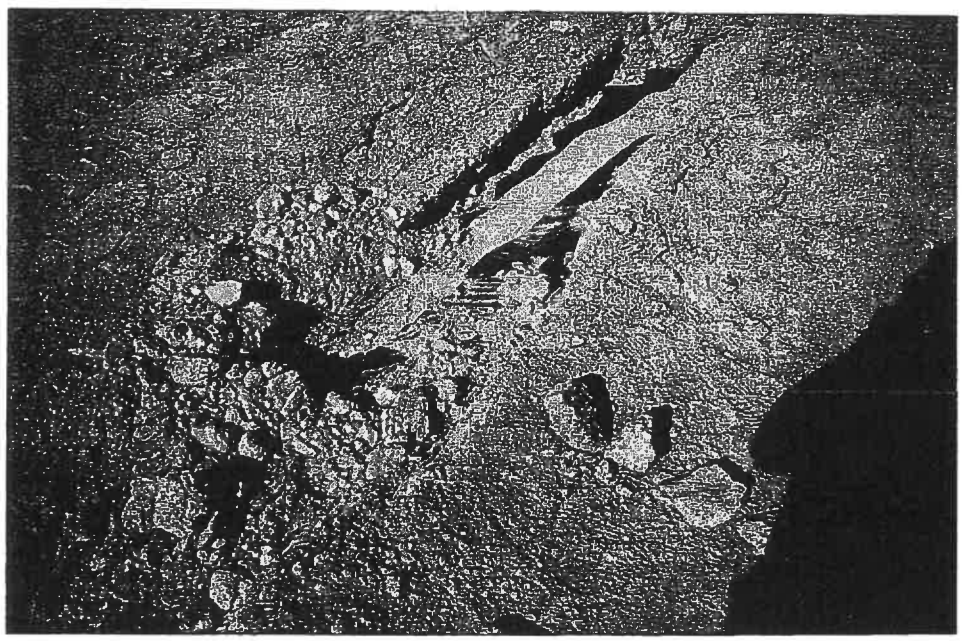

Figure 12 - Geomembrane Tear at anchor trench

SUMMARY

Anchorage construction is a small detail that is often left forgotten or receives little attention. While the emphasis is placed on retaining the geomembrane during construction, improper construction may have long term impacts. The emphasis must be placed on long-term performance and reducing the potential for tearing in the geomembrane even at the cost of potential of slippage or pull-out during construction. The seemingly least significant problem discussed in the case studies, that of a small tear near the anchor trench, proved to be the most costly because it occurred after refuse was placed

Although current design methods may be oversimplified, they seem to be sufficient to support anchor trench design. The few problems with anchorages that the author is familiar with can be explained with current design methods and prevented. More important than using sophisticated design equations, are establishing the basic premise (preventing tearing) and obtaining accurate design parameters, especially interface strengths.

RECOMMENDATIONS

The following recommendations are made for anchor trench design:

- Various types of anchorages may be used depending on site conditions
- Allow for geomembrane pull-out or slippage before tearing of the geomembrane
- If possible, provide a slip plane and a "stress-free" geomembrane
- Carefully evaluate parameters, especially interface and geomembrane strengths
- Construct the anchor trench as designed including:

    preventing erosion of backfill

    insuring backfill is placed in a timely manner

    insuring anchorage is not overbackfilled or the geomembrane is not extended too far

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